INTRODUCING NEW USES OF DRY PEAS, LENTILS, AND CHICKPEAS TO THE U.S. FOOD INDUSTRY WITH EDUCATIONAL WORKSHOPS AND TECHNICAL DEMONSTRATIONS FY 2008

US farmers harvest ~2.6 million pounds of dry peas, lentils, and chickpeas each year. Nearly 75% is exported whereas domestic market consumption has remained fairly stagnant for over 20 years. Several years ago, the pea and lentil industry embarked on a major product development initiative to explore the use of dry peas, lentils, and chickpeas as ingredients in high-value food products. Moving more of these commodities into the domestic market would create new markets while decreasing grower and processor transportation costs significantly.

This project represents Phase 2 of an initiative to introduce the concept to US food manufacturers of using dry peas, lentils, and chickpeas as ingredients to create a wide range of new high value foods that have not traditionally contained legumes such as biscuits, cookies, beverages, tortillas, nutrition/power/energy bars, dry starch mixes, flatbreads, pizza crusts, vegetarian spreads, and sauces. In Phase 1, key food industry professionals were reached at selected trade shows; additional technical research was conducted on the physical, chemical, and functional properties of the products; the technical research needs of R&D professionals were assessed; and work began to compile a comprehensive technical manual to guide product development specialists, nutritionists, and other food industry professionals in utilizing these new products.

In Phase 2, the Washington Dry Pea and Lentil Commission (WDPLC) hosted an educational session at the Institute of Food Technologists Annual Meeting and Food Expo in June 2009 that attracted over 40 attendees who learned about nutritional attributes and health benefits, use and functional properties of legumes as ingredients, and potential new applications in value-added products. In August 2009, WDPLC sponsored an intensive 2-day hands-on workshop and educational session at the Culinary Institute of America, Greystone, Napa Valley, California, where 29 research chefs and food scientists from Fortune 500 consumer packaged goods firms and from some of the world's largest food service companies received an expanded version of the educational session and gained first-hand experience cooking and baking a host of products using the ingredients. The program was well-received and will hopefully prove to be a catalyst for commercial product development.

Final Report
Processing Information and Technical Manual
Culinary Institute of America course, including YouTube video

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Introducing New Uses of Dry Peas, Lentils and Chickpeas to the US Food Industry with Educational Workshops and Technical Demonstrations

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The Washington Dry Pea & Lentil Commission was established in 1965 as a group of growers, processors, and traders of Washington grown dry peas, lentils, and chickpeas. The aim of the Washington Dry Pea & Lentil Commission is the advancement, protection, and development of the common interests of those Washingtonians engaged in growing, warehousing, processing, merchandising, peas and lentils, and related activities.

FINAL Report
Submitted by Jennifer L. William
December 31, 2009

Introduction

The Washington Dry Pea & Lentil Commission (WDPLC) would like to thank the USDA Federal State Marketing Improvement Program for awarding funds to support the dry pea and lentil industry of Washington State and its marketing efforts. This final report will summarize the activities that have been performed and the milestones achieved for each objective or sub-element of the narrative.

Marketing Issue

US farmers now harvest ~2.6 million pounds of dry peas, lentils, and chickpeas each year. Production of dry peas, lentils, and chickpeas (DPLCs) has been increasing, with nearly 75% being exported to countries around the world. Domestic market consumption has remained fairly stagnant for over 20 years. Growers have been anticipating economic growth in the US market for quite some time. Moving more DPLCs into the domestic market would decrease grower and processor transportation costs significantly.

In the last year, the pea and lentil industry has taken a new initiative to invest in the development of the domestic food market. New ingredient applications for dry peas, lentils, and chickpeas have been explored through a major new product development initiative. The Washington Dry Pea & Lentil Commission retained the services of a private product development group in January 2006. With their depth of experience, wealth of knowledge in food technology, cutting-edge use of market research tools and culinary skills, this group developed product formulations for twenty-five new value-added foods.

All of these foods are innovative, appeal to mass market players in the food industry, and offer a unique set of nutritional benefits to consumers. Most importantly, they are all made with dry peas, lentils, and chickpeas in the form of flours, flakes, purées, extrudes, etc. Because dry peas, lentils, and chickpeas have never been used in these types of applications, food manufacturers are 1) unaware of these new product applications and 2) uneducated about how to technically incorporate them into their processes as ingredients. Additionally, these products were developed as "bench-top" products with formulations that must be scaled up and processed on commercial-sized equipment.

Problems, Barriers and/or Challenges

The WDPLC has formulations for developed products made with US dry peas, lentils, and chickpeas in a wide range of new high value foods that have not traditionally contained legumes as raw materials. These foods include *biscuits*, *cookies*, *beverages*, *tortillas*, *nutrition/power/energy bars*, *dry starch mixes*, *flatbreads*, *pizza crusts*, *vegetarian spreads*, *sauces, etc.* The limited introduction of these products to food industry professionals at trade shows across the country has created a stir of interest among some value-added producers in the marketplace. Feedback about taste and texture of these products has been very positive.

Food manufacturers envision great potential for dry peas, lentils, and chickpeas as new functional ingredients. Food industry professionals are also keenly interested in more information about these new products. The WDPLC is receiving an increasing number of

requests for technical and nutritional information about these new products that will aid food processors in evaluating the potential for these new products in the market.

Opportunities and Potential Economic Impact

Thus far, FSMIP funds granted in September 2007 have been used by the Washington Dry Pea & Lentil Commission to 1) showcase the products at various trade shows across the country, 2) provide a snap-shot of information and reference materials to interested value-added producers, 3) allow for travel to food manufacturers requesting assistance with product trials and 4) begin writing, editing, and distributing the "USA Dry Peas, Lentils, and Chickpeas: Technical Data and Product Development Manual."

FSMIP funds granted in September 2008 afforded the WDPLC the opportunity to build upon the Commission's previous grant objectives. The WDPLC targeted and educated a specific audience in the food industry to include product development specialists, nutritionists, and food marketing professionals. The Commission designed a two-day course introducing new applications for dry peas, lentils, and chickpeas along with technical demonstrations of each process. In addition, the course provided information about how dry peas, lentils, and chickpeas as ingredients, function and enhance the nutritional value of foods.

This course presented key technical information such as product formulations, process flows, DPLC nutrition, and other details of new and traditional high value foods that utilize peas, lentils, and chickpeas as raw materials. The course was the perfect mechanism for the WDPLC to present the product research conducted with 2007 FSMIP grant funds to an audience of food industry professionals. The WDPLC focused on promoting the course to key food industry professionals in high priority and strategic US markets for the industry.

This project has supported the US dry pea and lentil industry in its efforts to explore new market opportunities for US agricultural products and negate some of the transportation costs to growers and processors of DPLCs in the states of Washington, Idaho, Oregon, North Dakota, South Dakota, and Montana. This course also supported the Washington Dry Pea & Lentil Commission's long term collaboration with the US rice and wheat industries, as many of these new products contain wheat and rice ingredients as well.

As stated in the original 2008 grant proposal, the WDPLC sought to achieve the following goal and objective:

Goal: The Washington Dry Pea & Lentil Commission will increase the usage of dry peas, lentils, and chickpeas in various forms as an ingredient in a variety of value-added food products.

Sole Objective: To **EDUCATE** the food industry of the *benefits* of legumes:

1. **Nutritional Attributes** – Dry peas, lentils, and chickpeas are low in sodium, fat, and cholesterol-free. They also provide a significant amount of folate, essential vitamins, and minerals.
2. **Health Benefits** – Can help reduce the risk of a variety of health problems such as obesity, heart disease, cancer and diabetes. Folate decreases the risk of neural tube defects (NTD) - most commonly spina bifida and anencephaly - in infants.

3. **Functional Properties** – Dry peas, lentils, and chickpeas, as ingredients, have unique properties that function to improve not only the nutritional quality of conventional foods but also texture, absorption, gelling of food systems.
4. **Innovation in Product Development** – Increased consumption of dry peas, lentils, and chickpeas will only be stimulated by educating the food industry of the new applications associated with using legumes.

Scope: Education of key food industry professionals in high priority and strategic markets for the Washington Dry Pea & Lentil Commission.

Timeframe: Initiate in September 2008 and complete by September 2009

As described in the work plan, the WDPLC would **EDUCATE** members of the food industry; teaching food scientists, product developers, chefs, research and development scientists and others how to apply dry peas, lentils, and chickpeas as ingredients in value-added foods. It would be accomplished with the careful ***planning***, ***promotion***, and ***execution*** of an intensive two-day course on legumes. The Commission is committed to educating food manufacturers about the attributes of DPLCs as ingredients with effective educational activities.

Planning – Each year, there are several trade shows driven by food research, food marketing, and nutrition. Three shows in particular, attract the Commission's specific audience for the course which includes product development specialists, nutritionists, and other food marketing professionals. The Commission had hoped to plan the courses either two days prior or two days following the trade shows below:

Trade Show	Dates	Location
Food Marketing Institute Show **(FMI)**	May 10-13, 2009	Las Vegas, NV
Institute of Food Technologists Annual Meeting & Expo **(IFT)**	June 6-10, 2009	Anaheim, CA
American Dietetic Association Food & Nutrition Conference Expo **(ADA)**	October 17-20, 2009	Denver, CO

For the convenience of the participants and to maximize the course attendance, the Commission initially planned to schedule the course for the 1st full day after the last day of each trade show listed above. However, an unusual development occurred and a different plan had to be adopted.

As the course planning began, reserving venues in close proximity to any of the above shows became practically impossible. The Commission first contacted the Anaheim Convention Center where the IFT show would be taking place, to see if rooms could be reserved for the course just following the show. The Convention Center stated that it had signed a contract with the Institute of Food Technologists, mandating that the Convention Center not reserve any of their convention center space to a competing food-themed event (no matter the size) 45 days prior to or 30 days after IFT.

Hotels in the Anaheim area were also called to determine if meeting spaces could be reserved at their sites before or after IFT and access to space was denied. The same contracts were put in place for the FMI Show and the ADA Conference. The Commission was forced to a) adjust its planning direction and b) formulate a new strategy for how to promote the course and

effectively attract the target audience to the course. Hosting three separate courses as originally proposed was no longer an option. Therefore, the Commission decided to host just one full course at one venue and focus on promoting the course through the most appropriate tradeshow.

The Commission consulted professors of food science and nutrition to get their thoughts on the ideal format for the course targeted at food industry professionals. Suggestions were made to facilitate the course as a hands-on group workshop at either a product development lab or culinary school facility. This would give the attendees the opportunity to observe, touch and taste the products as they are being made.

The Commission structured the course to include a blend of discussion, demonstrations and hands-on participation. The course participants would hear from the experts and then train with instructors in the kitchen. The Commission's hope is that they would receive the key message that dry peas, lentils, chickpeas, and their flours offer added-value as ingredients. As a result, they would be inspired to create new food products and develop new menu items at their respective companies.

Initially, Kendall College in Chicago, IL appeared to be the best venue for the course for a few different reasons. Kendall College is a state of the art facility, previously owned by Sara Lee, Inc. Chicago is thought to be a very convenient hub for travelers as there are two major airports that can be easily accessed. There are also several major food companies right in the Chicagoland area including Kraft Foods, McDonalds, ConAgra Foods, Sara Lee, PepsiCo and ADM. After extensive correspondence with administrators at Kendall College, the Commission found that the college was very limited in kitchen space for the hands-on workshops. Kendall also could not offer the Commission open dates that would be convenient to the potential participants or dates within the proposed timeframe for the grant.

The Commission decided to host the educational course at the Culinary Institute of America (CIA) at Greystone in St. Helena, CA for several reasons:

1. CIA has widespread recognition as the leader in culinary education for the food industry
2. CIA would assist the Commission with organizing a customized-program at their facility
3. CIA would provide Chef Instructors to facilitate hands-on workshops
4. CIA would allow the Commission to host the course featuring hot food and bakery items
5. CIA would provide binder course books with course curriculum dictated by Commission

The Commission entered into a contract with the CIA, a not-for-profit educational institution on May 27, 2009 with the agreed upon course date of August 27-28, 2009. The CIA agreed to provide one- 2-day program for up to 36 participants. With the date set and a preliminary program drafted that would meet the educational goals and objectives of the Commission, a strong promotion plan was put in place.

Promotion – By carrying out effective marketing and promotional activities, the Commission aimed to increase the awareness of the course. The activities would also attract registered participants from the top food companies and foodservice entities. The Commission set in motion a 4-step strategic promotion plan to attract members of the target audience and maximize the number of course participants.

1. **Direct marketing at trade show and forum**
    i. Educational Session Host
    ii. Food Expo Exhibitor
    iii. Attendee List Recipient
2. **Targeted direct mail invitations**
3. **Trade publications ads**
4. **Online advertising and event calendar listings**
5. **Website designed for potential attendees to apply for registration on-line**

The Commission decided to take full advantage of the marketing pull of the Institute of Food Technologists, a nonprofit scientific society with 22,000 members working in food science, food technology, and related professions in industry, academia, and government. IFT publishes various resources for the food industry, including Food Technology and the Journal of Food Science. IFT also hosts the world's largest annual convention on food grown, processed, manufactured, distributed, and eaten worldwide.

The IFT Annual Meeting & Food Expo attracts professionals involved in both the science and the business of food - experts from around the world from industry, academia, and government. Attendees come to learn about the very latest trends, the newest products, and the most recent scientific innovations...like new applications for dry peas, lentils, and chickpeas. By using the Institute of Food Technologists (IFT) Annual Meeting & Food Expo as a venue for course promotion, the Commission would have direct access to the decision makers working within research and development (R&D) of large food manufacturers and the foodservice industry.

IFT Annual Meeting – WDPLC Hosts Educational Session

Every year, IFT accepts proposals for educational sessions during the conference. The 2009 convention theme was "Food Science from Producer to Consumer." A proposal was submitted on behalf of the Commission entitled, *"Dry Peas, Lentils, and Chickpeas Are NOT Just for Soups Anymore! Explore New Applications for Legumes and Legume Flour."* The session was approved by IFT and the Commission was allotted a superb time slot on the first day of the convention. The educational session took place on June 7, 2009 1:30 pm – 3:00 pm. The Commission asked the following speakers to present on the following topics at the educational session pertaining to dry peas, lentils, chickpeas and their flours:

Presentation Title	Presenter/Speaker	Title	Company/Organization
Nutritional Attributes & Health Benefits	Kathleen Zelman, MS, RD	Director	WebMD
Innovation with Legumes As Ingredients	Chris Wolf, MBA	Director of Strategic Innovations	Turover Straus Group
Functional Properties and New Applications	Mehmet C. Tulbek, PhD	Technical Director	Northern Crops Institute

The educational session attracted over forty attendees. Kathleen Zelman, the Nutritional Director for WebMD and a member of the Board of Directors of the American Dietetic Association focused her presentation on nutritional benefits, ease of increasing per-capita pulse

consumption and creating better understanding of the place of pulses in the Food Pyramid scheme.

She was followed by Chris Wolf, Director of Strategic Innovation at Turover-Straus Group. Chris has worked with the USADPLC on product development for a few years, and he spoke about consumer perceptions and attitudes and the 'product platforms' that use cool season pulses in foods that consumers will desire including flatbreads, spreads, and snacks.

Dr. Mehmet Tulbek of Northern Crops Institute was the final speaker, and he dealt with the processes for creating value-added products using cool season pulses including milling, quality and pulse flour functionality. He discussed various products including pasta, extruded snacks, and baked products. The Q & A period showed that we had captured the interest of our audience, and many attendees stayed behind to ask additional one-on-one questions of the panelists.

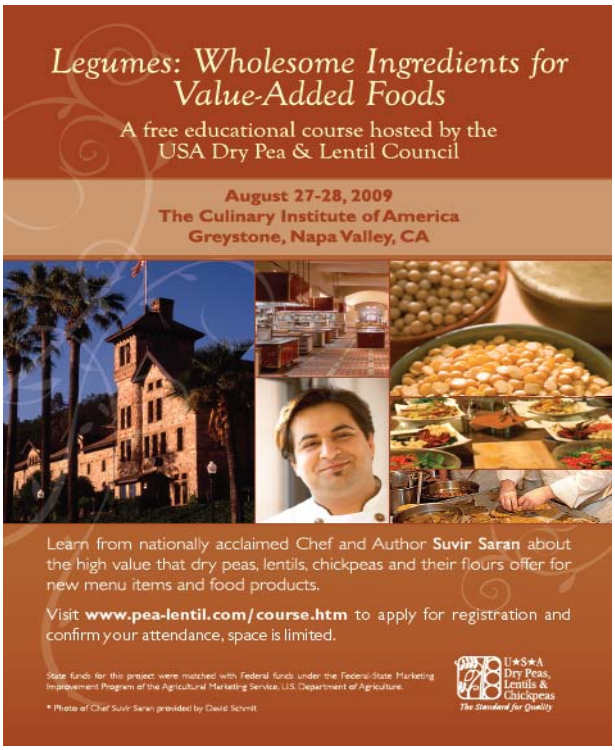
The Commission used the session to give the audience a taste of what they would learn if they chose to attend the full-out course/workshop which would take place **August 27-28, 2009**! Nearly 45 conference attendees joined the IFT educational session on dry peas, lentils, and chickpeas hosted by the Commission. Each session attendee also received a save-the-date card for the course (Figure 1 - p. 9). The session at IFT prove to be a perfect event for promoting the full course, entitled *Legumes: Wholesome Ingredients for Value-Added Foods*.

IFT Annual Meeting – WDPLC Exhibits the Food Expo

Additionally, the Commission participated as an exhibitor of the Food Expo component of the IFT convention in Anaheim. The show attracts thousands of food technologists, R &D staff and marketing managers including many international attendees. The Commission booth was staffed by Jennifer William, Kaye Effertz, Marketing Director NPGA, Cindy Cox of Premier Pulses, Naggie Jeradechachai of the Northern Crops Institute at North Dakota State University, and Peter Klaiber, WDPLC Director of Marketing. The booth theme was the use of processed pulse products – flours, grits, and dehydrated flakes – in high volume value-added applications.

The slowdown in the global economy was evident at the show with about 800 exhibitors on hand vs. over 1,000 exhibitors in previous years. Foot traffic was good at the show and a number of companies that were not exhibiting did attend and stop by the booth. With three additional industry members available to staff the booth, Jennifer William was able to walk the entire show over the course of two days, stopping to visit with any company that might have an interest in legumes for value-added applications and distributing save-the-date cards.

Figure 1. **Legumes:** *Wholesome Ingredients for Value Added-Foods* Course Save-the-Date Card (Front/Back)



IFT Annual Meeting – WDPLC Retrieves Electronic Leads / Attendee List Access

As an exhibitor of the Food Expo and host of the educational session, the Commission gained access to the entire conference attendee list which included contact information for the over 14,500 conference attendees. A number of leads were also developed from booth visits. The WDPLC staff filtered the contact list to identify those individuals that fit the profile of the target audience for the course, resulting in the top 500 preferred contacts to invite.

This list included product development scientists, R&D scientists, research chefs, food scientists, and chefs employed with food and foodservice companies from across the country. The Commission was able to expand the list of invitees to nearly 600 with an additional 100 contacts from previous tradeshows / health shows that the Commission was able to exhibit with support from FSMIP grant funds in FY 07-08. The Commission immediately pursued prospective course registrants by mailing a personal invitation (Figure 2 – p. 11) to each invitee.

Trade Magazines/Online Event Calendars

Invitations were sent to the following trade magazine offices. Course details were also posted on the online event calendars for the following magazines:

Chain Leader	Culinology
Food & Beverage	Food Arts
Food Processing	Food Product Design
Food Technology	Frozen Food Age
Prepared Foods QSR	

Figure 2. **Legumes:** *Wholesome Ingredients for Value Added-Foods* Course Invitation

Legumes: Wholesome Ingredients for Value-Added Foods

A free educational course hosted by the USA Dry Pea & Lentil Council

August 27-28, 2009
The Culinary Institute of America
Greystone, Napa Valley, CA

Learn from nationally acclaimed Chef and Author **Suvir Saran** about the "healthy magic" that lies within dry peas, lentils and chickpeas for the creation of new recipes and food products.

Through a blend of discussion, demonstrations and hands-on participation, attendees will learn the high value that dry peas, lentils, chickpeas and flours from each offer for new menu items and food products.

In addition, industry experts on nutrition, food processing, extrusion, and baking will be leading the discussions on utilizing dry peas, lentils, and chickpeas as ingredients.

Course registration, ground transportation and lodging provided by the USA Dry Pea & Lentil Council. Visit **www.pea-lentil.com/course.htm** to apply for registration and confirm your attendance, space is limited.

State funds for this project were matched with Federal funds under the Federal-State Marketing Improvement Program of the Agricultural Marketing Service, U.S. Department of Agriculture.

U★S★A Dry Peas, Lentils & Chickpeas
The Standard for Quality

* Photo of Chef Suvir Saran provided by David Schmit

Website Design

WDPLC Communications Manager, Erica Beck designed a website to feature information about the course, allow the prospective course attendees to review the tentative agenda (http://www.pea-lentil.com/pdfs/CourseAgenda.pdf) and apply for course registration (http://www.pea-lentil.com/course.htm).

Target Audience:

Since the course was limited to 36 total participants, the Commission formulated a strategy that would ensure that all of the participants were decision makers within R&D departments of large food manufacturers and food service entities. All individuals interested in registering for the course, had to apply and be granted a seat in the course.

Process for Applicant Screening:

Applications would be accepted online through the course registration web page (http://www.pea-lentil.com/course.htm) or via downloadable application form (http://www.pea-lentil.com/pdfs/Course%20Form.pdf) that could be faxed or e-mailed to the WDPLC office.

Food Marketing Manager, Jennifer William screened all applicants for the course, reviewing answers to several detailed questions pertaining to the types of products their companies developed that could incorporate legumes. The Commission was interested in filling the course with individuals that were committed to utilizing pulses/legumes as ingredients in various applications. Responses were used to gauge which applicants were truly interested in learning about what legumes offer. Tailoring the content of the course to the attending participants, would most likely result in the successful development of future products.

Jennifer would contact all applicants within 5 business days after receiving the completed applications. They were informed of their status of acceptance, denied, or wait-listed (the waiting list option offers the Council more time to assess the quality of other applicants). Once notified of their acceptance into the course, the applicant was asked to provide their flight itinerary or other travel plans so that ground transportation and hotel reservations could be arranged. Applicants on the waiting list for the course were notified by Monday August, 3, 2009 if there was space for them to attend the course.

The verbiage below was copied from the course website:

Thank you for your interest in attending the first-ever educational course hosted by the Washington Dry Pea & Lentil Commission!

Legumes: *Wholesome Ingredients for Value-Added Foods*

The pea and lentil industry has been working on new product applications for dry peas, lentils and chickpeas, and flours derived from each that we're excited to share with you. For example, these products can be used in traditional applications like hummus and soups, but they can also be included in roasted or fried snacks, nutrition bars, and even baked goods and beverages.

Since this course will cover applications for new food products for food manufacturers as well as menu items for large-scale restaurant chains, we expect a high interest for the 36 available spots. Course registration, ground transportation and lodging will be provided by the Washington Dry Pea & Lentil Commission therefore we're asking you to please complete a few questions to apply for attendance at the course.

Participants will have to cover their own airfare (if applicable) and airport transfers to/ from St. Helena, Calif., but the USA Dry Pea & Lentil Council will be providing lodging for 2 nights, ground transportation between the hotel and the CIA, and lunches and dinners.

We'll contact you within 7-10 business days of receiving your application to let you know if you have been accepted to attend. Registration for the course closes ***August 12, 2009****.*

Please don't hesitate to contact us if you have any questions!

Jennifer William, Food Marketing Manager
Email: jwilliam@pea-lentil.com
Phone: 208.882.3023

Course Application

Contact Information

First Name: _____
Last Name: _____
Address: _____
City:_____ State/Country: _____
Zip Code:_____
Email: _____
Tel. #: _____
Fax #: _____

Company Information

Company Name:
Company Website:
Job Title:

- ☐ Corporate Executive Chef
- ☐ Research Chef
- ☐ R&D, Test Kitchen Chef
- ☐ Product Development Chef
- ☐ Innovation Director
- ☐ Director of Research/Technical Director
- ☐ Chemist/Flavorist
- ☐ Food Scientist/Technologist/Engineer
- ☐ Nutrition Specialist
- ☐ Other R&D/Scientific/Technical:

Registration Questions

1) Please share with us any products you are working on that could include dry peas, lentils and chickpeas or flours derived from each.

2) What questions do you have about dry peas, lentils and chickpeas, or flours derived from each?

3) Are there any challenges or issues you've experienced in the past in working with dry peas, lentils and chickpeas, or these flours?

4) What types of health attributes are you creating new items around?
   - ☐ Gluten Free
   - ☐ High Fiber
   - ☐ Low Glycemic Index/Glycemic load
   - ☐ Resistant Starch
   - ☐ Other:

5) What consumer demands are you trying to respond to with new items?
   - ☐ Gluten free
   - ☐ High fiber
   - ☐ Low glycemic index/glycemic load
   - ☐ Low cost
   - ☐ Resistant starch
   - ☐ Vegetarian
   - ☐ Other:

6) How did you hear about the course?
   - ☐ Educational session/exhibit at Institute of Food Technologists (IFT) Annual Meeting
   - ☐ From a colleague
   - ☐ From a website (please name):
   - ☐ From a trade publication (please name):
   - ☐ Other:

Applicants and Confirmed Attendees

The Commission was pleased to receive applications from food scientist and research chefs from Fortune 500 consumer packaged goods (CPG) firms in the food industry as well as some of the largest foodservice companies in the world (see company logos). The chart below lists details about the number of applications and final attendees.

Total Applications Received	**41**
Total Applicants Accepted	38
Total Applicants Denied	3
Total Canceled/Did Not Show	9
Total Attended	29

Execution – Food Marketing Manager, Jennifer William directed the project with the aid of the Commission staff, the CIA staff, speakers, guest chefs, chef instructors, and industry members. The Commission collaborated with the Northern Crops Institute of North Dakota State University and the Culinary Institute of America to provide experts and lab technicians for the course. They assisted in both teaching and demonstrating during the course.

After months of preparation and planning, the Commission hosted its first-ever product development course specifically targeting the US retail and food services industries. It took place in beautiful, Napa Valley, CA at the Culinary Institute of America (CIA) Greystone Campus, August 27-28, 2009.

The 1.5 day, private, invite–and-application-only course was designed to educate the participants through a blend of discussion, presentations from leading experts on pulses, chef demonstrations, and hands-on kitchen sessions. The goals of the course were to educate targeted members of the food industry and increase their working knowledge of dry peas, lentils, and chickpeas as ingredients.

At the start of the program, the participants were extended a heartfelt welcome by Jennifer L. William, Food Marketing Manager and Greg Drescher, CIA Executive Director of Strategic Initiatives. Food Scientists and Product Developers from the Kellogg Company, Mars Food US, General Mills and Birds Eye Foods gathered in the 1st floor Ecolab Theater to learn how to incorporate legumes as wholesome ingredients in value-added foods. Corporate Executive Chefs from the most successful foodservice providers, like J.R. Simplot and HEB worked together in teams in the hands-on kitchen sessions developing soups, sauces, and entrees that they might add to their menu of offerings. R&D Scientists from the largest international ingredient suppliers, ADM and Cargill, worked side-by-side looking at the performance of pulse flours in gluten-free breads as well as fiber/protein enriched cookies, crackers, muffins and bars.

With a great line-up of speakers and chefs, the participants were fully-engaged. **The course agenda and speaker/chef bios can be found in Appendix A and Appendix B of this report.** On Day1, Chris Wolf of the Turover Straus Group began with a dynamic in-depth talk about the specific marketing opportunities for DPLCs as ingredients, in his presentation entitled *Giving Consumers More of What They Want: Convenient, Affordable, Nutritious, and Flavorful Pulse Products*. Amy Myrdal-Miller, MS, RD immediately followed with her presentation on the *Top 10 Reasons to Use Dry Peas, Lentils, and Chickpeas in Menu R&D & Product Innovation*, honing in on specific nutritional benefits of pulses as ingredients.

On Day 2, Dr. Mehmet Tulbek, an expert on pulse flour utilization, spoke to the class about the *Flour Functionality in Food Systems, Pulse Flour Milling Processes and Commercial Product Applications for DPLCs*. Certified Master Baker, Chef Richard Coppedge spoke to the class about gluten-free baking with lentil and pea flour. He was very impressed with the performance of the pulse flours in gluten-free baked goods and relayed that information to the participants as he conducted his demonstrations. USDA-ARS Research Scientist, Dr. Jose De J

Berrios, spoke about the use of *Gluten-free Expanded Lentil Snacks as Ingredients* in cereal bar applications that he has developed with the support of the USA Dry Pea & Lentil Council. **All speaker presentations can be accessed by *double-clicking the Adobe Document images* in Appendix C of this report.**

Between lectures, Guest Chef Suvir Saran and other top chefs from the CIA demonstrated healthful recipes using pulses (dry peas, lentils, and chickpeas), pulse flakes and pulse flours in savory dishes and baking applications. In addition to chef demonstrations, participants were able to gain hands-on experience cooking and baking with pulses in the CIA kitchens. A number of recipes were prepared by the group which included culinary dishes such as grilled fish and meat dishes, soups and stews, salsas, chutneys, salads, etc. Baked goods were also prepared which included breads, biscuits, pie dough, apple cinnamon cereal bars, etc. All food produced by the participants was served as appetizers, lunch and dinner throughout the duration of the course.

The teamwork environment was enjoyed by participants and industry members alike. The participants worked in teams and nearly 75 different recipes and formulations were cooked, tasted, and evaluated in the kitchen over the duration of the course. Interactive kitchen sessions allowed participants to create delicious food and work directly with pulses as ingredients. Many of the participants provided testimonial by video showing their eagerness to take what they have learned back to their company's product development team.

Results

Overall, this activity proved to be a phenomenal success for the US pea and lentil industry. The participants were vocally enthusiastic about the use of dry peas, lentils, and chickpeas in their future research and development efforts. In addition to the positive feedback expressed to Jennifer from the participants and other industry members in attendance, the chefs of the CIA showed great excitement about new uses/applications for peas and lentils. Chefs Richard Coppedge and Stephen Durfee were impressed with the performance of the pea flour in baking application and the flavor attributes. Chef Almir DaFonseca thought that the pulse flakes had enormous potential for use as coatings in fish, meat, and vegetable products. He suggested that the flakes would make a great coating for chicken nuggets, the most popular food among children by far.

The participants went home with a 150-page course curriculum binder that included all of the recipes (**see Appendix E for a select recipe**) and formulations used in the course as well as a supplier's guide with contact info for sourcing legumes. Now that the "**USA Dry Peas Lentils and Chickpeas**: *Processing Information and Technical Manual*" has been completed (hard copy/electronic version included in this report), it will be published and distributed to all registered attendees by mail in mid-January 2010. This manual will enhance the information presented in the course.

Evaluation Forms, Course Effectiveness, and Post-Course Follow-up

The participants were asked to fill out an evaluation form in order to gather feedback and assess the effectiveness of the course. **The evaluation form can be found in Appendix D of this report.** Seventeen forms were returned to the Commission and the scores and comments were tabulated (Please see attached excel file). The course feedback was incredible!

1. **100%** of the participants who evaluated the course on Day 1 and Day 2 **agreed** or **strongly agreed** that the sessions met their expectations, was well organized/prepared, were clear/understandable, and helped them better understand how to use dry peas, lentils, chickpeas and their flours as ingredients.

2. When participants were asked to rate their knowledge about dry peas, lentils, and chickpeas as ingredients coming into the course and having now completed the course, **88% of the participants increased their knowledge** from somewhat knowledgeable to very or extremely knowledgeable.

3. 82% of the participants responded that it would be **extremely likely** or **very likely** that they would incorporate dry peas, lentils and chickpeas as ingredients in new products, a current value-added product line, an ingredient offering, or a new foodservice menu item.

Below are some of the participant's comments about the ***strengths*** and ***weaknesses*** of the course:

It was a great course with a diverse group of attendees, which also made it interesting. And the speakers truly showed their passion for the subject at hand. Thanks for the invite.

Great course, great group! CIA Team was great and the over organization and coordination was well handled.

Strengths-well organized, different perspectives, great hand-on training with experienced chefs.
Weakness- too short :)

Nice balance of hands-on and lecture.
I would like to get more time with the chef presentations.
In the course, we did not get enough time to see everything.

Strengths- very well organized, very knowledgeable!
Weakness- not much that I can even think of. Great job Jennifer!!

Having PowerPoint print-outs of all presentations are always very helpful.

Strengths- very good speakers and chefs very knowledgeable.

Chef Saran is very funny but did not let the other chef talk.
It was not his presentation and he was on stage still. Not everything is Indian!

It was a very strong from a culinary perspective. My anticipation and hopeful expectations of the course was more driven by the actual type of project work I'm doing, which is to find novel snack applications. For instance, the talk on extrusion was interesting, but it's all been done before. My predicament is that I won't know what I'm looking for until I find it.

Excellent dishes! Excellent opportunity to meet suppliers! Too much food!

Overall, pretty good.

I would like to have had a featured chef that preached less ethnicity and American health negativity. In making the product more mainstream, an American focus on product development would have been beneficial.

The results from the evaluation forms and comments expressed to WDPLC Staff on-site and in the video footage clearly show how effective the course really was. Marketing Manager, Jennifer L William followed-up with all course participants to assess any progress being made with the development of new foods. She was overjoyed to find that 90% of the participants were

currently working on at least one project at their company where they are incorporating dry peas, lentils, and/or chickpeas as ingredients. Eight of the products are listed in the table below:

"Bacon chipotle" "BBQ" flavored fried pea snacks	**High protein breakfast cereal and cereal bar**
Tortilla chips and high fiber/protein cracker	Frozen ready-to-eat meals with lentils
New line of chickpea powder and lentil powder forthcoming	**Smoothie type beverage with pea protein**
Recent new launch of a split pea soup as a refrigerated deli item	IQF multi-grain lentils/chickpea blend

Possible Drawbacks and Lessons Learned

Like any 1st time event, there it always room for improvement. The 1.5 day course covered a broad array of applications with foods developed in two different kitchens (baking/hot). There were specific topics that did not get covered in-depth, like the US varieties of lentils and information on sourcing could have been better covered. There could have been a discussion included about the functional abilities of dry peas, lentils, and chickpeas as isolated ingredients. Additionally, the course may have needed to cover more about processing effects on legumes nutritional and functional properties.

Availability, ingredient cost, cost reduction, and substitution of legumes at various levels may have been desired topics that weren't covered. Some of the participants felt that the hot food items were too ethnically polarizing. Instead of having an ethnic slant toward Mediterranean and Indian cuisines, the course really should have taught them how to incorporate legumes into the food enjoyed by the average American's palette. Some participants loved the interaction with their fellow participants in teams where as others would have liked more technical demonstrations and interactions with the experts.

Conclusions

With the onset of obesity, heart disease, and diabetes in the United States, food companies are developing more and more healthier-for-you products that will make American feel good about what they eat. Food scientists are discovering that pulses/legumes are highly functional ingredients that can make their new products both delicious and nutritious. Consumers are showing greater interest in eating a more balanced diet and controlling their total daily caloric intake to fight obesity and maintain a healthier weight.

The response from the food and beverage industry has been the introduction of alternative snacks and baked goods designed to control "satiation". Satiation is the process that promotes meal termination and there are ways to stimulate it. Among the most popular ways is with added fiber and protein, two nutrients that dry peas and lentils are loaded with. The course highlighted the nutritional value of peas and lentils and how they can contribute to food product formulations that address growing concerns about digestive and cardiovascular health as well as weight control and diabetes.

Food scientists from the top snack/cereal manufacturers in the US, corporate executive chefs from the most successful foodservice providers, R&D scientists from the largest international ingredient suppliers and nutritionists from some of the most cutting-edge,

innovative start-up companies were participants of the course. Nearly 30 participants traveled from near and far to learn about three specific legumes; dry peas, lentils, and chickpeas.

The fact that these individuals applied for a seat in the course and that their companies arranged and paid for their travel to attend, tells the pea and lentil industry two things; 1) there is a strong opportunity for growth in the US market for our products. 2) Future success is eminent as long as our industry continues to seize opportunities like this course to provide education and support the real innovators of the food industry. Our goal is to increase the usage of dry peas, lentils, and chickpeas in various forms as an ingredient in a variety of value-added food products. The Washington Dry Pea & Lentil Commission executed an impactful educational activity that brings the pea and lentil industry closer and closer to that goal.

Certainly, the delicious foods that they created and tasted during the course inspired them to go back to the bench top, the kitchen, or the pilot plant at their respective companies and enhance the products/dishes that they develop with the wholesome goodness of dry peas, lentils, and chickpeas. The Washington Dry Pea & Lentil Commission staff worked very hard with the help of the CIA to design a custom program and the participants thoroughly enjoyed the class. At the very end of the course, many participants posed the question, **“When will the next course take place?”**

The WDPLC targeted and thoroughly educated their target audience in the food industry with this program including product development specialists, nutritionists, and food marketing professionals. As written in the original proposal, the Commission designed a two-day course introducing new applications for dry peas, lentils, and chickpeas along with technical demonstrations of each process. In addition, the course provided useful information about how dry peas, lentils, and chickpeas as ingredients, function and enhance the nutritional value of foods.

Appendix A – Course Agenda

LEGUMES: Wholesome Ingredients
For Value-Added Foods
August 27-28, 2009
AGENDA

Day One: August 27, 2009

2:00 PM **Arrival**

2:15 PM **Welcome & Opening Remarks** **Ecolab Theater, 1st Floor**
Session Overview & Group Introductions
Jennifer William
Food Marketing Manager
USA Dry Peas, Lentils, & Chickpeas

2:30 PM **Giving Consumers More of What They Want:** *Convenient, Affordable, Nutritious Products*
Chris Wolf, MBA
Director of Strategic Innovation
Turover Straus Group

3:00 PM **Nutritional Value of Peas, Lentils, & Chickpeas**
Amy Myrdal Miller, MS, RD
Director of Programming, Strategic Initiatives
The Culinary Institute of America

3:30 PM **Kitchen Orientation** **Teaching Kitchen, 3rd Floor**

3:45 PM **Hands-on Culinary Session "ice breaker"**
Focus: Easy, full-flavor Appetizers incorporating Dried Peas, Lentils, and Chickpeas
The group will be broken into teams to work on a few dishes each. The CIA instructors and Guest Chef Suvir Saran will float between the teams to provide inspiration and assistance.
CIA Chef Instructor Almir DaFonseca
CIA Pastry Chef Instructor Stephen Durfee
Guest Chef Suvir Saran

5:45 PM **Appetizers and Wine Reception**
Introduce & Recognize Industry Members

6:30 PM **Dinner at Wine Spectator at Greystone Restaurant**

Day Two: August 28, 2009

6:45 AM **Bus Departs El Bonita Motel**

7:00 AM **Bus Departs Eagle & Rose Motel**

7:00 AM **Continental Breakfast Buffet** **Teaching Kitchen, 3rd Floor**

7:30 AM **Legume Flours and Their Uses** **Ecolab Theater, 1st Floor**
Mehmet Tulbek, PhD
Technical Director
Northern Crops Institute

8:15 AM **Gluten Free Baking**
Chef Richard Coppedge, MB
The Culinary Institute of America

9:15 AM **Indian Flavors**
Guest Chef Suvir Saran

9:45 AM **Concurrent Hands-on Culinary Sessions** **Teaching Kitchen, 3rd Floor**

Baking Kitchen
Guest Chef Richard Coppedge, C.M.B.
Chef Stephen Durfee

Hot Kitchen
Guest Chef Suvir Saran
CIA Chef Instructor Almir DaFonseca

12:00 PM **Lunch from Production**

1:00 PM Break at Leisure, Optional Facility Tour, and Shopping time in Spice Islands Marketplace

1:30 PM **Gluten-free expanded snacks made from lentil-fiber based formulations** **Ecolab Theater, 1st Floor**
Jose De J Berrios, PhD
National Chair-American Association of Cereal Chemists International
USDA-ARS-WRRC - Processed Foods Research Unit

1:45 PM **Afternoon Lecture/Demonstrations**
Chef Almir DaFonseca
Guest Chef Suvir Saran
Chef Stephen Durfee

3:15 PM **Concurrent Hands-on Culinary Sessions** **Teaching Kitchen, 3rd Floor**

Baking Kitchen
Guest Chef Richard Coppedge, C.M.B.
Chef Stephen Durfee

Hot Kitchen
Guest Chef Suvir Saran
CIA Chef Instructor Almir DaFonseca

5:45 PM **Wrap up, Review, & Critique**

6:00 PM **Dinner from Production**

6:30 PM **Concluding Remarks** **Ecolab Theater, 1st Floor**
Program Evaluations
Program Adjourns

Appendix B – Chef and Speaker Biographies

DR. JOSE DE J. BERRIOS has twenty-four years of combined experience in the applied and basic research fields of Food and Agriculture. He has been head of the extrusion food program at the USDA-ARS-Western Regional Research Center for eleven years, conducting experiments and developing processes and formulations to increase legume utilization through the manufacture of new value-added extruded foods and food products with optimized nutritional and functional properties and desirable sensory attributes. He has authored and co-authored 55 publications, including book chapters, patents and abstracts. He has also been a reviewer for 14 major national and international journals and an invited speaker to more than 100 international and national conferences and symposia.

He serves as Adviser to and Collaborator to the following organizations;

- U.S.A. Dry Pea and Lentil Council, developing new value-added extruded food products, from dry peas, lentils and chickpeas;
- Pulse Innovation Project of Canada: working under the Whole Pulse Expert Advisory Committee;
- Several U.S. and International companies on R&D projects dealing with utilization of legume pulses
- National School Food Program (Programa Nacional de Colacion Escolar), a social program supported by the Ecuadorian Government
- United Nations Organization through the World Food Program (WFP).
- Collaborator for various research projects with national grower associations, private industry and scientists at the Food Science and Engineering Departments of the University of California, Davis, Washington State University, Pullman, WA; CA; Kansas State University, Manhattan, KS; the Universidad Complutense de Madrid, Spain; Universidad Nacional de Panama, State University of Campinas, Brasil; Universidad Autonoma de Nuevo Leon, Instituto Politecnico Nacional, and CEPROBI-IPN in Mexico.

RICHARD COPPEDGE, CMB is a professor in Baking and Pastry Arts at The Culinary Institute of America (CIA). Chef Coppedge currently teaches Advanced Baking Principles to students pursuing their bachelor's and associate degrees from the CIA. During his tenure at the CIA, he has taught various bread baking courses.

Chef Coppedge is the author of *Gluten-Free Baking with The Culinary Institute of America* (Adams Media, 2008). He also helped develop and provide content for the CIA's bread baking instructional video series.

Prior to joining the college's faculty in 1992, Chef Coppedge held positions in such prestigious properties as The Ritz-Carlton Hotel Company and Walt Disney World. Chef Coppedge was also the bread baker for The Dunes Club in Providence, RI and the Narragansett Bay Baking Company in Newport, RI. For 10 years he was an assistant professor in the baking program at Johnson & Wales University in Providence.

The CIA Faculty Member of the Year for 1994, Chef Coppedge is a member of the Bread Bakers Guild of America and the Retailer's Bakery Association. He received First Place for Pastry Grand Buffet, and a Silver Medal, Bronze Medal, and Judges Award at the Boston Food Show. Chef Coppedge earned awards for his bread displays at the New York Food Show from 1993 to 1995. He was a member of the CIA faculty team that won the coveted Marc Sarrazin Cup, grand prize of the *Societe Culinaire Philanthropique's* New York Culinary Salon, in both 1996 and 1997. Chef Coppedge is a Certified Master Baker (CM.B.). (Hyde Park, NY)

ALMIR DA FONSECA is a chef-instructor at the CIA at Greystone. Chef Da Fonseca, a native of Brazil, studied culinary arts at the Senace Trade School in Rio, apprenticing under the strict classical French teachings of Chef Jaques Arpi, and studying Italian cuisine under the teachings of Chefs Enzo Barbetti and Gisella Isidori of Italy. After moving to Northern California he served as executive chef at Lucas Wharf Restaurant, and later owned and operated his own restaurant, as well as Flavor Source Sauces and Catering Services, which he still owns. After selling his restaurant, Chef Da Fonseca became the corporate executive chef for Marconi Conference Center, a corporate chef and manager for Compass Group USA, and the corporate chef and manager for Delaware North

Companies. In 2003 he began his teaching career at the California Culinary Academy. Chef Da Fonseca joined the CIA in 2007. (Napa Valley, CA)

STEPHEN DUREFEE, CHE has been a baking and pastry instructor at The Culinary Institute of America at Greystone since 2000. Formerly executive pastry chef of the French Laundry in Yountville, CA, Chef Durfee worked for more than five years at the legendary restaurant, rotating through various kitchen stations until he took charge of the pastry department. While at the French Laundry, he won the 1998 James Beard Award for Pastry Chef of the Year and was named one of the 10 Best Pastry Chefs in America in 1999 by *Pastry Art & Design* and *Chocolatier* magazines. (Napa Valley, CA)

AMY MYRDAL MILLER, MS, RD is the program director for strategic initiatives at The Culinary Institute of America at Greystone. A registered dietitian with a master's degree in nutrition communications from Tufts University School of Nutrition Science and Policy, Amy has focused her career on nutrition research, education, and communications with a focus on promoting healthful foods and eating habits.

Prior to joining the CIA, Amy led domestic marketing and health research efforts for the California Walnut Commission, directed nutrition education and nutrition marketing programs for Dole Food Company, and conducted cardiovascular health research studies at the Rippe Lifestyle Institute in Shrewsbury, Massachusetts.

Amy was the 2003 recipient of the Produce for Better Health Foundation *Diamond Crystal Award* for her leadership in developing an online children's nutrition education program.

She is the co-author of *The Healthy Heart Cookbook for Dummies* and the executive editor of the *Dole 5 A Day Kids Cookbook.* Today Amy is blogging for www.amillioncooks.com on healthy eating topics.

Amy is a member of the American Dietetic Association (ADA), chair-elect of the Food & Culinary Professionals Dietetic Practice Group of the ADA, and a member of the *Cooking Light* Nutrition Advisory Board. (Sacramento, CA).

SUVIR SARAN is chef, consultant, and the author of two widely acclaimed cookbooks, *American Masala:* 125 *New Classics From My Home Kitchen* and *Indian Home Cooking.* Mr. Saran established new standards for Indian food in America when he teamed up with tandoor master Hemant Mathur to create the authentic flavors of Indian home cooking at Devi restaurant in New York City, the only Indian restaurant in the U.S. to have ever earned a *Michelin* star. Most recently, he introduced his American Masala Collection of porcelain kitchenware and dinnerware by Wade Ceramics Ltd. He serves as chairman, Asian culinary studies for The Culinary Institute of America's World Cuisines Council. With a focus on health and wellness, Mr. Saran works side-by-side with tlıe chefs of Sodexo to bring Indian flavors and cooking techniques into their kitchens across America. He teaches all over the U.S. and beyond, but when he is not traveling, he works on his 68-acre farm in upstate New York. (New York, NY)

DR. MEHMET C. TULBEK provides leadership in technical services at Nortlıern Crops Institute (NCI) for regional crops in the form of processing, consulting, processing solutions to processors and end users. Melımet develops and conducts educational programs that identify market opportunities and addresses quality characteristics desired by buyers and processors of regional crops and conducts market development activities to promote sales of regional crops.

An Istanbul-Turkey native, Melımet concluded his B.Sc. in Agricultural Engineering with the emphasis of Food Science and Technology at Ankara University in 1996. Mehmet finished his M.Sc. degree at Food Engineering Department of Istanbul Technical University. Melımet came to US in 2001 and conducted research on baking, pulse and flaxseed utilization at North Dakota State University Department of Cereal and Food Sciences during his Ph.D. study.

Mehmet is the former Pulse and Oilseed Specialist at Northern Crops Institute (NCI) and has been serving as Technical Director since July 2008.

Melmet is an active member of American Association of Cereal Chemists International, American Oil Chemists' Society and Institute of Food Technologists.

CHRIS WOLF is a widely quoted authority on consumer and food industry trends. For more than 20 years as a food consultant, he has been uncovering emerging opportunities based on consumer needs and helping marketers like PepsiCo, Tyson Foods, Nestle, Sara Lee, McDonald's, Subway and Starbucks Coffee to anticipate and capitalize on these trends. In addition to immersing companies in growth-driven insights, Chris also is skilled at adapting and facilitating group processes to drive strategy and innovation for his clients.

Throughout his career, Wolf has developed consumer trend-tracking models, strategic planning templates and invented interactive and energetic brainstorming sessions that feed innovation pipelines for marketing companies. He is now applying those skills to create new innovative processes for clients like the USADPLC at The Turover Straus Group.

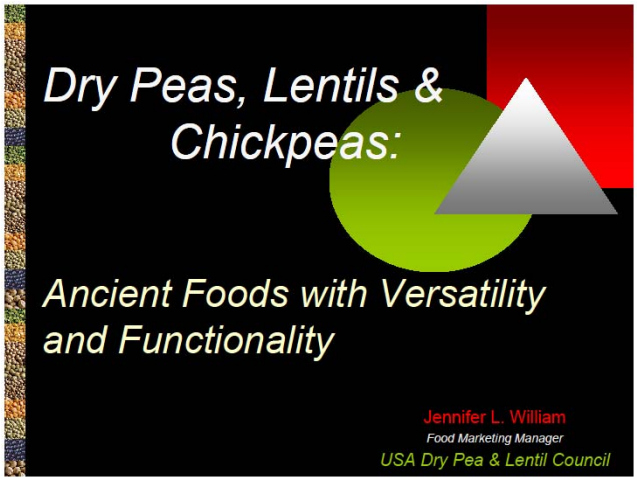
A graduate of the prestigious Kellogg business school, Wolf currently teaches = Marketing classes at Drury University and Missouri State University. His trend-oriented insights can also be found in QSR Magazine's monthly marketing column and on his weblog at www.thefoodscout.com.

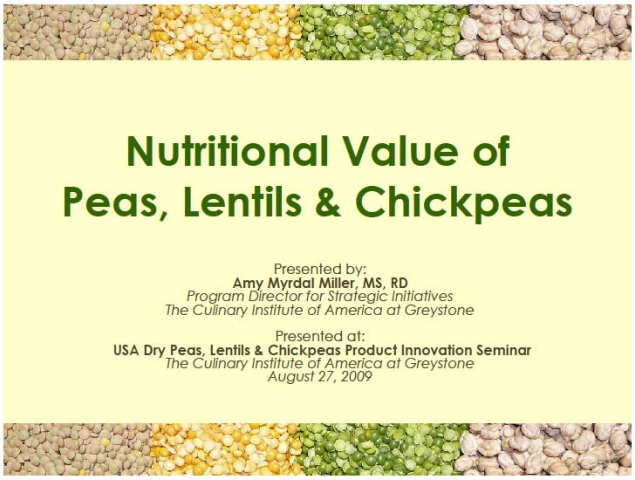
JENNIFER L. WILLIAM is the Marketing Manager for the Washington Dry Pea & Lentil Commission, (member of the USA Dry Pea & Lentil Council) the national organization that represents growers, processors, exporters, and traders of dry peas, lentils, and chickpeas grown in the United States. She is a proud graduate of the University of Illinois at Champaign-Urbana in Food Science (BS, MS) and Marketing (MBA). She is responsible for the development of new markets for legumes in the US. She promotes new applications for legumes as ingredients and provides education to the US food industry on these new uses across the country.

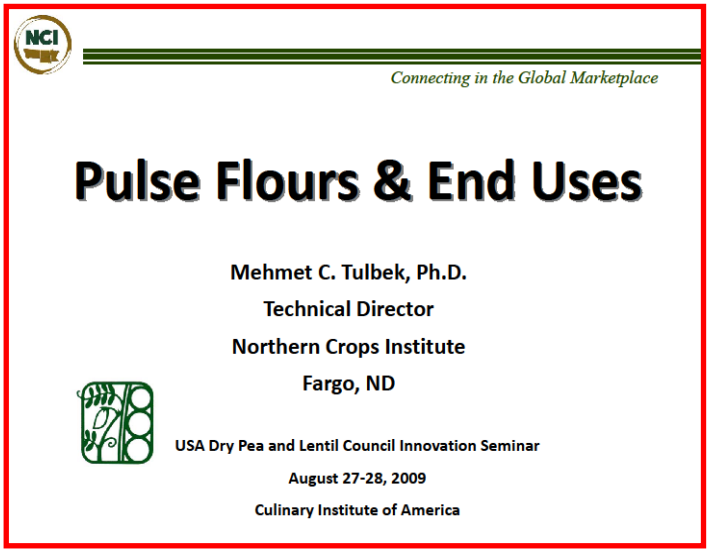
She conceptualized the Super Tortilla, a tortilla made with yellow pea, lentil, and chickpea flour, in 2006. The tortilla has since been re-named the Nutri-tillaTM, and commercialized as a viable product in the US market. She has served as a marketing research consultant for Griffith Laboratories, studying the natural/organic food industry to determine consumer buying habits and conducting research on the Mexican-style condiments market to identify new opportunities. She also has 4 years of part-time experience as a Quality Assurance Technician for Kraft Foods in Champaign, IL. In her spare time, she volunteers as a mentor for young women of color in the Spokane and Spokane Valley, WA communities.

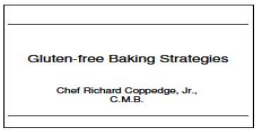
Appendix C – Presentation Slides

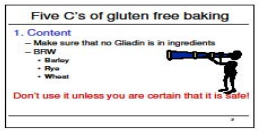
Double-click on the images below to open/view speaker presentations.

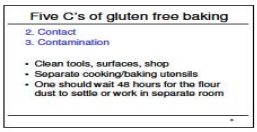


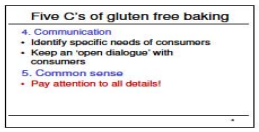


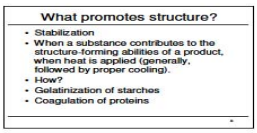


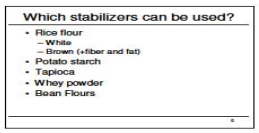












Due to a patentability issue, Dr. Jose D. Berrios, USDA-ARS-WRRC requested that his Power Point presentation be deleted from the PC from which he spoke and that it not be distributed to the conference participants.

Appendix D – Course Evaluation Form

Legumes: *Wholesome Ingredients for Value-Added Foods*
Evaluation Form, Day One – August 27, 2009

Please give us your opinion of today's session. Your comments will help us improve future information sessions. Please **circle** the number that corresponds with your level of agreement with each statement, with 1=strongly agree, 2=agree, 3=disagree, and 4=strongly disagree.

	Strongly Agree	Agree	Disagree	Strongly Disagree
1. Today's session **met my expectations**	1	2	3	4
2. Today's session was **well organized**	1	2	3	4
3. Today's session **moved along at the right pace**	1	2	3	4
4. Today's 1st presentation **helped me better understand the <u>marketing opportunities</u>** associated with using dry peas, lentils and chickpeas as ingredients.	1	2	3	4
5. Today's 2nd presentation **helped me better understand the nutritional benefits of** using dry peas, lentils and chickpeas as ingredients in value-added foods.	1	2	3	4
6. Overall, today's **presentations were …..**				
…..clear/understandable	1	2	3	4
….. **well prepared**	1	2	3	4
7. I found the hands-on kitchen sessions where we developed products in teams, to **be informative, interactive and fun.**	1	2	3	4
8. The hands-on sessions **helped me gain an understanding of how to work with** dry peas, lentils and chickpeas as ingredients.	1	2	3	4

<u>Please comment on the following</u>:

1. Did any particular sessions or speakers stand out and why?

2. Was there any aspect you were interested in, that was not covered in today's class?

3. How could the *Marketing and Nutrition Presentations or hands-on Kitchen Sessions* have been better or more helpful?

4. Any other comments?

Legumes: Wholesome Ingredients for Value-Added Foods

Evaluation Form, Day 2 – August 28, 2009

Please give us your opinion of this two-day course. Your comments will help us improve future information sessions. Please **circle** the number that corresponds with your level of agreement with each statement, with 1=strongly agree, 2=agree, 3=disagree, and 4=strongly disagree.

	Strongly Agree	Agree	Disagree	Strongly Disagree
1. Today's session **met my expectations**	1	2	3	4
2. Today's session was **well organized**	1	2	3	4
3. Today's session **moved along at the right pace**	1	2	3	4
4. The 3rd presentation by Dr. Tulbek on Day 2 **helped me understand the functionality** of dry pea, lentil, and chickpea flour as an ingredient.	1	2	3	4
5. The 4th presentation by Dr. Berrios on Day 2 **provided me with new insight about utilizing lentil flour in gluten-free extruded snacks**	1	2	3	4
6. Overall, today's **presentations were …..**				
…..clear/understandable	1	2	3	4
….. **well prepared**	1	2	3	4
6. Today's hands-on sessions **helped me better understand how to use** dry peas, lentils, chickpeas and their flours as ingredients.	1	2	3	4

Overall Course Evaluation:

A. **Questions were encouraged** and there was ample time allotted for Q&A throughout the course.	1	2	3	4
B. Overall, I learned more about dry peas, lentils and chickpeas in this course than I had known prior to taking this course.	1	2	3	4
C. Specifically**,** I learned more about dry pea, lentil and chickpea FLOUR in today's session than I had known prior to taking this course.	1	2	3	4
D. I feel this Course was well worth my time.	1	2	3	4

We value your feedback and hope you will take time to let us know the following:

1. Please rate your knowledge about dry peas, lentils, and chickpeas as ingredients coming into the course.
   a. Extremely knowledgeable
   b. Very knowledgeable
   c. Somewhat knowledgeable
   d. Not at all knowledgeable

2. Please rate your knowledge having now completed the course.
    a. Extremely knowledgeable
    b. Very knowledgeable
    c. Somewhat knowledgeable
    d. Not at all knowledgeable

3. How likely are you to incorporate dry peas, lentils, and chickpeas as ingredients in **new products**, a **current value-added product line**, an **ingredient offering**, or **new foodservice menu item**?

    a. Extremely likely
    b. Very likely
    c. Somewhat likely
    d. Not likely

4. If you decide that you want to proceed with preliminary in-house work with USADPLCs as ingredients, our industry members are happy to provide you with small samples and additional information at your request. Please circle the sample type(s) you want to receive below.

    a. Raw dry peas
    b. Raw lentils
    c. Raw/canned chickpeas
    d. IQF Lentils
    e. IQF Chickpeas
    f. Raw legume flour
    g. Pre-cooked Yellow pea flour
    h. Pre-cooked Lentil flour
    i. Pre-cooked Chickpea flour
    j. Pre-Cooked/Dehydrated Dry Peas, Lentils, and Chickpeas
    k. Organic Dry Peas, Lentils, and Chickpeas
    l. None of the above

5. Did attending this course make you **more** or **less** interested in using dry peas, lentils, chickpeas, and their flours in product development?

    a. Dried peas
    b. Lentils
    c. Chickpeas
    d. Raw legume flour
    e. Pre-cooked legume flour
    f. None of the above

6. Can you think of any additional questions that you have that were not answered or was unclear?

7. Finally, what did you feel were the strengths and weaknesses of this Course?

Thank you very much!

Appendix E – Select Recipe

These muffins were a big hit!

CHICKPEA BREAKFAST MUFFINS

Yield: 40 Portions

Ingredients	**Amounts**
Chickpeas	2 cups
Lemon juice	2 Tbs
Orange juice	2 Tbs
Vegetable oil	¼ cup
Lemon zest	1
Orange zest	1
Egg yolks	2 ea
Flour, AP (sifted)	2/3 cup
Sugar	¾ cup
Baking powder	2 tsp
Salt	½ tsp
Egg whites	2 ea
Sugar	2 Tbs
Lentil Crunch as needed	

Method

1. Rinse chickpeas and remove any loose skins. Puree in a food processor until smooth.
2. Add the lemon and orange juice, vegetable oil and zests. Puree just to incorporate.
3. Blend in the egg yolks. Transfer mixture to a mixing bowl.
4. Sift together the flour, sugar, baking powder and salt. Stir into the chickpea mixture.
5. Whisk egg whites until frothy. Gradually add the remaining sugar and whip to soft peaks. Fold the egg whites into the batter.
6. Pipe or scoop batter into prepared muffin cups. Sprinkle each with a bit of lentil crunch.

Bake 10-12 minutes at 325°F, or until a toothpick inserted in the center of a muffin comes out clean.

Recipe adapted from The Pea and Lentil Cookbook

USA Dry Peas, Lentils & Chickpeas

PROCESSING INFORMATION & TECHNICAL MANUAL

USA Dry Pea & Lentil Council

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1

CHAPTER

Introduction

USA DRY PEA &
LENTIL COUNCIL

Dry peas, lentils, and chickpeas—known as pulse or legume crops—are among the world's most ancient commodities. Archeologists have discovered peas in caves in what is present-day Thailand that date back more than 11,000 years. The royal Egyptian tombs contained lentils, which were meant to sustain the dead on their journey to the afterlife. In the Christian Bible, Esau sold his birthright for a pottage of lentils. And, in Italy, the names for peas (*Pisum sp.*), lentils (*Lens culinaris*), and chickpeas (*Cicer arietinum*) found their way into the names of the prominent Roman families of Piso, Lentulus, and Cicero.

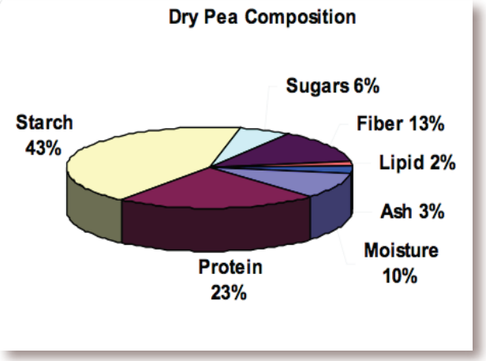
According to Italian writer and academic Umberto Eco, it may even be true that peas, beans, and lentils actually saved Western Civilization during the Early Middle Ages (476 to 1000 AD). It is well documented that the introduction of pulses into crop rotation practices resulted not only in increased farm productivity, but also in improved protein content and a more diverse and nutritional diet for the populace. The development is credited with saving generations of people from malnutrition and helping facilitate the repopulation of Europe after the Black Plague pandemic of the late 1340s.

Perhaps in recognition of legumes' extraordinary qualities, many cultures have developed a range of traditions in which the eating of peas and lentils figure prominently. Among the most notable is *No Ruz*, the New Year's celebration in Iran. During this 13-day celebration, every house maintains a table known as the "seven S's," which includes seven symbolic objects beginning with the letter S. Germinating lentil seeds, known as *sabzi*, hold the place of honor in the center of the table to symbolize renewal and rebirth.

For hundreds of years, the people of northern Italy have enjoyed their own New Year's tradition called *Capo d'Anno* (literally "head of the year") in which lentils, symbolizing coins, are eaten to ensure good fortune for the year ahead. Consuming these "coins" is thought to make wealth and prosperity part of one's blood and being. Eating lentils, rather than more exotic or expensive foods, is also considered an act of humility to both heaven and society, and a means for averting the sin of pride.

Over time, the United States has seen much of its own rich tradition of eating legumes replaced by a preference for fast food and microwavable meals. Fortunately, Americans are starting to rediscover these overlooked ingredients. Nutritionists have, for example, begun pointing to the legume-rich diets of the Mediterranean as one possible route to improved health.

The media, meanwhile, is increasingly touting the benefits of the nutritional attributes and phytochemicals found in legumes. Recent research shows that the antioxidants, flavonoids, plant estrogens, vitamins, minerals, protein, and fiber in legumes can help prevent, and may even contribute to, the reversal of many major chronic diseases.



Source: Northern Crops Institute

Add these health benefits to their delicious flavor and incredible culinary versatility and it is little wonder that Americans are once again finding a place for peas, lentils, and chickpeas in their diets and on their dining room tables. *See Appendix C for a collection of sample formulations.*

Dry Peas, Lentils, and Chickpeas in the United States

The first U.S. lentils were grown in 1916 in eastern Washington in a region known as the Palouse. These lentils were not native to the area and were brought by a *Russlanddeutscher* Seventh Day Adventist minister named Schultz (his first name has been lost to history).

Reverend Schultz's seeds eventually reached J.J. Wagner, a farmer in the aptly named Washington town of Farmington. Wagner planted a single acre of lentils in 1916. Finding that they grew well in the rich, volcanic soils of the region, he began producing the legume for the vegetarian Seventh Day Adventist communities.

In time, his market grew to include Seventh Day Adventist academies and colleges across the U.S. Looking to protect what he had built, Wagner refused to sell any lentil seed to the local seed company. He did, however, apparently agree to sell seed to a fellow farmer who eventually opened the market by selling the seed himself.

By 1937, the first commercial acreage of lentils had been contracted, growing to include some 3,000 acres by 1948. Today, U.S. farmers harvest more than 250,000 acres of lentils. Most of these farms, many of which now also grow other legumes, reside in a regional belt north of 45°N latitude that runs from North Dakota, through Montana and Idaho, and into Oregon and eastern Washington.

Successful production of dry peas, lentils, and chickpeas requires a unique combination of soil, moisture, and climate. This makes them especially well suited to this

region, as they tolerate its characteristic cool spring weather and do not need artificial irrigation, relying only on rainfall during the growing season.

Pulses are planted annually in rotation with other crops, generally cereal grains such as wheat and barley, and are able to convert atmospheric nitrogen into usable nitrogen for plant growth, reducing the need for additional fertilization of following crops.

Major U.S. Dry Pea Cultivars

Yellow Cotyledon Type
- Eclipse
- Mozart
- DS Admiral Miami

Green Cotyledon Type
- Majoret
- Cruiser
- Nitouche

Split peas and lentils from the U.S. are dried naturally in the sun and harvested at a low moisture rate. Because of their small size, it is not necessary to soak them. Soaking them may result in overcooking. In contrast, whole peas and chickpeas require soaking before cooking.

Today, U.S. legumes are the world's gold standard for quality. Perfect climate and soil conditions, combined with many generations of harvesting and processing expertise, help to consistently produce the highest quality and most functional legumes grown anywhere.

World Market for Dry Peas, Lentils, and Chickpeas

Only about 30 percent of the pulse crops grown in the U.S. is actually consumed in domestic food and feed markets. The rest is exported to consumers around the globe, generally from U.S. ports in the Gulf of Mexico or in the Pacific Northwest and from Canadian ports in Vancouver or Montreal.

The harvested pulses are stored in elevators throughout the growing region in which fans circulate air to keep the peas, lentils, and chickpeas dry and free of mold. An important step in processing pulses is to pass the product over screens to sort out dirt and pebbles and to separate pulses by size, in accordance with buyers' specifications. In some operations, electronic color sorters are used to ensure that pulses are uniform in color. Next, pulses are thoroughly cleaned to ensure that foreign matter and chips are removed, and then the product is bagged.

Once bagged, peas, lentils, and chickpeas are ready for shipment. The bags are loaded into shipping containers, each of which holds about 20 metric tons. These containers then find their way onto trucks, train cars, barges, and oceangoing cargo ships for transport to markets throughout the U.S. and around the world.

Variety Classifications and Standards

Grading standards have been established by the United States Department of Agriculture Federal Grain Inspection Service (USDA FGIS). The goal is to ensure that buyers receive a clean, wholesome product that conforms exactly to the grade ordered. The grading standards allow accurate communication among all parties in a trading transaction, regardless of language, political, or cultural barriers.

Dry Peas

Peas are thought to have originated in northwest Asia and have been discovered in Egypt dating from c. 4800–4400 BC. They were an important part of the diet of most people in Europe during the Middle Ages, and by the 1600s–1700s they had become popular in their "green" or immature form. They eventually spread to North America, where Thomas Jefferson grew more than 30 cultivars of peas on his estate.

Dry peas dry naturally in the late summer sun and are most commonly split to speed cooking time. During processing, they are sorted and then bombarded against a baffler, which causes them to break in two halves. Americans are most familiar with green peas, but yellow peas are also grown in the U.S. Northern Plains of Montana and North Dakota. They are most commonly consumed in India and taste slightly different than green peas.

USA Pea Varieties and Their Characteristics

Dry Green Peas Light-green seed coat, dark green cotyledon

Dry Yellow Peas Light-yellow seed coat, deep-yellow cotyledon

Green Split Peas Dark-green cotyledon

Yellow Split Peas Deep-yellow cotyledon

Marrowfat Peas Light-green seed coat, dark-green cotyledon

Austrian Winter Peas Mottled dark-green/brown seed coat, yellow cotyledon

USA Lentil Varieties and Their Characteristics

Regular Lentils Light-brown, mottled seed coat; yellow cotyledon

Eston Lentils Tan to green seed coat, yellow cotyledon

Red Chief Lentils Light-tan seed coat, red cotyledon

Pardina Lentils Speckled, grayish-brown seed coat; yellow cotyledon

Large Green Lentils Bright-green, clear seed coat; yellow cotyledon

Crimson Lentils Reddish-brown seed coat, red cotyledon

Lentils

Lentils may have been among the first agricultural crops ever grown. Production is thought to have begun in the Near East and then spread to the Mediterranean, Asia, Europe, and finally the Western Hemisphere.

The lentil is a cousin of the bean and both are part of the legume family, which have seeds that grow within pods. The name "lentil" was inspired by their lens-like shape, with "lens" being the Latin word for "lentil."

The size and appearance of lentils vary depending on the variety. The outer seed coat can be mottled or speckled and ranges in color from reddish-brown to grayish-brown to green. The inner coat, or cotyledon, can be red or yellow.

Chickpeas

The chickpea was originally cultivated on the lands bordering Mesopotamia and the eastern Mediterranean and has been grown in India, the Middle East, and parts of Africa for many years. Chickpeas are estimated to be at least 7,500 years old.

Between 80 and 90 percent of the world's chickpea supply comes from India, while most acreage in the U.S. is in California, eastern Washington, Idaho, and Montana. Acreage continues to grow to make up for supplies that formerly came from Mexico, which has in recent years cut back chickpea production in favor of pinto beans.

Like lentils, chickpeas take their name from their shape, which resembles the beak of a baby chick. Some may also know chickpeas by their other name, garbanzo beans.

2

CHAPTER

General Properties of Dry Peas, Lentils & Chickpeas

USA DRY PEA & LENTIL COUNCIL

Legumes belong to the botanical family *Papilionaceae* within the order *Fabaceae* (also called *Leguminosae*). The *Fabaceae* family includes about 600 genera and 13,000 species, making it the third largest family within the plant kingdom. Familiar legumes aside from dry peas, lentils, and chickpeas include soybeans, fava beans, peanuts, lupins, beans, lucerne (alfalfa), clovers, and vetches.

Legumes are distinguished by three principal characteristics:

- A butterfly-shaped, or papilionaceous, flower
- Production of pods that contain seeds
- An ability to use atmospheric nitrogen to produce their own protein compounds (this is true for nearly all legumes and is made possible by the symbiotic relationship between nitrogen-fixing bacteria in the soil and the nodules in the legumes' roots)

Legumes fall into the following two general categories:

Grain Legumes

Grain legumes are cultivated primarily for their seeds, or grains, which are harvested at maturity and marketed as dry products rich in protein. More than 40 species and myriad varieties of grain legumes are cultivated throughout the world. The major grain legumes grown in the U.S. include dry peas, lentils, chickpeas, soybeans, fava beans, lupins, vetches, and dry beans.

Forage Legumes

Forage legumes (mostly with small grains) are grown and used as feedstock for animals, either via grazing the crop or through the production of silage or hay, and for industrial purposes. Popular forage legumes include lucerne and clover.

What Is a Pulse?

The edible seed of a legume is known as a pulse, a name taken from the Latin word *puls,* meaning a thick soup. Familiar pulses include peas, beans, lentils, and chickpeas. They are most commonly cultivated as a food for human consumption, in large part because of their rich protein and starch content. A percentage is also grown for animal feed.

Considered environmentally friendly crops, pulses are less dependent on fossil fuels and reduce the need for fertilizer applications thanks to their ability to obtain much of their nitrogen from the atmosphere. Pulses also offer low crop residues and low carbon-to-nitrogen ratios. This eliminates the need for burning and makes it very easy to

rotate to the next crop using reduced tillage.

Pulse crops have a *hypogeal* type of germination, which means that the plants' seed leaves (cotyledons) remain below ground. This makes pulse crops more frost-tolerant than soybeans or dry beans. Pulse crops are also more tolerant of having the soil disturbed, such as tillage operations like harrowing, culti-packing, or rotary hoeing.

Dry peas are an excellent source of:

- Copper
- Fiber
- Folic Acid (Folate)
- Manganese
- Thiamin

Dry peas are a good source of:

- Iron
- Magnesium
- Phosphorus
- Potassium

Dry Pea Varieties

Dry peas, like their lentil cousins, have been around for thousands of years. The earliest evidence dates from Neolithic times in Syria, Turkey, and Jordan. Finds were made in present-day Thailand that date from 11,000 years ago. Discoveries have also been made in Egypt and what is today Georgia, Pakistan, Afghanistan, and India.

Cultivated peas have been classified into two types: (1) garden peas (*Pisum sativum ssp. hortense*), which are identified by the wrinkled nature of their seed and cotyledon, and (2) field peas (*Pisum sativum ssp. arvense*), also known as dry peas. This second type is distinguished by its smooth seed surface. The two types are genetically different and produce starches with different granular morphologies and characteristics.

Within the dry pea family, two main varieties are grown throughout the world: the dry green cotyledon and the dry yellow cotyledon. Split peas are simply dry peas (green, yellow, or red) that have been split. Most people are familiar with green split peas, which have a bright green color due to chlorophyll and boast a stronger taste than yellow split peas.

As an annual herbaceous plant the dry pea can be indeterminate (climbing) or determinate (bush or dwarf). One has normal leaves and a vine length of 3 feet to 6 feet. The other is semi-leafless with modified pale-green leaflets reduced to tendrils resulting in shorter vine lengths of 2 feet to 4 feet. They usually have a single stem, but can branch from nodes below the first flower.

Depending on the variety, dry peas start flowering after a specific number of *nodes* (i.e., the part of the plant's stem that bears a leaf) are reached. All varieties, except for the Austrian Winter Peas, which are reddish-purple, the self-pollinating blossoms are white, with flowering occurring normally two to four weeks out, depending on the variety and weather. Flowering continues until drought or nitrogen deficiency brings it to an end. Dry pea varieties are distinguished by determinate or indeterminate flowering. Determinate varieties mature in 80 to 90 days, indeterminate varieties in 90 to 100 days.

The pods of the dry pea are about three inches long and contain four to nine seeds, which can have a green, yellow, or cream-colored seed coat. By the time some pea

varieties reach maturity, the plant becomes a prostrate vine.

Peas are a cool season crop with planting taking place from winter through early summer depending on location. The seeds may be planted as soon as the soil temperature reaches 50 degrees F (10 degrees C), with the plants growing best at temperatures of 55 degrees F to 65 degrees F (13 degrees C to 18 degrees C), and outside versus in greenhouses.

Dry pea seedlings can withstand considerable frost exposure without damage. If damage does occur and the main shoot is killed, new shoots will originate from nodes below the soil surface. Dry peas also prefer slightly acidic, well-drained soils.

Planting is typically done in the spring. Where frost is not an issue, planting can occur in the fall and early winter. Once planted, it takes dry peas about 60 days to bloom and 100 days to mature the dry seed. Because high temperature during blossoming results in reduced seed set, production of dry pea as a summer annual in the United States is limited to the northern states.

The moisture requirement for the dry pea is similar to that of cereal grains. The ideal

includes good rains and/or early irrigation, and no rain during pod fill and ripening. Dry peas can be grown in a wide range of soil types, from light sandy loams to heavy clays. But in each case, there must be good drainage as dry peas don't tolerate soggy or water-soaked conditions.

Dry peas grow best when planted into a seedbed with a minimum amount of residue on the soil surface. Good soil contact with the seed is also important, so seedbeds that are firm and well worked tend to be favored. Such features of the soil environment can impact the percentage of seedlings that emerge. Seed and soil-borne pathogens may have a major effect on emergence.

Another factor is the pea seed germination rate, which increases as the temperature increases. But if temperatures reach 64 degrees F (18 degrees C) or higher, the percentage of germinating seeds decreases.

Temperature is also critical during flowering. Being a cool season crop, dry peas cannot tolerate hot weather or drought stress during this period. This makes seeding early very important. As early in the spring as feasible is best, provided the soil temperature in the upper inch is over 40 degrees F (4 degrees C). Unless erosion is an issue, fall plowing is recommended as a good way to help enable early spring planting.

Among harvested seeds, color variability within a particular variety is usually related to the seed's maturity and the storage conditions. If irregular pigmentation is evident in a given lot of seeds from a single-stage harvest it may be due to the differing ripeness of the seeds.

Dry Pea Classes

Smooth Green Dry Peas
Dry peas of the garden type that have smooth seed coats and green cotyledons and contain not more than 1.5 percent of other classes. Includes: Majoret, Cruiser, Nitouche, Columbian.

Smooth Yellow Dry Peas
Dry peas of the garden type that have smooth seed coats and cotyledons and contain not more than 1.5 percent of other classes. Includes: Eclipse, Mozart, DS Admiral, Miami.

Wrinkled Dry Peas
Dry peas of the garden type that have wrinkled seed coats and contain not more than 1.5 percent of other classes.

Mottled Dry Peas
Dry peas of the mottled dry pea type that contain not more than 1.5 percent of other classes.

Miscellaneous Dry Peas
Dry peas that do not meet the criteria for any other class of dry peas and contain not more than 1.5 percent of other classes.

Mixed Dry Peas
Any mixture that does not meet the requirements for the classes: smooth, green, smooth yellow, wrinkled, or winter dry peas; or any mixture of different types of miscellaneous dry peas. Mixed peas rarely appear on the market. Slight mixtures sometimes occur, affecting the quality or grade of peas. This is especially true of peas of widely different types.

Use of Dry Peas

Peas were originally grown mostly for their seeds. Dry peas can be hydrated by soaking and either canned or frozen and then served as a vegetable. Applications for canned or frozen peas include stir-fry dishes, pot pies, salads, and casseroles. Most dry peas are put through a splitting process and the split peas are then used in the popular North American dish, split pea soup.

In many Asian countries, peas are roasted, salted, and consumed as snacks. In parts of the Mediterranean, they are added to meat and potatoes to make a hearty stew. Dry yellow split peas are used in the UK to make the traditional pease pudding or porridge, while dried, rehydrated, and mashed marrowfat peas, known in England as "mushy peas," are a common accompaniment to fish and chips and meat pie.

Dry pea flour also figures in many uses worldwide. It is valued not only as a vegetable protein source, but also, in part, for its unique functional properties. In keeping with the increasingly popular use of vegetable proteins as functional ingredients in the food industry, dry peas have proven especially sought after due to their wide acceptance as part of the human diet. For example, slurried pea flour offers a viscosity that makes it uniquely useful as a thickening agent in certain food products.

Dry peas can also be used as a green manure crop, which is plowed back into the soil to restore nutrients, and provide large amounts of fixed nitrogen to the soil. Dry peas may also be grown as a forage crop for hay, pasture, or silage, while pea starch can be used for industrial purposes such as adhesives.

The Health Benefits of Dry Peas

As with other legumes, dry peas are rich in nutrients. A good source of protein, one-quarter cup of dry split peas also provides 13 grams of dietary fiber or 52 percent of the daily recommended 25 grams (based on a 2000-calorie diet). Peas offer more than one-third of the recommended daily value for folate, a nutrient that plays a critical role in the prevention of birth defects. Dry peas also have little or no fat and no cholesterol, making them a smart addition to almost any diet.

The many nutrients in dry peas may help lower the risk of heart disease, stroke, and various cancers, while enhancing quality of life by helping manage weight and prevent hemorrhoids and diverticulitis. The soluble fiber in dry peas and low glycemic index may help stabilize blood sugar levels, which is especially important for people with diabetes. In addition, the presence of phytochemicals in dry peas is another reason why they, like other legumes, should be consumed regularly. The body uses phytochemicals to fight disease.

Lentil Varieties

The lentil *(Lens culinaris*) is a feathery legume with lens-shaped seeds, which typically grow two to a pod. The plant originated and was among the first crops to be domesticated in the Near East. It has been a part of the human diet since Neolithic times.

A similarity in shape to the lentil, which is Latin for "lens," also led to the eye's borrowing the name for its optical lens. This same lens-lentil association appears in myriad languages, from Arabic to Vietnamese.

Lentil types comprise a wide variety, with colors that include yellow, red-orange, green, brown, and black. Red, white, and yellow lentils have their skins removed in a process called *decortication*. Many lentils types come in large and small varieties and are sold in many forms, with or without the skins, whole or split.

Lentil plants are herbaceous, with thin stems and branches. Plant height ranges from 12 inches to 15 inches for most varieties, but can vary from 8 inches to 30 inches depending on variety and environment.

The plants have a slender taproot with fibrous lateral roots. Rooting patterns range from a many-branched, shallow root system to types that are less branched and more deeply rooted. The taproot and lateral roots at the surface layers of soil have nodules that vary in shape from round to elongated. The stems are square and ribbed and usually thin and weak, while the branches sprout directly from the main stem and may emerge from the cotyledon node below ground or from nodes above ground.

The leaves of the lentil are relatively small compared to those of other large-seeded

USA Lentil Varieties

USA Pardina Lentils
The Pardina lentil, sometimes called the Spanish brown lentil, is favored for its excellent taste (slightly nutty) and its cooking characteristics. These lentils maintain their shape and texture very well when cooked and do not fall apart even if slightly overcooked. Although the Pardina lentil is originally from Spain, over 90 percent of the world's production is now grown in Washington and Idaho.

USA Richlea Lentils
The medium-sized Richlea lentil is greenish-tan and often mistaken for the Regular lentil because of its similar size and color. The Richlea lentil is distinguished from the Regular lentil by its general lack of mottling.

USA Red Chief Lentils
These red lentils are quick cooking because the brown outer skin is typically removed. Simply boil for six to eight minutes for a great visual and nutritional addition to any meal. Try adding to soups as a thickener or to salads for something different.

USA Regular Lentils
Also known as the Brewer lentil, this greenish-tan lentil is the most common lentil type available in the U.S. The mottled appearance of the Regular lentil is a natural genetic trait that was inherited from its Chilean lentil parents.

USA Crimson Lentils
These colorful, small-sized lentils have a pinkish-brown skin that covers a red seed. The lentil is thought to originally derive from Turkish red lentils.

USA Beluga Lentils
This small, black lentil gets its name from its similar appearance to Beluga caviar. Look for this attractive variety to grow in popularity in years to come.

USA French Green Lentils
This is the same type of lentil as the du Puy lentil from the du Puy region of France, though it is not generally called du Puy when grown in the U.S. It is a great visual and nutritional addition to any meal.

USA Large Green Lentils
This is the lentil of choice among many South American countries.

USA Eston Lentils
These small green or tan lentils are most often exported. To avoid cooking problems from hard seeds, make sure that the Estons you purchase are from the U.S.

Lentils, ¼ cup dry

Nutrition Facts

Calories 170	Calories from Fat 5
	% Daily Value*
Total Fat 0.5g	1%
Saturated Fat 0g	0%
Trans Fat 0g	
Cholesterol 0mg	0%
Sodium 0mg	0%
Potassium 458mg	13%
Total Carbohydrate 29g	10%
Dietary Fiber 15g	60%
Sugars 1g	
Protein 12g	

Vitamin A 0%	Vitamin C 4%
Calcium 2%	Iron 20%
Thiamin 28%	Vitamin B6 13%
Pantothenic Acid 10%	Folic Acid 57%
Phosphorus 22%	Magnesium 15%
Zinc 15%	Copper 12%
Manganese 32%	

*Percent Daily Values are based on a 2,000 calorie diet. Your daily values may be higher or lower depending on your calorie needs.

	Calories	2,000	2,500
Total Fat	Less than	65g	80g
Saturated Fat	Less than	20g	25g
Cholesterol	Less than	300mg	300mg
Sodium	Less than	2,400mg	2,400mg
Total Carbohydrate		300mg	375mg
Dietary Fiber		25g	30g

Calories per gram
Fat 9 · Carbohydrate 4 · Protein 4

food legumes. The pods are oblong, compressed, 6 mm to 20 mm long and 3 mm to 10 mm wide, and usually contain one to two lens-shaped seeds. Seed diameter ranges from 2 mm to 9 mm, while colors can vary from light green or greenish red to gray, tan, brown, or black. The seeds of some varieties can have purple and black mottling and speckling.

Lentils are usually sown in late April or early May, when soil temperatures are above 40 degrees F (4 degrees C). The North American lentil crop is planted in early spring and harvested in late summer. Early seeding will increase the height and size of the plant at first bloom, while planting after April can result in lower quality and diminished seed yield.

Lentils are an excellent source of:

- Fiber
- Folic Acid (Folate)
- Iron
- Manganese
- Phosphorus
- Thiamin

Lentils are a good source of:

- Copper
- Magnesium
- Pantothenic Acid
- Potassium
- Vitamin B6
- Zinc

Use of Lentils

Lentils are most well know for their namesake soup, which is popular across North and South America and Europe. In India and elsewhere, lentils are often combined with rice, which has a similar cooking time. Typically, lentils are consumed as a soup or joined with vegetables and boiled to a stew-like consistency before being seasoned with a mixture of spices to make a variety of side dishes, including the Indian dhal. These are then served over rice and roti.

In the Jewish tradition, the round shape of the lentil symbolizes the life cycle, and for this reason they have become traditional food for mourning.

The Health Benefits of Lentils

The *Superfoods Rx Diet*, released in 2008, included lentils for their nutritional attributes. In addition, lentils and legumes are highlighted as key daily ingredients in the Mediterranean Diet.

The product of more than 50 years of scientific research into the eating habits of those living along the Mediterranean Sea, the diet is today considered by many to be the "gold standard" for healthful eating.

Lentils in particular offer a high level of protein that is well-suited to this diet, which recommends eating an abundance of foods from plant-based sources.

In fact, among plant-based foods, lentils boast the highest amount of protein after couscous, barley, and beans. They have been and remain a critical part of the diet in many parts of the world, especially on the Indian subcontinent. Mixing lentils with grains, such as rice, creates a complete protein dish.

In addition to the high protein content, lentils are high in dietary fiber, folate, manganese, phosphorous and thiamin. Lentils one of the best vegetable sources of iron, also boast a high tannins content. As a phytochemical in plants, tannins have antimicrobial properties. In the body, tannins can act as an antioxidant and may reduce blood pressure, lower cholesterol, and help regulate the immune response

Chickpea Varieties

Chickpeas (*Cicer arietinum*), like all legumes, are members of the subfamily *Faboideae* of the family *Fabaceae*. Thought to have been first grown in Mesopotamia up to 7,500 years ago, chickpeas are considered one of the earliest cultivated vegetables on earth.

Chickpeas are divided into two types: Desi and Kabuli. The classification is based on

seed size, color, and the thickness and shape of the seed coat. Desi types tend to be smaller, angular seeds with thick seed coats that range in color from light tan and speckled to solid black.

If intended for human food, they require a specialized seed-coat removal process. Decortication requires adjusting the moisture level of the seeds to facilitate the mechanical removal of the thick seed coat, after which the seeds resemble a small yellow pea.

Kabuli types, also known as garbanzo beans in the U.S., have larger seeds with paper-thin seed coats that range in color from white to pale cream to tan.

Chickpea plants stand erect and resemble a bush with primary, secondary, and tertiary branching. They flower profusely and have an indeterminate growth habit, continuing to flower and set pods as long as conditions support it. Pods appear on the primary and secondary branches and on the main stem, with each of the individual round pods generally containing one seed in Kabuli types and often two seeds in Desi types.

Chickpeas can be seeded into standing or tilled stubble and fallow. To reduce soil-borne diseases, Kabuli chickpea types are planted when soil temperature at a depth of 2 inches to 3 inches reaches at least 50 degrees F (10 degrees C). Desi types can be planted in soil that is 40 degrees F (4 degrees C) or above.

Chickpeas tend to grow best in fertile sandy, loam soils with good internal drainage. They are a cool season annual crop performing best in 70 degrees to 80 degrees F (21 degrees to 26 degrees C) daytime

temperatures and 64 degrees to 70 degrees F (17 degrees to 21 degrees C) night temperatures. Because of their deep tap root system, they can endure drought conditions by extracting water from deeper in the soil. Chickpeas generally mature in 120 days.

Use of Chickpeas

Chickpeas are consumed mostly as a dry pulse crop. They are one of the most popular vegetarian foods the world over and can be prepared in a variety of ways for an almost limitless range of dishes.

Chickpeas, ¼ cup dry

Nutrition Facts

Calories 180	Calories from Fat 25
	% Daily Value*
Total Fat 3g	5%
Saturated Fat 0g	0%
Trans Fat 0g	
Cholesterol 0mg	0%
Sodium 10mg	0%
Potassium 438mg	13%
Total Carbohydrate 30g	10%
Dietary Fiber 9g	36%
Sugars 5g	
Protein 10g	

Vitamin A 0%	•	Vitamin C 4%
Calcium 6%	•	Iron 15%
Thiamin 16%	•	Vitamin B6 13%
Folic Acid 70%	•	Phosphorus 18%
Magnesium 14%	•	Zinc 11%
Copper 21%	•	Manganese 55%

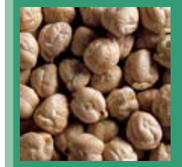
*Percent Daily Values are based on a 2,000 calorie diet. Your daily values may be higher or lower depending on your calorie needs.

	Calories	2,000	2,500
Total Fat	Less than	65g	80g
Saturated Fat	Less than	20g	25g
Cholesterol	Less than	300mg	300mg
Sodium	Less than	2,400mg	2,400mg
Total Carbohydrate		300mg	375mg
Dietary Fiber		25g	30g

Calories per gram
Fat 9 · Carbohydrate 4 · Protein 4

USA Chickpea Varieties

Kabuli takes its name from the Hindi word for "from Kabul" as the variety was thought to have originated in Afghanistan.



USA Large Kabuli Chickpeas
Large Kabulis have a lighter color, larger seeds, and a smoother coat than the Desi variety of the chickpea.

USA Small Kabuli Chickpeas
All U.S. chickpea varieties are identifiable by a white seed coat and golden-yellow cotyledon.

USA Desi Chickpeas
All U.S. chickpea varieties are identifiable by a dark-brown coat and brown-yellow cotyledon.

Mature chickpeas can be cooked and eaten cold in salads, cooked in stews, ground into flour, ground and shaped into balls and fried (*falafel*), stirred into a batter and baked (*farinata*), cooked and ground into a paste (*hummus*), or roasted, spiced, and eaten as a snack. Unripe chickpeas are often picked out of the pod and eaten raw, while the leaves are used as a green vegetable in salads. In the Philippines, chickpeas are preserved in syrup and enjoyed as sweets and in desserts. They can even be fermented into an alcoholic drink similar to sake or ground, roasted, and brewed as a coffee substitute.

In North America, most Kabuli chickpeas are marketed as canned chickpeas for salads at home or in restaurant salad bars. They are also marketed as dry chickpeas and ground flour for baking purposes. Other common uses in the U.S. include as an ingredient in soups and stews and as part of vegetable combinations. *Hummus*, a dip or spread made from cooked, mashed chickpeas, has also become a major product in the U.S. in recent years.

Chickpeas are an excellent source of:

- Fiber
- Folic Acid (Folate)
- Iron
- Manganese
- Copper

Chickpeas are a good source of:

- Iron
- Phosphorus

About 90 percent of chickpeas, the majority of which are Desi types, are consumed in India. Decorticated Desi chickpeas are commonly processed into South Asian food products.

The Health Benefits of Chickpeas

As well as being good to eat, chickpeas are also good for you. Some ancient cultures associated them with Venus, thinking them an effective medicinal for increasing sperm and milk, bringing about menstruation and urine, and even helping to treat kidney stones.

Today, we know that chickpeas, like other legumes, provide a valuable source of folate, iron, manganese, and protein. They are also a healthy source of complex carbohydrates and are low in fat. Most notably, chickpeas are high in dietary fiber—one-half cup of canned chickpeas provides 24 percent of the daily recommendation of 25 grams of fiber (based on a 2000-calorie diet).

The benefit of a high fiber diet goes beyond regularity and prevention of hemorrhoids and diverticulitis. It reduces the risk of cardiovascular disease by lowering blood cholesterol levels, helps control blood sugar levels in people with diabetes, and may even help protect against several forms of cancer.

See Appendix C for a collection of sample formulations using dry peas, chickpeas, and/or lentils.

Chemical Composition

Pulses (dry peas, lentils, and chickpeas) are some of the most widely available, inexpensive, and nutritionally complete staple foods in the world. Offering a balanced

proportion of proteins, starches, fiber, and minerals, they are a valuable feature of a healthy human diet. Health benefits have been ascribed to three main components found in legumes: non-nutritional factors, proteins, and carbohydrates.

There is an extensive amount of literature on the nutritional aspects of grain legumes, including the digestibility of main nutrients (mainly proteins, starch, and dietary fiber), colonic fermentation, post-prandial glycemia and insulinemia, and some data on lipid metabolism. Their high fiber content means that legumes help to protect against diabetes, cardiovascular disease, and maybe even some cancers.

Because pulses are low in fat and rich in protein, fiber, minerals, and vitamins, they have a low *glycemic index* (i.e., small rise of glucose after a meal) and can contribute to improved blood glucose control. It is thought that regular consumption of pulses can help lower blood cholesterol concentration.

At the same time, legumes provide the amino acids necessary to build and repair muscles and assure proper muscle development. They also nourish muscles with a range of other nutrients, including folacin and minerals. They boast a low allergenic capacity compared with some other sources of protein.

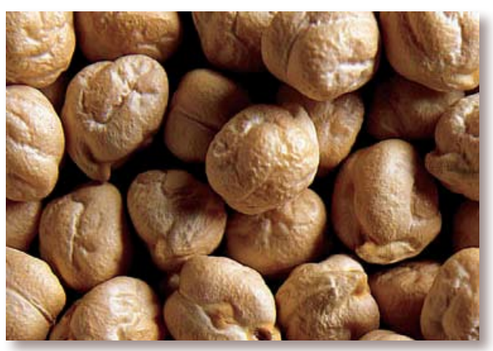
Over the previous two decades, non-nutritional factors, such as phytates, tannins, alkaloids, saponins, oligosaccharides, etc., have been linked with health-promoting properties. These elements are increasingly considered natural bioactive substances and are credited with playing an important role in the prevention of heart disease and some types of cancer.

The amount of protein, starch, fiber, oil, vitamins, and minerals vary in proportion and importance depending on the legume. For example, numerous studies have demonstrated significant genetic variability in seed protein composition, which offers the possibility of breeding for improved protein nutritional value.

A better understanding of the fundamental aspects of assimilate uptake, transport, partitioning, and metabolism in legume seeds, and the genetic factors that regulate all of these processes, will help contribute to the successful breeding of improved legume seed quality over time.

Chickpeas have one of the highest nutritional compositions of any dry edible legume. The chickpea's average nutritional content is 22 percent protein, 67 percent total carbohydrates, 47 percent starch, 5 percent fat, 8 percent crude fiber, and 3.6 percent ash. The fat (lipid) fraction is high in unsaturated fatty acids, primarily linoleic and oleic acids.

Chickpea protein digestibility is also the highest among the dry edible legumes. The content of the amino acid lysine is adequate, while the sulphur-containing amino acids, methionine and cystine, are the first limiting amino acids. Chickpeas are con-



sidered a cholesterol reducer due to their unsaturated fatty acid and fiber content, and they are also unique in their ability to moderate the rise in plasma glucose after meals.

In addition, the chickpea mineral component includes generous amounts of potassium, phosphorous, iron, and magnesium. Apart from being eaten as a vegetable, grain legumes are also a source of raw material for the processing industry. Fractions isolated from grain legumes can be used as simple ingredients or as additives. Legume starch and fiber both have useful functional properties and can be readily used in food products.

Starch, protein, and fiber can be extracted, using wet or dry processes, from a variety of grain legumes and used as ingredients for food. A-galactosides can be isolated during wet processes from the soluble extract. Due to their high fermentability, a-galactosides induce the production of gases responsible for the digestive discomfort related to pulse consumption. These oligosaccharides are quite characteristic of grain legumes and are present in all species to one degree or another.

The characteristics of the extracted fiber very much depend on its origin. As a result, inner fibers are often used as texturing agents, while outer fibers are most commonly used in bakery and extruded products to increase the fiber content of the food.

The proportion of world dry pea production that is processed into protein, starch, and fiber fractions remains very small to date.

Moisture Content

Seeding, Growth, and Harvesting

Dry peas are adapted to grow during the cool season when *evapotranspiration* (i.e., the sum of evaporation and plant transpiration into the atmosphere) is minimal and rely on stored soil moisture for a large part of their growth cycle. In years of warm, wet springs and cool, wet summers, desiccant herbicides are important tools for promoting faster drying to avoid threats like pod shattering and sprouting, and seed coat slough and bleaching.

Despite having moisture requirements similar to those of cereal grains, dry peas have a lower tolerance to saline and water-logged soil conditions. Peas commonly die after 24 to 48 hours in a water-logged condition, making poorly drained and saline or alkaline soils a hazard when growing peas. Maintaining firm seed-to-soil moisture contact is critical. So seeding peas well into moisture is important, with a half inch being the minimum and one to three inches the preferred depth.

Excessive tillage in the spring is also to be avoided to prevent drying out the seedbed. By comparison to cereal grains pea seed

requires considerably higher amounts of moisture for germination. It is their relatively shallow root system and high water use efficiency that make them an excellent rotational crop with small grains, especially in arid areas where soil moisture conservation is key.

Dry peas can be harvested when seed moisture is less than 15 percent. Harvesting at very low moisture levels will cause losses from cracking and splitting, which can result in the crop being downgraded for the seed and food markets. Harvesting at too high a moisture content will require immediate aeration or drying.

Ideal threshing and separation occurs when the crop is below 13 percent seed moisture, while the harvest starts in late July when pods are dry and seed moisture is less than 13.5 percent.

Like dry peas, lentils have been adapted to grow during the cool season when evapotranspiration is minimal. They usually rely on stored soil moisture for a large part of their growth cycle. Proper packing after seeding is also very important to prevent moisture loss, and to make the ground smooth and even for harvest.

Also similar to dry peas, as long as moisture is available, lentils will continue to flower and set pods. If growers wait for the crop to dry naturally under such high-moisture conditions, they risk compromising the integrity and value of the crop. Weeds can also mechanically impair the harvest of the crop. Swathing improves the moisture uniformity of the lentil seed and reduces the amount of seed discoloration, helping protect seed quality and value.

In each case, the level of moisture can also impact herbicide effectiveness and pest control. The density and injury wrought by the wireworm, the larvae of the click beetle that feeds on plant roots, are directly related to soil moisture. Wireworms are generally low in years of average or below-average precipitation, and high and more destructive in years of above-average precipitation.

Due to a deep tap-root, the chickpea can use water from greater depths than other pulse crops. But because of its indeterminate nature, and the fact that it continues growing into the fall, the chickpea can deplete a field's subsoil moisture. If it is a dry fall and there is limited winter precipitation, this can undermine the cereal crop yields the following year.

Chickpeas are seeded at a depth of one inch below moisture for the Desi type and up to two inches below moisture for the Kabuli type. Kabulis may be planted to a depth of four inches to use available soil moisture for germination. To protect this necessary level of moisture, it is often recommended with chickpeas to minimize soil tillage to reduce moisture loss. This is especially important for the large-seeded Kabuli chickpeas. Chickpeas can be harvested at 18 percent moisture.

Desi chickpeas require a specialized seed coat removal process if used for human food. The process, called decortication, involves adjusting the moisture level of the seeds to facilitate the mechanical removal of the thick seed coat.

Storage

The moisture content of the legume has a major impact on how long that crop can be stored and remain nutritious and edible. This is because the outside of the seed can host thousands of fungi spores and bacteria. Though natural, such bacteria, if left to propagate in an environment of higher than recommended moisture, can promote disease and seriously compromise seed quality.

Seed moisture must, therefore, be carefully monitored when storing pulses. Peas can be safely stored at 15 percent moisture, chickpeas and lentils at 14 percent. Moisture is tested several times during the first few weeks of storage to maintain proper levels and to prevent *seed tendering* or sweating (i.e., the balancing of inner and outer seed moisture levels).

If moisture levels are too high, grain dryers are often used, though always with extreme caution as they can cause mechanical and thermal damage to pulse crops. Aeration is used to cool and dry the seed and to avoid storage complications.

Managing storage moisture levels for chickpeas can be especially challenging. When a chickpea seed is harvested, the outside seed coat normally has a lower moisture level than the inside of the seed. As it sits in the bin, the moisture level tempers, which can cause the overall moisture level to rise.

The result is that a crop that was harvested at a safe moisture level can, just a week later, have a moisture level higher than the recommended 14 percent. For this reason, chickpeas, like lentils, tend to be stored in a hopper-bottomed bin that has aeration, which, when left on, can bring the moisture down to prescribed levels.

Protein Content

The history of legumes is intertwined with that of human civilization. During times when meat was not available, legumes became an important staple by providing essential supplementing protein, as well as key vitamins and minerals. Protein was the major reason for the development of pulses, especially in Europe. It remains a signature feature of the diet of many millions of people around the world, often combined with a cereal crop to provide energy.

The protein values of legumes tend to range from 18.5 grams to 21.9 grams/100 grams for raw grains and from 21.3 grams to 23.7 grams/100 grams for freeze-dried cooked legumes. Pulses are also an important part of vegetarian diets because they

are rich in the amino acid lysine, and when combined with a source of the amino acid methionine, such as cereals, provide the balanced protein necessary for growth.

The higher protein of the legume seed and foliage is thought to be due in part to the additional nitrogen that legumes receive through nitrogen-fixation symbiosis. In round-seeded peas, high protein content is also often associated with increased *legumin* (i.e., a globulin found in legume seeds) content. The amount of protein varies in proportion and importance, depending on the species.

Studies conducted in the late 1990s suggest that the effect of the environment is the first source of variation for seed protein content. Among the variables contributing to the environmental influence on protein content is the efficiency of plant nitrogen nutrition.

The impact of legume variety on protein content is also usually significant, with a difference of 2 percent versus 3 percent when comparing the varieties with the lowest and highest protein content. Among U.S. pea cultivars, the Nitouche and Majoret varieties offer the highest protein content.

Yield does not appear to influence legume protein content. When the yield is low, it is possible to have low protein content if the nitrogen nutrition is deficient at flowering time and after. It is also possible to have a high yield and a high protein content at the same time. Similarly, no connection has been made between protein content and crop *height at harvest* (i.e., the standing ability).

In the search of new food protein resources, commercial facilities have begun focusing on extracting protein concentrates from pulses by air classification or wet milling techniques. Legume seeds can be *fractionated* (i.e., the separation out of component ingredients) to obtain the desired protein concentrates and isolates.

> "Due to a deep tap-root, the chickpea can use water from greater depths than other pulse crops."

Numerous studies have demonstrated significant genetic variability in seed protein composition and this offers the possibility of breeding for improved protein nutritional value. Before this can be done, the link between protein content, protein composition, and nutrient supply to the seeds will need to be further explored.

Also required will be a better understanding of the environmental interactions, the complex relationships between crop yield potential, plant carbon costs, and protein content. Additional investigation is similarly necessary into the various sources of instability, including drought stress, high temperatures, and symbiosis mechanisms.

Legumes provide both energy and protein for humans and animals. Increasing legume protein content and yield at the same time via genetic improvement through breeding is a goal currently being worked on by researchers. It is hoped that the results of these efforts will help point producers to the best strategies for improving their crops, while highlighting the existing potential for genetic progress in grain legumes.

Starch Content

Starch is the main carbohydrate reserve found in plants, accounting for 22 percent to 45 percent in the pea seed. It is also a major source of nutrition for humans and animals, and an important raw material for industry.

Starch content varies between genera, from negligible amounts to half the dry seed weight in a wild-type, round-seeded pea. Mutations that affect the activities of enzymes of the starch can dramatically affect not only the starch content but also its composition. Most starches from grain legumes also have a relatively high *amylose* (i.e., the inner portion of a starch granule) content compared to most starches.

Cooking legumes can significantly increase the rapidly digestible starch and decreases the resistant starch. Known as a prebiotic, resistant starch passes through the stomach and small intestine undigested. In the colon, it is digested along with dietary fiber to stimulate the growth of "good bacteria" and produce fatty acids that researchers have determined have anti-cancer properties.

It is thought that certain legume genes that affect starch synthesis might enable legume starch to be used for a wide range of food and non-food applications. Part of the interest is due to the beneficial health effects offered by legume starch. Their low glycemic index is, for example, credited with contributing to the prevention of diseases related to insulin resistance.

Legume starch has unique properties, including a good stability at high temperature and high point viscosity compared with cereal or tuber starches. These properties can be further improved by starch processing, including using chemical and biotechnological methods.

As with protein, legume seeds can be fractionated to capture the desired starch concentrates and isolates. Pea starch, for example, is usually made available as a byproduct of protein extraction. This makes it a relatively cheap source of starch compared to corn, wheat, and potato. Among dry pea varieties, the Miami and Nitouche have the highest starch content at 45 percent and 44 percent, respectively, while Majoret has the lowest at 41 percent.

Pea starch is used in some industrial applications like the paper and board industries, among detergent manufacturers, in the water-treatment industry, and for production of textiles, plastics, and pharmaceuticals. It is also an integral part of noodle manufacturing in China.

To date, starch from peas is used in deep-frozen dishes, dressings, extruded bakery products, cookies, crackers, sauces, instant soups, and puddings. They are often incorporated to modify food texture, which is important both for processing and consumer acceptance.

The isolation of starches from peas is difficult. Two techniques include pin milling and air classification. Air classification is the most commonly used commercial method. Separating the starch granules from the protein requires a very high degree of particle size reduction (achieved by pin milling). The major result from the air classification process is a low-protein starch, which is separated from the fine protein during the process. The concentrate is about 65 percent starch.

Researchers have also developed a process to extract starch from wrinkled peas. This involves the steeping of wrinkled pea seeds in warm water, separating hulls from cotyledons via hulling with rubber rollers, gentle particle size reduction of the cotyledons, and high-pressure disintegration of the screened-out protein/starch in the water. This facilitates the extraction of up to 89 percent of the starch present in the wrinkled peas.

> "The fiber from legume seeds boasts excellent hydration properties."

Starch has also been isolated from chickpeas, including one particular variety that seems to have similarities with native maize starch.

The production of legume starches remains small when compared to the 6 million total tons of starch produced each year. However, thanks to the characteristics of legume starches, especially their amylose content, food producers and others see a large potential for new applications targeted at industrial uses and human nutrition.

Fiber Content

Legumes have more dietary fiber than any major food group. One-half cup of cooked split peas provides 10 grams of dietary fiber or 40 percent of the daily recommended 25 grams (based on a 2000-calorie diet.) Servings of the most commonly consumed grains, fruits, and vegetables contain 1 to 3 grams of dietary fiber.

Some fibers are soluble and others insoluble. Most plant foods contain some of each kind. Soluble fiber can slow the absorption of lipids and lower blood cholesterol. It can also slow the increase of fecal bile excretion, promoting reduced intestinal absorption of fat and cholesterol. Insoluble fiber assists in maintaining regularity and helps prevent gastrointestinal problems.

When legumes are part of a diet low in saturated fat and cholesterol, dietary soluble fiber may actually reduce the risk of coronary heart disease. The exact mechanism by which this happens remains unknown, but scientists theorize that insoluble fiber adds bulk to stool, which in turn dilutes carcinogens and expedites their passage through the lower intestines and out the body.

The typical American eats only about 11 grams of fiber a day, according to the American Dietetic Association. Health experts recommend a minimum of 20 grams to 30 grams of fiber a day for most people. The Food and Drug Administration (FDA) has recognized fiber's importance by requiring it to be listed on the Nutrition Facts panel of food labels along with other key nutrients and calories.

Dietary fiber content varies according to the legume species, the variety, and the

Quick Facts

Legumes contain:

- 3 times as much iron as meat
- 2 times as much magnesium as rice
- 4 to 5 times as much potassium as meat
- 2 times as much phosphorous as 2 pounds of eggs, 3 times as much as a two pounds of meat

processing of the legume. In most legumes consumed by humans, the content ranges from 8 percent to nearly 28 percent, with soluble fiber in the range 3.3 percent to 13.8 percent. Dietary fiber content in the cotyledon of legume seeds is generally low compared to that of the testa, or outer seed coat.

The fiber from legume seeds boasts excellent water hydration properties that can be utilized in food products to replace fat in items including confectionery products, dressings, and meat. Such fiber provides a broad range of positive effects, both physiological and metabolic, related to the source of the fiber (from cotyledon or hull), with the nature of that benefit being dependent on the form in which the fiber is ingested.

The composition of the dietary fiber depends very much on its location in the seed coat (outer fiber) or in the cotyledons (inner fiber). A major difference between the inner and outer dietary fiber is the amount of cellulosic and non-cellulosic polysaccharides present.

The cell walls of the cotyledons contain a range of polysaccharides, including pectic substances (about 55 percent), cellulose (about 9 percent), and non-starchy non-cellulosic *glucans* (i.e., a polysaccharide that is a polymer of glucose) (6 percent to 12 percent). The seed coat contains large quantities of cellulose (35 percent to 57 percent) and lower amounts of *hemicelluloses* (i.e., polysaccharides that are more complex than a sugar and less complex than cellulose) and *pectins* (i.e., a water-soluble carbohydrate).

In terms of its use, inner fibers are generally employed in texturing or bulking of products. In many cases, they can replace food additives, offering the benefit of more favorable labeling of the product. The fiber is most commonly used in bread and baked goods, particularly biscuits, and to enrich mousses, jellies, drinks, and desserts.

The outer fiber is used primarily to enrich the fiber content of food, but without changing its technical properties. It is found mostly in bakery and extruded products, snacks, and cereals.

Processing can be applied to improve the functional characteristics of fiber. For example, a mixture of cellulose and appropriate enzymes has been used to enhance important characteristics like mouthfeel and smoothness. Success in this regard is influenced by the fiber dimensions, porosity, hydration, and rheological and fat-binding properties.

The dietary fiber is captured as a byproduct of the process of fractionation in which protein and starch concentrates are obtained from legume seeds. Preparations are generally richer in dietary fiber when obtained from hulls. Cotyledons contain variable

amounts of starch and protein, while the inner-fiber exhibits higher water-retention capacity than outer fibers.

Micronutrient Profile

Lentils, dry peas, and chickpeas are good sources of important minerals like iron, magnesium, phosphorous, and manganese. They also contain significant amounts of phosphorous, and the B vitamins, which play a key role in cellular metabolism. Lentils and chickpeas provide zinc as well.

While the iron aids in the prevention of anemia, zinc is one of several nutrients necessary for fending off infections. What's more, eating the recommended portion of legumes helps avoid the low magnesium that can come from a diet too heavily weighted with refined grains and cereals.

Lentils and chickpeas also boast among the highest concentrations of folate (or folic acid as it is called when used in supplements), a single cup providing 37 percent of the recommended daily allowance.

> "The typical American eats only about 11 grams of fiber a day."

A form of the water-soluble vitamin B9, folate is essential for growth and good health. But because it is not made by the body, it must be obtained from foods and supplements. For this reason the Food and Drug Administration (FDA) instituted rules in January 1, 1998, that grain products such

as breads, macaroni, rice, corn meal, and enriched flours are required to be fortified with folic acid.

Among its many health benefits, folate is necessary for the formation and development of new and normal tissue. Because new tissue forms at a rapid pace during pregnancy, the body's need for the important nutrient nearly doubles at that time, helping prevent anemia and the risk of neural tube defects such as spina bifida.

Folate also helps break down *homocysteine* (i.e., an amino acid associated with heart disease) in the body, improves metabolism functions as well as the immune and nervous systems, and promotes cell growth and division. New research suggests that folate may reduce asthma and allergy suffering as well.

3

CHAPTER

USA Dry Pea, Lentil & Chickpea Production

USA DRY PEA &
LENTIL COUNCIL

Cool season food legumes, including dry peas, lentils, and chickpeas, are an important feature of the dry farm lands of the western U.S. The two principal growing regions include the Northern Plains, comprised of Montana, North Dakota, and South Dakota, and the Palouse, which includes eastern Washington, northern Idaho, and northeastern Oregon.

Lentil production began in the Palouse in 1916, dry pea production in the 1920s, and chickpea production in 1981. The region offered excellent growing conditions and a growing season with annual rainfall of 15 inches to 24 inches (400 mm to 600 mm), most of which fell in the fall and winter months.

More recently, the Northern Plains region has become an increasingly important production area. Since the 1990s, the lion's share of U.S. food legume production has moved from the rolling hills and loess soils east of the Palouse into the Northern Plains region, where pulses fit well with the established crop rotation.

By 2009, North Dakota had become the largest producer of pulse crops in the U.S. Montana occupies the second position, cultivating the greatest number of yellow peas in the U.S., in addition to significant acreage devoted to lentils. Pacific Northwest farms in Washington and Idaho remain the largest producers of green peas and chickpeas. For U.S. production numbers for 2008, see tables on pages 45-54.

In those areas that receive sufficient rainfall to support annual cropping, food legumes continue to replace summer fallow. The region boasts considerable potential and its role as an important producer of dry peas and lentils is expected to continue. Meanwhile, the range of U.S. food legume varieties has changed over time and is likely to continue to evolve as breeding programs develop improved types.

The field history is an important consideration in pulse production. To allow for proper site preparation, the decision to grow pulses in a given field is usually made a year or two in advance. Approached this way, the "pre-plant" period for any field includes each of the production seasons that followed the previous pulse crop and the late fall, winter, and early spring that preceded planting of the pulse crop.

"By 2009, North Dakota had become the largest producer of pulse crops in the U.S."

The previous crop is especially important if the pulse crops are directly seeded into stubble. Sowing pulses into clean fields is preferred, but pulses are frequently seeded on stubble. In such situations, weed com-

petition is often an issue and can be complicated further by volunteer plant growth.

Seed selection includes considerations like crop quality potential, adaptability to the *planting conditions* (i.e., disease and environment), and improvement in the overall rotation—both economic and environmental.

Some varieties are well adapted to particular regions due to maturity rate, disease resistance, blooming date, and tolerance to temperature variations. Other considerations are based on quality such as color consistency, resistance to bleach and pod shatter, harvestability, and handling concerns like cracking during shipment. Pulses are best grown following a cereal crop like winter wheat or spring barley as cereals are less likely to carry pulse diseases.

Another benefit of planting pulse crops in rotation with cereals is that cereal crop yields often increase due to cereal pest (disease, insect, and weed) cycles being disrupted. In addition, food legumes conserve soil moisture and limit soil erosion by offering an option other than summer fallow. Pulses also increase the nitrogen content of the soil. This is a significant consideration, providing value to the producer in addition to the crop.

When it comes to seeding, maintaining firm seed-to-soil contact is critical, making moist soil, and the avoidance of dry soil, a critical step. Most pulse seeds can emerge from deep seeding depths due to their large size. Deep seeding is not a necessity provided that the seed is placed in firm, moist soil.

After planting, pulse crop beds are rolled to smooth the soil surface. This improves the harvest rate by reducing losses and breakage of low-hanging pods at harvest. Rolling also buries rocks, making harvest easier and safer. Harvest typically takes place in August. The crop must dry out on the vine to a certain degree first, which usually occurs without the aid of chemicals.

Chemicals that aid drying are, however, important during cool, wet summers when natural drying is not possible. Waiting for natural drying to occur can lead to pod shattering, sprouting, seed coat slough, and seed bleaching. When weeds are not a problem, dry peas and lentils are mechanically swathed or direct harvested.

India is the world's major producer of food grain legumes (about 13 million tons in 2003/2004): chickpeas (5.3 million tons), lentils (0.8 million tons), dry beans (about 3 million tons), and other pulses. Canada, Australia, and Turkey are the main world suppliers of chickpeas and lentils. Approximately 75 percent of U.S. cool season food legumes are exported.

Most U.S. legumes are used for food either as whole pulses, as with decorticated Crimson and Red Chief lentils, or as decorticated and split peas, as seen with green and yellow dry peas. New and novel uses, including incorporation into starches and snack items, continue to grow as interest in these healthy, versatile foods increases.

Given such developments, the future for food legumes in the U.S. looks bright. There is considerable room for expansion of production in the Dakotas, Montana, and the western states of Washington, Idaho, and Oregon. The trend to replace summer fallow in these states is opening additional acreage for legume production to meet increasing demand.

Finally, as of this writing none of the pulses available worldwide are genetically modified, and there are no plans to begin production of such pulses.

Environmental Benefits of Legumes

While cool season legumes directly contribute to the economy of the Palouse, the Northern Plains, and other U.S. production areas, they also contribute indirectly through their positive effects on other crops. Dry peas, lentils, and chickpeas are typically grown in *rotation* (i.e., alternating years) with cereal grains. In contrast to dry beans, the cooler weather preferred by legumes during the growing season, especially at bloom, fits well with the climates conducive to small grains like wheat or barley.

The crop rotation strategy boasts a number of advantages. The pairing with grains reduces the potential for diseases and helps to control weeds, insects, and other pests in both crops. The grains also benefit from the increased nitrogen and other nutrient values in the soil after rotation with lentils, dry peas, or chickpeas.

Legumes produce their own nitrogen from the atmosphere through a symbiotic relationship with a soil bacterium. As a result, commercial nitrogen applications are unnecessary or significantly reduced for the legume crops. The same is true with regard to the need for commercial nitrogen or other fertilizers in the grain crops, which can utilize the remaining nitrogen in the soil to reduce the input cost for the producer. Reduced nitrogen applications also reduce the use of the natural gas necessary to produce the nitrogen, thereby helping reduce greenhouse gas production. For both the producer and the environment, using nitrogen produced by the plant is a much better approach and promises a smaller ecological impact.

The Harvesting of Legumes

The harvesting of a cool season legume crop consists of a single pass with a combine, a mechanical harvesting device that integrates many operations. It cuts the plant from the ground, separates the seeds from the rest of the foliage, distributes the

residue across the field, and transfers the resulting product to a storage bin via a truck. In the U.S., the harvest generally begins in August and is conducted through September.

Harvesting of lentils, dry peas, and chickpeas is carefully timed. Using the combine on the crop prematurely can result in an immature, underdeveloped crop. Harvest the crops too late and the excessive dryness can cause crop loss due to the shatter of the pods prior to or during harvest.

Moisture Content of Harvested Material

Ideal harvest timing includes waiting for moisture content to be acceptable for storage. Harvesting too early can result in a product with too much moisture content for storage, making it prone to spoilage.

The crop is usually cut when the product is not yet ready to shatter but dry enough to store without damage. No product is stored at more than 15 percent moisture, with 12 percent or less being the optimum moisture level for a harvested crop.

Differences in Harvest Times

Although dry pea, lentil, and chickpea crops are relatively drought-tolerant, both the timing and amount of precipitation affect growing duration and the scheduling of harvest times. In the Palouse, for example, late-season rains after July 15 will delay harvest, while early-season drought prior to July 1 will significantly accelerate harvest dates. Planting is typically done in April and May, with an August harvest.

In Idaho and Washington, dry pea crop maturity is reached about 100 days after emergence, with harvest starting in late July when pods are dry and seed moisture is less than 13 percent. The peas are harvested directly in the field. In the Northern Plains, the planting date and harvest dates are typically two to three weeks later because of colder winter soil temperatures. Harvest is typically starts in August and completes in early September.

Lentil crops also reach maturity about 100 days after emergence, with harvest in mid-August, when the crop is swathed and then combined. In Washington, lentils bloom approximately 60 days after crop emergence and all varieties are harvested in August, being cut and swathed into windrows approximately one week before combining.

Swathing of lentils in the Northern Plains in Montana and North Dakota is risky due to frequent wind storms, which would blow away the windrows. Lentils are cut directly by the combine in this region. In all cases, a timely harvest is critical to avoid seed bleaching, seed shatter and post-maturity disease. All of these issues degrade the quality of the crop and reduce the yield.

Storing Legumes

Once the pulse has been threshed, the seeds must be carefully stored prior to delivery to the processing plant. Excessive heat can lead to discoloration. Excessive moisture can result in mold and fungal problems. Clean, protected facilities and aeration during periodic transfers from one storage bin to another help guard against post-harvest pest infestation or damage.

When properly selected, legumes can be safely kept in storage for long periods of time without deterioration, allowing end-users to buy in bulk. With dry peas, the pea weevil can emerge during post-harvest storage, leaving damaged seeds that must be separated in processing. The pea weevil is most effectively controlled in the field during the growing season, helping prevent higher processing costs. Generally, all peas are held long enough to allow for the emergence of the pea weevil larvae prior to processing.

Seed moisture must be carefully watched when storing pulses to prevent disease or damage. Peas can safely be stored at 15 percent moisture, chickpeas and lentils at 14 percent. If moisture levels are too

high, grain dryers are often used, though always with extreme caution as they can cause mechanical and thermal damage to pulse crops. Moisture is tested several times during the first few weeks of storage to maintain proper levels and to prevent seed sweating. Aeration is used to cool and dry the seed and to avoid storage complications.

A significant amount of the chickpea crop remains at least for a short time stored on the farm before being delivered to the processor. Once chickpea seed is harvested, its outside seed coat usually has a lower moisture level than the inside of the seed. But if left to sit in the storage bin, the moisture level can balance out (also called *tempering* or *sweating*), causing the overall moisture level to rise.

In this way, chickpeas that were harvested at a safe moisture level can just a week later exceed the recommended 14 percent level. Left untreated, the crop can spoil. For this reason, chickpea producers often store the crop in a hopper-bottomed bin that has aeration, which can help bring down the moisture level.

Lentils are also commonly stored on the farm for a time before delivery to the processor. As with chickpeas, it is most common for lentils to be stored in a hopper-bottomed bin with aeration. If the crop includes a great deal of green weed seeds, the lentils, though safely stored at 14 percent moisture, are typically cleaned or aerated as soon as possible after harvest to prevent heat damage. Lentil varieties with green seed coats will discolor with age, decreasing the grade and price of the crop.

If they are not kept in cool, dark conditions at a moisture content at or below 14 per-

cent, those lentils with green seed coats can discolor as tannins within the seed coat oxidize. Other factors such as high humidity and high temperatures can also cause color change. In each case, such changes in color impact the grade and price received for the crop.

> "Dry peas, lentils, and chickpeas can be safely stored for three to four years."

Moisture levels up to 16 percent and temperatures below 59 degrees F (15 degrees C) are considered safe for dry pea storage. If supplemental heat drying is necessary, air temperatures are kept below 109 degrees F (43 degrees C) to preserve germination. Temperatures up to 158 degrees F (70 degrees C) should only be used for drying feed peas. A great deal of respiration occurs in pea seed after it is placed in storage.

Dry peas, lentils, and chickpeas can be safely stored for three to four years. Storage lengths of this duration can, however, result in color loss, moisture absorption, and desorption as well as hardness or case hardness issues.

Post-Harvest Handling

Deterioration Factors and Their Control

As noted above, moisture control via temperature control and proper aeration can minimize crop loss due to deterioration. Exposure to sunlight can also cause a degradation in color. Good storage facilities maintain the product by protecting it from direct sunlight.

Care needs to be taken when handling chickpea seed in order not to damage the beak or crack the seed coat, which impact the quality. This is especially important under conditions of extreme cold. The cold can damage the seed coat by causing it to become quite fragile and crack easily when handled. Many pulse producers forego use of the typical grain auger and elect to use a conveyor to transport the chickpea to the bin to minimize the risk of damaging the seed.

Similar sensitivity is shown when handling lentil seed to avoid cracking the seed coat. In fact, handling is minimized where possible and the use of conveyors favored. Extremely dry seed can be tempered in the spring before seeding to decrease the risk of mechanical damage. The lentil seed coat, like pea seed, is prone to greater fragility under extreme cold and can crack easily when handled.

Methods of Reducing Deterioration

Handling and storage procedures described above reduce deterioration due to seed coat damage or heat. Pesticide and fungicide use is minimized when pre-harvest and post-harvest controls are carefully monitored. In addition to reducing the cost of storage, limited chemical use maintains the crop well below maximum residue limits (MRLs).

Quality Control Procedures

Quality control begins with the seed source. Producers generally work with the processor to select the best varieties from reliable seed producers to ensure the harvested product is the best quality and offers good, marketable traits.

Product Grading Standards

The inspection of legumes is a service provided under the Agricultural Marketing Act of 1946. It is offered upon request by either a Federal Grain Inspection Service (FGIS) designated cooperator (e.g., the State of Washington) or an FGIS field office, depending upon the location of the lot and the type of inspection requested. Official inspections are performed by trained and licensed (or authorized) official personnel employed by FGIS or a cooperator.

The U.S. Grade Standards provide the produce industry with the uniform language for describing the quality and condition of commodities in the marketplace. In partnership with industry members, the Agriculture Marketing Service (AMS) of the United States Department of Agriculture (USDA) develops and revises these standards so that they always reflect modern business practices.

The USDA post-harvest inspection standards assess insect infestation, color, odor, moisture content, standardization in size and color, and many other factors. FGIS provides a system by which grain can be tested and graded anywhere in the U.S. under consistent and uniform procedures. Inspections involve securing a representative sample from each lot and classifying each of the individual peas or lentils in accordance with the established grades. The inspector's report shows the percentage of peas or lentils in each of the various grades. Application of the standards requires the services of private or official inspectors.

> "For green peas, the most important grading factor for the human market is seed color."

Crops are tested for pesticide and fungicide residue and are not allowed to exceed set limits for these factors. Strict sampling standards ensure proper grading of the product. Dry peas, lentils, and chickpeas are sampled first for insect infestation and are not sampled for other factors if sufficient evidence of infestation is found. Special care is typically taken to protect samples from manipulation, substitution, and improper handling.

There are many ways in which a sample may lose its representativeness. A sample will no longer be considered representative if it is:

1. Spilled, no matter how little is lost or how much could be recovered.
2. Stored in an improper manner or in an area not under the control of official personnel.
3. Not analyzed on the same day as it is obtained and stored in a cool, dry place to prevent any change in condition.
4. Transported by means that do not ensure the integrity of the sample.

When marketing food-grade dry peas, numerous factors affect market grade, including market class (e.g., green or yellow cotyledon, specialty types), seed size and shape, splitting potential, harvest moisture, seed handling techniques during harvest and storage, and seed damage factors (e.g., bleach, cracked seed coats, splits, shriveled seed, earth tag, chalk spot, etc.).

For green peas, the most important grading factor for the human market is seed color. Green varieties are susceptible to bleaching as they near maturity, often caused by high humidity, bright sunshine, and warm temperatures. Other major factors in downgrading pea quality include soil particles, splits, cracked seed coats and shriveled, immature seed.

Unlike other legumes, *decorticated lentils* (i.e., lentils from which the hulls have been removed) are treated as a processed product and are considered a non-standardized commodity. They may be inspected for quality factors (e.g., damaged kernels, skinned lentils, etc.) but not graded.

For inspected legumes, a certificate is issued for the individual lot or submitted sample whether for kind, class, grade, factor analysis, equal-to-type, or other quality designations as defined in the standards or instructions, or for any other approved services performed. Other services that may be shown on the certificate include check weighing, check loading, check counting, condition of food containers, plant approval, and observation of loading.

Organic/Natural Dry Peas, Lentils, Chickpeas, and Other Special Varieties

In response to its continued growth, the USDA began tracking overall organic food production in 2009. U.S. organic food sales amount to approximately 4.5 percent of total food sales, though the portion that is made up of organic pulses remains uncertain. As organic pulses have only recently begun to attract attention, there remains a dearth of market statistics. A significant portion are grown as a green manure, cover, or forage crop, and less for human consumption.

At the retail level, overall organic sales have grown 15 percent to 20 percent each year for the past couple of decades, led

most recently by dairy and meat. The dramatic growth in dairy is an indicator that many more organic feed peas are grown now than were grown 10 years ago. Peas are, in fact, likely the largest organic pulse crop as they are relied on by larger organic farmers as an important feature of their crop rotation plan to increase the quality of the subsequent wheat crop.

Though a definite figure has not yet been established by the USDA, it is estimated that the number of acres devoted to the production of organic pulse crops is in the thousands—about 1.5 percent of total agricultural acreage. In 2001, according to the USDA, certified organic dry peas and lentils were grown on more than 9,300 acres. North Dakota led with over 3,500 acres. Organic dry peas and lentils accounted for approximately two percent of the total dry pea and lentil acreage in the U.S. The European Union total is about equal to the U.S. market for organic sales, though its percentage of organic food sales to total sales is larger.

Much of the overall organic food consumed in the U.S. is imported from producers outside the U.S. Currently, a significant quantity of those organic legumes are imported from Canada, Turkey, India, China, and South America. Foreign organic legume production has always been larger than domestic U.S. production, with Canada, Australia, Turkey and India being key producers.

The challenges of organic pulse farming include the following:

- Organic farmers cannot use synthetic herbicides or pesticides, so weed pressure is always an issue. Chickpeas are a particular challenge since toxic or synthetic seed treatments are prohibited, highlighting the risk of ascochyta blight.
- Organic farmers are required to use organic seed when available. Seeding rates also tend to be higher than for cereal grains, meaning that seed costs per acre are significantly higher for organic legumes than for organic wheat.
- The organic pulse market remains niche in size. As a result, there are a limited number of buyers in a given region and often no local markets for feed-grade product.
- Organic edible legume markets tend to be very quality sensitive, making it difficult to sell anything less than a top-grade lentil in most years.
- Competition is aggressive in both domestic and foreign markets.
- There is little university research on organic legume production and organic variety development.

All indications are that organic markets at the retail sales level will continue to grow at 10 percent to 20 percent per annum for the foreseeable future. Expectations are that demand for organic food will continue to outpace growth in all other food categories. This, combined with the increasing awareness of the connection between diet and health, suggests that the demand

for organic legumes will also increase and that organic legume production will grow as an important, albeit small, part of overall production.

> "Pea crops are monitored closely to determine the proper stage for harvest."

A Comparison of the Production of Pulse Varieties

Dry Peas

Soil and Seeding

Dry peas can be grown in a wide range of soil types, from light sandy to heavy clay. Despite having moisture requirements similar to those of cereal grains, dry peas have a lower tolerance to saline and water-logged soil conditions than do cereal grains. Because they can die after 24 to 48 hours in a water-logged condition, dry peas are not planted in poorly drained or saline or alkaline soils.

At the same time, maintaining firm seed-to-soil moisture contact is critical as dry peas rely on stored soil moisture for a large part of their growth cycle. A seeding depth of one to three inches is customary.

Seedbed preparation is also essential for dry peas. Traditionally, a finely worked, firm seedbed is prepared for use with preplant herbicides. After seeding, a packer is used to smooth and firm the soil surface for good seed-to-soil contact. A plant stand of 15 to 20 plants per square foot after emergence is desired for optimum yield.

Dry peas are self-pollinating and emerge and perform well in a variety of seedbeds, including direct seeding into grain residue. They are typically grown following cereal crops like winter wheat or spring barley. Most are spring-seeded, with optimal planting dates ranging from mid-March to mid-May when soil temperatures are above 40 degrees F (4 degrees C).

Emergence normally takes 10 to 14 days. Pea roots can grow to a depth of three to four feet, though more than 75 percent of the root biomass resides within two feet of the soil surface. The older, bottom pods mature first, and the crop is at maturity when all pods are yellow to tan in color. During hot, dry weather, peas mature very rapidly. Because high temperatures during blossoming results in reduced seed set, production of dry pea as a summer annual in the U.S. is limited to the northern states.

Due to the prostrate vines that some varieties develop by the time they reach maturity, dry pea plants can be difficult to harvest. Increasingly, growers prefer a dry pea variety that stands upright at harvest, such as the semi-leafless types with shorter vines, because they allow a faster harvest, minimal equipment modification, and higher quality seed.

Pea crops are monitored closely to determine the proper stage for harvest. In most cases, plants mature from the bottom up. They are near maturity when the bottom 30 percent of the pods are ripe, the middle 40 percent of pods and vines are yellow, and the upper 30 percent of pods are in the process of turning yellow.

Dry peas are usually harvested the same time as wheat, or as soon as the seed is hard. If harvesting is delayed, seeds may

shatter. To reduce such losses dry pea harvesting is typically carried out before all pods are dry, or at night or early morning, when pods are wet with dew. Because dry peas do not ripen as uniformly as other crops, it can be necessary to harvest while there are green leaves and pods remaining.

Harvest usually begins in late July when seed moisture is 8 percent to 18 percent, depending upon the growing region. Harvest of determinate varieties occurs when the bottom peas rattle in the tan to brown pods, the middle and top pods are yellow to tan, and the seeds are firm and shrunken. They are harvested directly in the field, with each pod typically containing six to eight mature peas.

Production Trends

Dry peas rank fourth in terms of the world production of food legumes below soybeans, peanuts, and dry beans. Yellow peas and green peas, along with other minor classes, are the most commonly grown, with yellow peas accounting for approximately two-thirds of U.S. production.

The largest use of dry peas in Europe and North America is in the compound feed industry, whereby whole seeds are ground and mixed with ground cereal seeds to produce feeds.

In 2004, dry peas were produced in over 84 different countries for a total world production of approximately 11.91 million metric tons. Canada, France, and China, are the major dry pea producers in the world followed by Russia, India, and the United States.

From 1993 to 2002, world dry pea production steadily declined to a low of 9.859 million metric tons. As of 2008, total production worldwide is estimated to be 10.3 million metric tons.

About 2.5 million metric tons were exported in 2003. Over 140 countries imported dry peas in that year. Europe, Australia, Canada, and the United States raise nearly 4.5 million acres and are the major exporters of dry peas.

The U.S. accounted for just over four percent of world dry pea production in 2004. Acreage devoted to dry peas is on the increase, rising from 149,000 acres in 1993 to a record high 530,000 acres in 2004. By 2006, there were approximately 924,174 acres of field peas grown in the U.S. Because of their high quality, U.S. dry peas are used primarily for human consumption.

For years, U.S. dry peas were primarily grown in the Palouse region of Washington and Idaho. In the 1990s, North Dakota and Montana began production efforts of their own. In 1991, North Dakota planted about 1,600 acres of dry peas. By 2002, the state produced 47 percent of total U.S. output, followed by Washington at 31 percent, Idaho 15 percent, Montana five percent, and Oregon two percent.

Total U.S. production of dry peas reached approximately 517,962 metric tons in 2004, nearly doubling the previous record high of 269,164 metric tons recorded in 1998.

North Dakota's role in dry pea production continued to grow in the new century, reaching 610,350 acres by 2006, fully 66 percent of total U.S. production.

More than 70 percent of the total U.S. dry pea production is exported to India, China, and Spain for food and feed processing.

Lentils

Soil and Seeding

For lentils, the seeding depth should be 1.2 inches to 3 inches. Proper packing after seeding is very important to make the ground smooth and even for harvest, and it also helps prevent moisture loss. While tolerant to frost, lentil seedlings are very sensitive to wind damage. In such cases, new lentil seedlings will typically emerge from nodes beneath the surface.

Performing well in a variety of seedbeds, lentils are often seeded directly into grain residue or standing stubble if residues are insufficient to protect the soil surface. They are typically grown following winter wheat or spring barley.

Usually sown in late April or early May, lentils are most successful when soil temperatures are above 40 degrees F (4 degrees C). In North America, lentils are planted in early spring and harvested in late summer. By seeding early, farmers are able to increase the height and size of the plant at first bloom. Lentils planted after April typically result in a lower crop quality and smaller seed yields.

Lentils are drilled in rows six to seven inches apart. The crop is adapted to grow during the cool season and in most of the production region lentils rely on stored soil moisture for a large part of their growth cycle.

Lentils are self-pollinating, As with other legumes, lentils start flowering after a specific number of nodes have been reached and continue until drought or nitrogen deficiency ends flowering. Maturity is reached about 100 days after emergence.

No drying is necessary, as the crop naturally dries in the field. All varieties are harvested in August and September. Lentils are cut and swathed into windrows approximately one week before harvesting to dry down the weeds and the lentils in instances of uneven crop maturity or heavy weed infestation. Swathing improves moisture uniformity of the lentil seed and reduces the amount of seed discoloration.

Swathing occurs when about 30 percent of the lowermost pods turn tan and their seeds rattle. Doing so under conditions of higher humidity may reduce shattering. Lentils can also be straight-cut (i.e., meaning one-pass with the same implement cuts and harvests the seed from the pods).

Swathers or straight-cut combines are best equipped with a flex header, or a pick-up reel and vine lifters, since lentil plants tend to lay quite flat on the ground at harvest.

Because dry seed is prone to chipping and peeling during threshing, producers try to thresh at about 18 percent moisture and use aeration to dry the sample to 14 percent for safe storage.

> "Disease pressure limits the crop rotation for lentils to once every three to four years."

Harvested lentils are shipped back to the buyer from the farm and then shipped to market or further processed per specifications of the buyer. Processing can entail hulling and splitting of the lentil before shipping. As a food, lentils can be stored indefinitely in a cool, dry place without losing nutritional value, taste, or freshness.

Disease pressure limits the crop rotation for lentils to once every three to four years.

Production Trends

Nearly 90 percent of the lentil crop in the U.S. is exported, although domestic consumption is on the rise. Export markets include Asia, the Middle East, Latin America, Europe, and Africa. Recent niche markets for small Spanish brown lentils (Pardina variety, grown for sale to Spain) and red lentils (Crimson variety, grown for sale to the Asian market) have provided greater profitability than the traditional large yellow cotyledon (Brewer variety) market. An increasing number of acres in the U.S. are being seeded with specialty lentils like the Pardina and Crimson.

Chickpeas

Soil and Seeding

Seeding rates for chickpeas tend to provide three (Kabuli) to four (Desi) plants per square foot to help promote adequate seed size at harvest. Seeding depth is about 1 inch below moisture for Desi and up to 2 inches below moisture for Kabuli chickpeas, though Kabulis can be planted down to 4 inches to use available soil moisture for germination.

The chickpea has deeper taproots than peas and lentils, giving it more drought tolerance. Chickpea resistance to early or late frost is similar to that of peas and lentils, with chickpeas offering a higher temperature tolerance during flowering than peas. Plant height of the Kabuli ranges from 14 inches to 22 inches and from 10 inches to 20 inches with Desi types. Kabuli chickpeas generally mature two weeks after Desi types.

Seed color is the most significant factor in determining a chickpea crop's marketability as dark or discolored seed coats may make them unacceptable to food processors. Decisions such as harvest timing and methods have the greatest impact on developing seeds with the light yellowish-cream color preferred by the market.

It is also important that the small protruding beak-like structure that distinguishes chickpeas must not be damaged during harvesting. Chickpeas can be harvested at 18 percent moisture and stored at 14 percent seed moisture.

Chickpea plants are distinguished by stiff stems and generally upright growth, with pods developing several inches above ground. There is a threat of pod loss if there is a break in the small stem that attaches the pod to the plant. Pod shattering, on the other hand, is not as common as in some other legumes.

Chickpeas are usually straight-cut but can be swathed ahead of the combine if straight-cut equipment is not available. To reduce pod loss, swathing is generally done when the plants are slightly damp. Wind is also a factor as it can damage swaths.

Since green, immature seeds can result in chickpeas being downgraded and their value impacted, producers prefer to harvest when the majority of the crop is mature. This can require the field to be harvested in stages, leaving immature areas to a later date.

Producers normally harvest when the seeds are at approximately 18 percent moisture. Care must be taken not to damage the seed, especially the large Kabuli types. Due to their different seed coats, Kabuli and Desi chickpeas are handled in a slightly different way.

The recommended crop rotation for chickpeas is once every four years, mostly because of the aggressive nature of ascochyta blight, one of the major diseases for the chickpea. A once-in-four-year rotation will allow for the breakdown of chickpea residue on which the disease thrives.

Production Trends

World chickpea production is roughly three times that of lentils. Among pulse crops marketed as human food, world chickpea consumption is second only to dry beans. The major chickpea exporters include Turkey, Australia, Syria, Mexico, Argentina and Canada. About 90 percent of the crop, mostly of the Desi type, is consumed in India.

North American chickpea production was once concentrated in California and the Pacific Northwest. Today, U.S. chickpea production is located in Idaho, Washington, Oregon, Montana, North Dakota, South Dakota, Nebraska, Colorado, and California. Production has also expanded to over 1 million acres in the Canadian Prairies (primarily Saskatchewan).

In the U.S., Kabuli chickpeas are most commonly sold as canned garbanzo beans for use in salads. They are also marketed in a dry form and used in ground flour for baking. If used as human food, Desi chickpeas are decorticated, which involves adjusting the moisture level of the seeds so the thick seed coats can be removed. Decorticated Desi chickpeas are used in East Asian processed products as well as South Asian cuisines.

2008 USADPLC CROP PRODUCTION REPORT
TOTAL U.S. PRODUCTION

REGULAR GREEN PEAS

Year	Acreage	Hectares	lbs/acre	Pounds	Metric Ton
2008	308,429	124,914	1,475	454,848,250	206,318
2007	331,247	134,155	1,798	595,666,181	270,192
2006	382,406	154,874	1,542	589,801,822	267,532
2005	391,664	158,624	1,676	656,522,845	297,797
2004	276,456	111,965	2,467	682,052,193	309,377
2003	232,007	93,963	1,590	368,843,629	167,306
6 Year Average	320,368	129,749	1,758	557,955,820	203,498

SMALL SIEVE GREEN PEAS

Year	Acreage	Hectares	lbs/acre	Pounds	Metric Ton
2008	2,639	1,069	2,060	5,437,040	2,466
2007	2,666	1,080	1,713	4,565,921	2,071
2006	2,960	1,199	2,042	6,043,003	2,741
2005	3,652	1,479	1,859	6,788,589	3,079
2004	4,754	1,925	2,365	11,241,771	5,099
2003	3,566	1,444	1,480	5,278,705	2,394
6 Year Average	3,372	1,366	1,920	6,559,172	2,975

LARGE LENTILS***

Year	Acreage	Hectares	lbs/acre	Pounds	Metric Ton
2008	32,322	13,090	822	26,557,024	12,046
2007	35,298	14,296	1,319	46,567,997	21,123
2006	19,280	7,808	1,162	22,406,300	10,163
2005	20,329	8,233	1,002	20,365,039	9,238
2004	5,319	2,154	2,225	11,832,954	5,367
5 Year Average	20,057	8,123	1,427	25,293,073	11,473

SMALL CHICKPEAS

Year	Acreage	Hectares	lbs/acre	Pounds	Metric Ton
2008	8,398	3,401	1,730	14,526,035	6,589
2007	15,065	6,101	1,110	16,726,000	7,587
2006	31,978	12,951	1,125	35,970,119	16,316
2005	10,760	4,358	1,427	15,357,975	6,966
2004	1,540	624	652	1,003,738	455
5 Year Average	13,548	5,487	1,209	16,716,773	7,583

MEDIUM LENTILS** Reported as "Regular Lentils" before 2004					
Year	Acreage	Hectares	lbs/acre	Pounds	Metric Ton
2008	143,047	57,934	986	140,979,638	63,948
2007	186,635	75,587	1,293	241,381,853	109,490
2006	295,509	119,681	1,174	346,914,397	157,359
2005	303,043	122,732	1,267	384,090,129	174,222
2004	259,598	105,137	1,191	309,240,698	140,271
2003	76,671	31,052	861	65,999,436	29,936
6 Year Average	210,751	85,354	1,129	248,101,025	112,538

YELLOW PEAS					
Year	Acreage	Hectares	lbs/acre	Pounds	Metric Ton
2008	528,089	213,876	1,285	678,631,812	307,825
2007	548,600	222,183	1,955	1,072,502,616	486,484
2006	581,134	235,359	1,434	833,541,060	378,092
2005	403,762	163,524	1,945	785,322,022	356,220
2004	226,383	91,685	1,706	386,248,087	175,201
2003	72,580	29,395	1,790	129,912,434	58,928
6 Year Average	393,425	159,337	1,686	647,693,005	293,792

AUSTRIAN WINTER PEAS					
Year	Acreage	Hectares	lbs/acre	Pounds	Metric Ton
2008	11,504	4,659	1,271	14,621,871	6,632
2007	25,220	10,214	1,253	31,606,527	14,337
2006	49,066	19,872	924	45,354,050	20,572
2005	7,170	2,904	1,145	8,210,131	3,724
2004	17,486	7,082	1,565	27,357,702	12,409
2003	18,650	7,553	1,280	23,879,468	10,832
6 Year Average	21,516	8,714	1,240	22,737,083	11,417

LARGE CHICKPEAS****					
Year	Acreage	Hectares	lbs/acre	Pounds	Metric Ton
2008	65,327	26,458	1,396	91,196,956	41,367
2007	115,997	46,979	983	114,002,016	51,711
2006	112,751	45,664	1,048	118,211,146	53,620
2005	85,738	34,724	982	84,194,649	38,190
2004	20,198	8,180	1,277	25,787,441	11,697
2003	28,546	11,561	953	27,209,441	12,342
6 Year Average	71,426	28,928	1,107	76,766,942	34,821

SMALL LENTILS* Reported as "Other Lentils" before 2004					
Year	Acreage	Hectares	lbs/acre	Pounds	Metric Ton
2008	72,756	29,466	1,094	79,603,188	36,108
2007	91,168	36,923	1,229	112,047,206	50,824
2006	104,986	42,519	950	99,737,766	45,241
2005	68,808	27,867	958	65,939,078	29,910
2004	72,702	29,444	1,037	75,364,122	34,185
2003	158,983	64,388	1,115	177,343,425	80,442
6 Year Average	94,901	38,425	1,064	101,672,464	46,118

2008 U.S. PRODUCTION SUMMARY TABLE

	Acres	lbs/acre	Pounds	Metric Ton
Green Peas	311,068	1,480	460,285,290	208,784
Yellow Peas	528,089	1,285	678,631,812	307,826
AWP	11,504	1,271	14,621,871	6,632
Lentils	248,125	996	247,139,850	112,102
Chickpeas	73,725	1,434	105,722,991	47,956

* Pardina, Morton, Eston Varieties

** Brewers, Richlea, Merrit, red Chief Varieties

*** Mason, Pennell, Palouse, VanGard, Laird Varieties

**** US Large Chickpeas includes CA Production

Notes:
This report contains yield and acreage data from industry processors, the Farm Service Agency, and the National Agricultural Statistics Service.
Acreage data for 2008 has been amended since posting of the Industry Seeded Acreage Report, July 2008.

USADPLC 2008 PRODUCTION REPORT - PNW

REGULAR GREEN PEAS					
Year	Acreage	Hectares	lbs/acre	Pounds	Metric Ton
2008	81,524	33,017	1,649	134,411,267,	60,969
2007	79,587	32,233	1,557	123,950,881	56,224
2006	89,364	36,192	1,506	134,580,322	61,045
2005	114,659	46,437	1,370	157,082,830	71,252
2004	121,307	49,129	1,978	239,984,275	108,856
2003	112,107	45,403	1,281	143,613,629	65,143
6 Year Average	99,758	40,401	1,557	155,603,867	70,582

SMALL SIEVE GREEN PEAS

Year	Acreage	Hectares	lbs/acre	Pounds	Metric Ton
2008	2,639	1,069	2,060	5,437,040	2,466
2007	2,666	1,080	1,713	4,565,921	2,071
2006	2,960	1,199	2,042	6,043,003	2,741
2005	3,652	1,479	1,859	6,788,589	3,079
2004	4,754	1,925	2,365	11,241,771	5,099
2003	3,566	1,444	1,480	5,278,705	2,394
6 Year Average	3,378	1,366	1,920	6,559,172	2,975

LARGE LENTILS***

Year	Acreage	Hectares	lbs/acre	Pounds	Metric Ton
2008	2,631	1,066	925	2,433,832	1,104
2007	3,205	1,298	824	2,642,447	1,199
2006	1,400	567	653	913,700	414
2005	4,329	1,753	442	1,915,039	869
2004	5,319	2,154	2,225	11,832,954	5,367
5 Year Average	3,563	1,443	1,036	4,326,035	1,962

SMALL CHICKPEAS

Year	Acreage	Hectares	lbs/acre	Pounds	Metric Ton
2008	3,006	1,217	1,680	5,049,475	2,290
2007	5,565	2,254	1,116	6,211,000	2,817
2006	10,014	4,056	1,181	11,829,300	5,366
2005	4,760	1,928	1,178	5,607,975	2,544
2004	1,540	624	652	1,003,738	455
5 Year Average	5,470	2,215	1,032	6,163,003	2,796

MEDIUM LENTILS**

Reported as "Regular Lentils" before 2004

Year	Acreage	Hectares	lbs/acre	Pounds	Metric Ton
2008	39,811	16,123	981	39,061,090	17,718
2007	43,795	17,737	972	42,587,853	19,318
2006	48,059	19,464	1,098	52,753,702	23,929
2005	72,039	29,176	918	66,141,917	30,002
2004	79,109	32,039	1,114	88,146,884	39,983
2003	75,671	30,647	855	64,696,436	29,346
6 Year Average	59,747	24,198	990	58,897,980	26,716

YELLOW PEAS

Year	Acreage	Hectares	lbs/acre	Pounds	Metric Ton
2008	10,591	4,289	1,924	20,375,299	9,242
2007	12,200	4,941	1,690	20,621,681	9,354
2006	7,754	3,140	1,417	10,987,560	4,984
2005	13,096	5,304	1,558	20,397,994	9,252
2004	10,122	4,099	1,873	18,954,321	8,598
2003	12,510	5,067	1,406	17,589,934	7,979
6 Year Average	11,046	4,473	1,644	18,154,465	8,235

AUSTRIAN WINTER PEAS

Year	Acreage	Hectares	lbs/acre	Pounds	Metric Ton
2008	3,947	1,599	1,557	6,147,306	2,788
2007	7,720	3,127	1,184	9,139,962	4,146
2006	14,787	5,989	1,054	15,581,200	7,068
2005	7,170	2,904	1,145	8,210,131	3,724
2004	7,754	3,140	2,087	16,183,482	7,341
2003	9,250	3,746	1,256	11,614,468	5,268
6 Year Average	8,430	3,418	1,381	11,146,091	5,056

LARGE CHICKPEAS

Year	Acreage	Hectares	lbs/acre	Pounds	Metric Ton
2008	52,258	21,164	1,270	66,342,176	30,093
2007	79,247	32,095	914	72,462,016	32,869
2006	80,875	32,754	1,039	84,032,326	38,117
2005	58,738	23,789	925	54,332,649	24,645
2004	20,198	8,180	1,277	25,787,441	11,697
2003	17,030	6,897	883	15,040,241	6,822
6 Year Average	51,391	20,813	1,051	52,999,475	24,041

* Pardina, Morton, Eston Varieties

** Brewers, Richlea, Merrit, red Chief Varieties

*** Mason, Pennell, Palouse, VanGard, Laird Varieties

Notes:
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SMALL LENTILS* Reported as "Other Lentils" before 2004					
Year	Acreage	Hectares	lbs/acre	Pounds	Metric Ton
2008	44,594	18,061	1,201	53,548,917	24,290
2007	61,501	24,908	1,183	72,780,106	33,013
2006	71,801	29,079	857	61,498,566	27,896
2005	63,808	25,842	934	59,614,078	27,041
2004	72,702	29,444	1,037	75,364,122	34,185
2003	81,623	33,057	964	78,655,425	35,678
6 Year Average	66,005	26,732	1,029	66,910,202	30,351

USADPLC 2008
PRODUCTION REPORT - MIDWEST

REGULAR GREEN PEAS					
Year	Acreage	Hectares	lbs/acre	Pounds	Metric Ton
2008	226,905	91,897	1,412	320,436,983	145,349
2007	251,660	101,922	1,874	471,715,300	213,969
2006	292,912	118,629	1,553	454,961,500	206,369
2005	277,005	112,187	1,803	499,440,015	226,545
2004	155,149	62,835	2,849	442,067,918	200,521
2003	119,900	48,560	1,878	225,230,000	102,164
6 Year Average	220,589	89,338	1,895	335,998,453	182,486

LARGE LENTILS***					
Year	Acreage	Hectares	lbs/acre	Pounds	Metric Ton
2008	29,691	12,025	812	24,123,192	10,942
2007	32,093	12,998	1,369	43,925,550	19,924
2006	17,880	7,241	1,202	21,492,600	9,749
2005	16,000	39,520	1,153	18,450,000	8,369
4 Year Average	23,916	17,946	1,134	26,997,836	12,246

SMALL CHICKPEAS					
Year	Acreage	Hectares	lbs/acre	Pounds	Metric Ton
2008	5,392	2,184	1,758	9,476,560	4,299
2007	9,500	3,848	1,107	10,515,000	4,770
2006	15,737	6,373	980	15,423,019	6,996
2005	6,000	2,430	1,625	9,750,000	4,423
2004	1,889	765	453	855,000	388
5 Year Average	7,704	3,120	1,185	9,203,916	4,175

MEDIUM LENTILS** Reported as "Regular Lentils" before 2004					
Year	Acreage	Hectares	lbs/acre	Pounds	Metric Ton
2008	103,236	41,811	987	101,918,548	46,230
2007	142,840	57,850	1,392	198,794,000	90,172
2006	247,450	100,217	1,189	294,160,695	133,430
2005	231,004	93,557	1,376	317,948,212	144,220
2004	180,489	73,098	1,225	221,093,814	100,287
2003	1,000	405	1,300	1,300,000	590
6 Year Average	151,003	61,156	1,245	189,202,545	85,822

YELLOW PEAS					
Year	Acreage	Hectares	lbs/acre	Pounds	Metric Ton
2008	517,498	209,587	1,272	658,256,513	298,583
2007	536,400	217,242	1,961	1,051,880,935	477,130
2006	573,330	232,199	1,435	822,468,500	373,069
2005	390,666	158,220	1,958	764,924,028	346,967
2004	216,261	87,586	1,698	367,293,766	166,603
2003	60,070	24,328	1,870	112,322,500	50 ,949
6 Year Average	382,371	154,863	1,699	629,524,374	285,550

AUSTRIAN WINTER PEAS					
Year	Acreage	Hectares	lbs/acre	Pounds	Metric Ton
2008	7,557	3,061	1,121	8,474,565	3,844
2007	17,500	7,088	1,284	22,466,565	10,191
2006	34,138	13,826	866	29,547,250	13,403
2005	12,000	4,860	1,050	12,600,000	5,715
2004	9,732	3,941	1,148	11,174,220	5,069
2003	9,400	3,807	1,305	12,265,000	5,563
6 Year Average	15,055	6,097	1,129	16,087,933	7,298

LARGE CHICKPEAS					
Year	Acreage	Hectares	lbs/acre	Pounds	Metric Ton
2008	7,129	2,887	1,570	11,192,780	5,077
2007	29,750	12,049	1,001	29,780,000	13,508
2006	19,876	8,050	874	17,379,820	7,883
2005	17,000	6,885	1,106	18,802,000	8,529
2004	5,128	2,077	1,020	5,228,600	2,372
2003	11,516	4,664	1,057	12,169,200	5,520
6 Year Average	15,065	6,102	1,104	15,758,733	7,148

SMALL LENTILS*					
Year	Acreage	Hectares	lbs/acre	Pounds	Metric Ton
2008	28,162	11,406	935	26,054,271	11,818
2007	29,667	12,015	1,324	39,267,100	17,811
2006	33,185	13,440	1,152	38,239,200	17,345
2005	5,000	2,025	1,265	6,325,000	2,869
2004	0	0	0	0	0
2003	77,360	31,331	1,276	98,688,000	44,765
6 Year Average	28,896	44,108	992	34,762,262	15,768

* Pardina, Morton, Eston Varieties

** Brewers, Richlea, Merrit, red Chief Varieties

*** Mason, Pennell, Palouse, VanGard, Laird Varieties

Notes:
This report contains yield and acreage data from industry processors, the Farm Service Agency, and the National Agricultural Statistics Service. Acreage data for 2008 has been amended since posting of the Industry Seeded Acreage Report, July 2008.

2008 USADPLC PRODUCTION REPORT: STATE BY STATE COMPARISON

ACREAGE											
State/ Year	Green Peas	Small Sieve	Yellow Peas	AWP	Large Chickpeas	Small Chickpeas	Large Lentils	Medium Lentils	Small Lentils	Red Lentils	Total Pulse Acres
ID 08	29,360	1,364	2,919	1,841	23,641	1,669	1,316	7,141	22,052	1,635	92,938
ID 07	19,550	1,378	2,680	4,600	37,905	4,215	1,700	11,335	28,272		11,635
WA 08	51,549	1,275	7,474	1,147	28,617	1,337	1,315	25,089	22,542	5,196	145,541
WA 07	58,907	1.288	9,320	1,220	38,542	1,350	1,505	31,710	33,229		177,071
0R 08	615	0	198	959	0	0	0	750	0	0	5,522
OR 07	1,130	0	200	1,900	2,800	0	0	750	0		6,780
CA 08	0	0	0	0	5,940	0	0	0	0	0	5,940
CA 07	0	0	0	0	7,000	0	0	0	0		7,000
MT 08	43,890	0	209,608	4,590	4,038	1,900	9,504	39,798	11,138	8,841	333,306
MT 07	49,500	0	209,000	15,000	12,250	1,500	12,000	57,000	14,000		370,250
ND 08	183,015	0	307,890	0	3,092	3,492	20,187	44,429	17,025	9,176	588.307
ND 07	190,960	0	320,000	0	13,500	6,000	20,093	78,640	15,667		644,860
SD,NE MN 07	3,083	0	4,535	2,967	3,610	1,805	0	5,926	971	992	23,889
SD, NE MN 07	11,200	0	7,400	2,500	4,000	2,000	0	7,200	0		34,300

PRODUCTION											
State/ Year	Green Peas	Small Sieve	Yellow Peas	AWP	Large Chickpeas	Small Chickpeas	Large Lentils	Medium Lentils	Small Lentils	Red Lentils	Total Production
ID 08	48,628,212	2,810,293	5,618,151	3,314,520	28,960,652	2,804,155	1,217,115	7,141,050	26,480,234	1,635,480	128,609,862
ID 07	32,816,502	2,828,871	4,349,681	6,114,962	36,019,996	6,211,000	1,102,292	13,916,537	30,325,875		133,683,716
WA 08	84,798,599	2,626,747	14,386,888	2,065,338	37,381,524	2,245,320	1,216,717	25,088,952	27,068,683	5,195,608	202,074,376
WA 07	89,269,879	1.737.050	15,902,000	630,000	35,874,020	0	890,155	28,021,316	42,318,481	NR	214,642,902
OR 08	984,456	0	370,260	767,448	0	0	0	0	0	0	2,122,164
OR 07	1,864,500	0	370,000	2,395,000	566,000	0	0	650,000	135,750		5,963,250
CA 08	0	0	0	0	13,662,000	0	0	0	0	0	13,662,000
CA 07	0	0	0	0	11,760,000	0	0	0	0	NR	11,760,000
MT 08	39,501,000	0	188,647,200	5,508,000	3,230,000	1,805,000	5,702,400	35,818,200	8,910,000	6,630,525	295,752,325
MT 07	84,122,500	0	323,256,327	19,500,000	12,250,000	1.575,000	16,800,000	82,650,000	18,900,000	NR	559,053,827
ND 08	277,853,365	0	465,074,583	0	4,352,780	5,866,560	18,420,792	49,760,383	16,173,675	8,717,461	846,219,599
ND 07	368,552,800	0	715,674,608	0	13,770,000	6,540,000	27,125,550	110,096,000	20,367,100		1,262,126,058
SD, NE MN 08	3,082,618	0	4,534,730	2,966,565	3,610,000	1,805,000	0	0	970,596	991,979	17,961,489
SD, NE MN 07	19,040,000	0	12,950,000	3,875,000	3,760,000	2,400,000	0	6,048,000	0		48,073,000

2008 STATE PRODUCTION SUMMARY TABLE (lbs)					
	Green Peas	Yellow Peas	AWP	Lentils	Chickpeas
Idaho	51,438,505	5,618,151	3,314,520	36,473,879	31,764,807
Washington	87,425,346	14,386,888	2,065,338	58,569,960	39,626,844
Oregon	984,456	370,260	767,448	0	0
California	0	0	0	0	13,662,000
North Dakota	277,853,365	323,256,327	0	93,072,310	10,219,340
Montana	39,501,000	188,647,200	5,508,000	57,061,125	5,035,000
Others	3,082,618	4,534,730	2,966,565	1,962,575	5,415,000
Total	460,285,290	536,813,556	14,621,871	247,139,850	105,722,991

Small Lentils - Pardina, Morton, Eston Varieties
Medium Lentils - Brewers, Richlea, Merrit, Varieties
Large Lentils - Mason, Pennell, Palouse, VanGard, Laird Varieties
Red Lentils - Red Chief, Red Robin, Crimson, Morton

Notes:
This report contains yield and acreage data from industry processors, the Farm Service Agency, and the National Agricultural Statistics Service.
Acreage data for 2008 has been amended since posting of the Industry Seeded Acreage Report, July 2008.

4
CHAPTER

Processing Methods for Dry Peas, Lentils & Chickpeas

USA DRY PEA & LENTIL COUNCIL

Once legumes have been harvested and precautions taken to ensure safe storage, processing is conducted before they are shipped and ultimately find their way onto grocery shelves and dinner tables.

The processing of dry peas, lentils, and chickpeas is a specialized and important part of the production process and is designed to ensure a consistent, high-quality product. This has led to the establishment of standards meant to guide producers, processors, and vendors around the world.

Compliance with these standards is achieved by subjecting the legume seeds to an elaborate series of cleaners, separators, splitters, dryers, polishers, graders, and color sorters. The goal is to provide food manufacturers and their consumers with top-quality dry peas, lentils, and chickpeas every time a purchase is made.

Having passed through processing, the seeds proceed to packaging, which helps ensure that a wholesome product is delivered to the distributor and, ultimately, to the consumer. Overseas shipments are normally packaged in large 100-pound polypropylene or jute sacks for easy bulk handling. Almost any combination of grade and package is available from processing plants.

How and Why Legumes Are Used

In recent years, legumes have in recent years attracted increasing interest as useful ingredients in a range of prepackaged and processed foods in the U.S. and abroad, generally in canned or dehydrated form.

Researchers have found that legume flours can be used to fortify foods that have typically been fortified with wheat and other traditional flours. Depending on the variety and the way in which they are processed, legume flours may show unique properties in complex systems.

Pea flour, for example, is now used widely in the processed meat industry where heat and mechanical stability are important. It has also had excellent results in canned foods, cooked sausages, pâtés, and other items.

Processing can enhance the functional characteristics of legumes as well. A mixture of cellulose and enzymes has, for example, been used to augment important details like the mouthfeel and smoothness of products. The unique properties of legume starch, including good stability at high temperatures and high viscosity compared with cereal or tuber starches, can be further improved by processing.

Pea starch has become popular as a thickening agent in soups, sauces, and many other products. Until recently, the main limitation of the use of pea starch has been the relatively high cost of its isolation.

The bulk of the research on pulses has concentrated on the effects of processing on the protein quality of legumes. Changes in

protein brought about by processing are, to many processors, more important than other changes in nutritional value. The protein can absorb water or fat, be soluble under certain conditions, and maintain foaming and emulsification properties. This helps processors achieve the desired texture and quality (e.g., chewiness) for foods. The goal is to employ processing to minimize the loss of nutritional value while maximizing protein quality.

Despite the fact that there is a large amount of information available on the effects of processing on various components of grain legumes, interpreting this data has proven challenging. Among the difficulties is the fact that even varieties of the same legume species differ in their content and availability of specific components, such as protein and lysine.

After legumes have been processed and converted into primary products, they can be cooked and then used for a variety of purposes. Many are processed to make different products for use in the home or in commercial enterprises. Food developers commonly incorporate processed legumes into soups, including canned soup, frozen soup, shelf-stable mixes, "instant" dry soups and others, as well as extruded and puffed snacks and breakfast-cereal-type foods. ***See Appendix C for a collection of sample formulations.***

The processing industry uses various quality checks, kinds of equipment, and processes to ensure buyers a clean, wholesome product that conforms exactly to the grade ordered. The consistent, industry-wide grading standards, established by the Federal Grain Inspection Service of the U.S. Department of Agriculture, help achieve this end by facilitating accurate communication among all parties in a trading transaction. Each variety of pea and lentil has precise standards for size, color, and other factors. Storing each crop type separately from the others results in better quality and uniformity. Food safety is a primary concern for both processors and customers, so there are processors that carefully segregate product preserve the identity of product and may provide traceability to the exact origin of the crop.

Although all products must conform to these minimum standards, some processors use additional methods to guarantee superior quality for their customers. These processors customize orders to reach the customer's desired level of quality.

Processing Legumes

Legumes go through several processes before they are ready to be used either as a plated item or as an ingredient in food preparations. These processes can include cleaning, drying, sorting, splitting, milling, and fractionating. Depending on the pulse and its intended use, other steps like dehulling (decorticating), puffing, roasting, and grinding may be included as well.

Once the field-dried pulse product is received at the processing facility it is visually inspected for color and general quality and then loaded into storage bins. Storage of the newly received product is key to quality and optimum preservation of the crop.

Each crop requires slightly different storage conditions, so humidity and temperature are controlled to maintain the best conditions for preservation and to eliminate the possibility of pest or fungal infestation.

As the product is dropped from the receiving bins for initial air cleaning, magnets are used to attract and remove any metal debris or stones from the product. In addition, many processors conduct a second and final screening with rare earth magnets to ensure removal of metal before after the product has been bagged.

After completion of processing, the product is bagged and shipped to the customer. Quality checks vary from one processor to another, including inspection and packaging methods used before shipment.

In most cases, pulses are first soaked in cold water overnight for 4 to 12 hours. Hydration can be enhanced by using warm/hot water; this also helps prevent seed hardness. Heating is more costly for processors and can trigger an unwanted increase in microbial growth. Pulses with thick, tough seed coats are often first abraded and mechanically cracked before soaking to help facilitate moisture uptake. If the seed coats are unpalatable, they can be removed by hand from soaked seeds. This also promotes faster cooking and more digestible cotyledons.

Asian producers often hold their food legumes at ambient temperatures for several days after soaking. This enables them to germinate, which activates certain enzymes that then partially *hydrolyze* (i.e., digest) the proteins, starch, and oligosaccharides. It also inactivates tannins, releases minerals, and synthesizes many vitamins. The sprouted grains are then consumed directly or dehulled, roasted, and ground for use in blends and other foods.

Whole food legumes or hulled splits are either ground dry into a flour or ground wet into a batter for other food uses, often in combination with cereal and millet. The properties of the product, such as mouthfeel, texture, and others are impacted by the composition of the flour, the fineness of the grinding, the ratio of particle size grades, and the cooking conditions.

Cleaning

The first step in the processing regimen of a legume is cleaning. Processors run the pulses over gravity tables, which act as a filter to rid them of foreign material like pebbles, dirt and any undeveloped, broken, damaged, or shrunken pieces.

For split peas, initial cleaning and de-stoning is performed after receipt of the dried product, followed by steaming and tempering. These processes prepare the dry peas for a uniform split in the pea splitter and minimize shattering and other product loss issues. Sometimes, steaming and tempering is done just prior to splitting.

Sorting

By forcing air through the gravity table, products of the sought-after size are effectively separated out, while outsized product and foreign material fall below into a separate area. The sorted product is then air-cleaned again to eliminate dust.

Cleaned legumes are graded according to their seed size using separators. For chickpeas, the separators usually employ five sieves varying in dimension from 6 mm to 10 mm. Legumes can be processed through an electronic color sorter to ensure uniform coloration.

The product will then often proceed to a metal detection system prior to a final air-blast cleaning and bagging. Sending products through additional magnets that act as prescreeners enables processors to help ensure absolute food safety prior to final packaging.

Dehulling or Decortication

The dehulling of legumes generally consists of two steps: 1) loosening the hull (by the dry or wet method), and 2) removing the hull and cleaning. Loosening the hull can be done by a variety of means, including:

- Prolonged sun drying until the hull is loosened
- Applying small quantities of edible oil, followed by sun drying and tempering
- Soaking the legumes in water for several hours, followed by coating them with red-earth slurry and sun drying
- Soaking in water for several hours to loosen the hull before manufacture of food products
- A combination of the above

Dehulling (decortication) produces refined cotyledons with good appearance, texture, and cooking qualities. Legumes that have gone through this process are more easily digested and efficiently utilized by the body.

The process can be a time-consuming procedure depending on how tightly the legume hull wraps around the *endosperm* (i.e., the nutritive matter in the seed), because of the thin layer of gums and *mucilages* (i.e., the gummy secretions or gelatinous substances present in plants).

The success with which a legume can be dehulled is influenced by the variety, season when harvested, and location of cultivation. Larger or bold-grain varieties are easier to dehull and give a higher yield, making them the preferred variety among millers. Smaller varieties, meanwhile, require repeated pre-dehulling treatments and other complex procedures. Because their hulls are comparatively easy to remove, dry peas, lentils, and chickpeas require less drying and fewer oil or water treatments.

Freshly harvested legumes are more difficult to process, likely because of their higher moisture content. Legumes of this kind are either stored for some period of time to reduce moisture, or are treated with lime water or a solution of sodium carbonate to loosen the hull.

There are a variety of ways to decorticate food legumes. The oldest and most common technique involves spreading out the seeds to dry in the sun or mixing them with a bit of water before pounding them in a mortar with a pestle. The hull is winnowed off to get the clean cotyledons. Similar methods are used in commercial mills, though being much larger in scale they are adapted for greater yield and operational efficiency. The dehulling of legumes on a commercial scale is generally based on dry-processing techniques.

Smaller processors can expect about 50 percent removal with the first effort. The process is then repeated several times until almost all the grain is converted into dehulled, split cotyledons. It can be difficult with this approach to achieve complete removal of the hull from the grain. Breakage is also a common downside.

Another method for dehulling is based on adjusting the moisture of the grain to loosen the hull. The grain is first exposed to heated air in a tempering bin, for a pre-determined time based on the variety. Through gradual aeration it reaches a critical moisture level. The hull is then removed in an abrasion-type hulling machine, while efforts are made to minimize scouring or breaking the endosperm. If it is to be split, the whole dehulled grain is then ready to proceed to a splitting machine.

Splitting

Many of the operations, particularly decorticating and splitting, are mechanized. Splitting is often carried out in parallel with dehulling, though both are more effective if undertaken as independent operations.

Adding water prior to dehulling helps bring about splitting. Such a step does, however, often leave portions of hull on the split cotyledons (dhal) that then have to be removed by polishing machines. During splitting, the germ, which forms about 2 percent to 5 percent, is typically lost.

After drawing or winnowing off the hull, the split cotyledons are separated by sieving. Any leftover whole grains that have not been split are similarly processed until as much of the grain as possible is dehulled.

Milling

Once splitting has been completed, the material moves on to the milling stage, a critical step in legume processing. Reduction of the particle size must be undertaken to expand the surface area of the material, thereby increasing its availability or drying efficiency.

The bulk density of the material is controlled by creating a particle size distribution consisting of a matrix of larger particles the gaps between which are filled by smaller particles. Success here helps ensure a free-flowing material for maximum milling efficiency and contributes to end-product functionality.

Four Milling Techniques

There are four principal techniques used to bring about the size reduction necessary for processing. These are impact milling, attrition milling, knife milling, and direct-pressure milling.

Impact Milling

Impact milling involves use of a hard object to strike a wide area of the particle to fracture it. A rotating assembly then uses blunt or hammer-type blades, such as with hammermills, pin mills, cage mills, universal mills, and turbo mills. The impact technique is recommended for pulse milling applications due to particle size variability.

Attrition Milling

By contrast, attrition milling relies on a horizontal rotating vessel filled with a size-reduction solution. Treated to grinding media, the materials tend to be turned into free-flowing, spherical particles. This method, which includes the ball mill, can reduce 1,000-micron (20-mesh) particles of friable materials down to less than 1 micron.

Knife Milling

With knife milling, a sharp blade applies high, head-on shear force to a large particle, cutting it to a predetermined size, while also minimizing fines. A rotating assembly of sharp knives or blades is used to cut the particles. Examples like knife cutters, dicing mills, and guillotine mills can reduce two-inch or larger chunks or slabs of material, including elastic or heat-sensitive materials, to 250 to 1,200 microns.

Direct-Pressure Milling

Direct-pressure milling occurs when a particle is crushed or pinched between two hardened surfaces. This can involve two rotating bars or one rotating bar and a stationary plate and can typically reduce one-inch or larger chunks of friable materials down to 800 to 1,000 microns. Examples include roll mills, cracking mills, and oscillator mills.

Process Features

The rotor speed, feed rate, screen size, screen type, and moisture content of peas all affect pea milling quality. Rotor speed is the primary factor and can significantly impact the milling process.

Feed Throat

The feed throat introduces material into the milling chamber. A gravity feed throat delivers material tangentially to the rotation of the blades.

Blade profile

The type, quantity, and shape of a milling blade helps determine the degree of reduction achieved. The blade profile offers the flexibility of a knife on one side and an impact tool on the other, with the former being used for gentle granulation and latter for more aggressive reduction.

Feed Rate

Milling is most effective if the product is fed uniformly into the feed throat using a variable feed system (15 to 60 rpm). It should be noted that high feed rates increase energy consumption.

Rotor Speed

The rotor speed affects particle size distribution and as a general rule, and with all other variables remaining constant, the faster the rotor speed, the finer the grind.

Two Types of Food Milling

Impact milling

- The particle is fractured after being hit by a hard object that applies a blunt force across a wide area.
- The particle passes through a rotating assembly that uses blunt or hammer-type blades.
- Examples: hammer mills, pin mills, cage mills, universal mills, and turbo mills

Direct-pressure milling

- The particle is crushed or pinched between two hardened surfaces.
- Two rotating bars or one rotating bar and a stationary plate generally produce this milling action.
- Examples: roll mills, cracking mills, and oscillator mills

Rotor speeds of 3000 to 7200 rpm are used with flat blades in fine-grinding applications such as with coarse and fine pea flour and other legume flours, while speeds of 1000 to 3000 rpm are used with sharp blades in coarse grinding applications.

Screen

The screens can be round or rectangular, with screen thickness and the total open surface area of the screen affecting the *comminuting* (i.e., pulverizing) operation. The diameter of the screen holes doesn't necessarily designate the particle size of the finished product as impacted particles follow a tangential trajectory from the blades and approach the screen at a shallow angle. The higher the rotor speed, the smaller the angle under which the particle approaches the screen and the smaller the screen openings appear to the particle.

Fractionating

In the search for new food protein and fiber resources, commercial facilities have begun focusing on extracting protein concentrates from pulses via a process called fractionation that allows researchers to separate out component ingredients to obtain the desired concentrates and isolates.

Dietary fiber in legumes is actually captured as a byproduct of the process by which protein and starch concentrates are acquired from legume seeds. The results are generally richer in fiber when obtained from the hulls.

The separation of pure legume starch is difficult because of the presence of a highly hydrated fine fiber (cotyledon cell wall material) and the strong adherence of large amounts of insoluble proteins.

Fractionation typically takes the form of a dry or wet method: air classification or wet milling. Dry and wet separation processes have been used for some time to fractionate grain legumes for both experimental purposes and industrial applications.

Wet Method

The traditional wet process is intended for food applications. Using this method, the hulls are removed from the seeds and then milled or ground into flour. The legume flour is pulped using a decomposing agent like an alkaline solution to pull out the protein, which is then dried. The solid matter left after the protein has been separated out is screened through a series of sieves to recover the starch. Like fiber, pea starch is usually made available as a byproduct of protein extraction.

Another wet approach includes soaking the whole grain, followed by straining the result, now a slurry, through a cloth. This is common in Thailand, the Philippines, and other Southeast Asian countries as a means for removing the hull to extract the starch. In some West African countries, whole peas, or the remains from stone grinding, are soaked in water and agitated until the hull separates and is then captured by sieving.

For chickpeas and dehulled split yellow peas, starch fractionation involves steeping the seeds in warm water with *toluene* (i.e., a colorless, water-insoluble, flammable liquid often used as a solvent) to prevent fermentation. This is followed by wet grinding and repeated screening.

Lentils are better served by a similar method that also includes resuspension in a 0.2 percent sodium hydroxide (NaOH) solution, which dissolves most of the protein.

The wet method is particularly useful if the pulse is to be ground into a paste for further processing. On the other hand, if it is to be dried, the wet method can be difficult and time consuming, often involving the loss of nutrients in the soak-water.

Dry Method

The dry method uses a mill and air classification process to break down the dehulled seeds and separate out the starch and protein fractions. Dry processes have been employed more successfully with grain legumes than with other legume varieties because in legumes starch is the principal storage compound rather than oil.

"In India, the grains are oil treated and sun dried before being mixed with two percent to three percent stone powder."

Removal of the loosened hulls from the grain in the dry-milling technique is commonly done in small machines. These usually take the form of under-runner disc-shellers or grinders with emery or stone contact surfaces. A plate mill is sometimes used to both hull and split the soaked and dried grains.

In India, the grains are oil treated and sun dried before being mixed with two percent to three percent stone powder. They are then hulled in a rice-huller. The usable pieces are removed by sieving, while the hull, powder, and small bits remain in the stone powder.

Wet Versus Dry

In a comparative study of dry and wet milling, dry air classification of pea flour containing 22 percent protein and 55 percent starch yielded fractions containing 53 percent protein and 83 percent starch. The protein fraction also contained some broken starch granules in addition to most of the lipid, ash, sugars, flavor, and color compounds in the flour.

The protein isolated from wet milling contained 88 percent protein and refined starch contained less than 1.0 percent protein. The refined fiber was light colored and relatively free of other constituents. The main drawback of the wet milling method is the resulting loss of protein and starch in the whey and washes, as well as the expensive effluent recovery requirements.

Puffing

Puffing of legumes has been practiced in Asia, Africa, and Latin America for years. It is achieved by first subjecting the pulse to high temperatures, about 176 degrees F (80 degrees C), for a short time. Water is then added and allowed to absorb overnight. The grain is finally roasted, which prompts the cotyledons to expand, thereby splitting the hull so that it can be more easily removed.

Studies show that in addition to moisture conditioning or moisture addition prior to heating, puffing can be improved by certain hardening agents such as calcium phosphate, egg white, gums, calcium, or sodium caseinate.

5

CHAPTER

Traditional, Value-Added Applications of Dry Peas, Lentils & Chickpeas

USA DRY PEA &
LENTIL COUNCIL

Thanks to their robust nutritional profile, pleasant flavor, comparatively low cost, and cooking versatility, legumes have been an important part of the human diet for millennia. From the Fertile Crescent to the Palouse and over to the Northern Plains, USA dry peas, lentils, and chickpeas have provided an incredibly broad array of products and been incorporated into an endless variety of dishes.

As previously discussed, food legumes are a valuable source of dietary proteins and significant contributors to a healthy diet in many parts of the world. Foods based on legumes are prepared with a wide range of recipes and prepared with a host of different methods, including soaking, decortication, grinding, sprouting, fermentation, boiling, mashing, roasting, milling, parching, frying, and steaming.

Legumes go through several primary processes (e.g., dehulling, boiling, roasting, splitting, dehydrating, and grinding, etc.) before they are ready to be used in food preparations. For example, as was noted earlier, roasting or puffing of legumes by subjecting them to high temperatures for a short time has been practiced in Asia, the Middle East, and South America for many years.

One challenge with preparing pulses can be the length of time it takes to cook them. To expedite use, pulses are often processed first before being treated to additional cooking, frying, or roasting. Popular methods in the developed world include canning cooked pulses and incorporating them into what are referred to as ready-to-eat (RTE) products, such as chili.

Without access to such production options, producers in developing countries typically process pulses to be sold as shelf-stable products, requiring a minimum investment in packaging. Examples include low-moisture foods like *baries*, *papads*, *leblebi*, and others.

Throughout the world, food manufacturers use pulses as ingredients for products targeted at niche markets or to serve products that are unique within different cultures such as falafel, hummus, and dhal. Since the 1980s, technological advances in research and development in both products and machinery have led to a greater demand among food manufacturers for equipment that will enable them to boost capacity and enhance product quality.

Once a small industry, employing pulses as a base ingredient for a vast array of products is today an increasingly popular practice and offers myriad benefits for both food developers and consumers alike. The diversity of products that can be produced using pulses frees manufacturers to introduce ingredients from different legumes. This enables them to modify the taste and texture of the food item, while helping ensure that consumers enjoy a product that is unique, healthful, and easily distinguishable from traditional snack foods. ***See Appendix C for a collection of sample formulations.***

Soups

Soup represents the most common use for food legumes. Manufacturers are always searching for new soup varieties because they understand that shoppers increasingly expect to be offered consumer-friendly options. They are learning that incorporating legumes won't substantially raise the cost of goods, while offering a rich nutritional profile and making possible an ever-expanding variety of recipes.

Today, virtually every region in the Middle East seems to have its own signature lentil soup recipe. There is a Levantine lentil soup with silverbeet, an Armenian variety that uses lamb stock, a sour Cypriot version with vinegar, and an Arabian offering distinguished by spices, tomatoes, and lime.

In North Africa, lentils are joined with chickpeas and lamb for a popular stew called harira. Egyptians have *koushari*, a mix of lentils, noodles, and rice, a traditional Coptic meatless "fasting" dish.

As health- and heart-conscious consumers increasingly demand a healthy option, food developers have incorporated legumes into canned soup, frozen soup, shelf-stable mixes, "instant" dry soups and others. They can also be used as a soup thickener to add an affordable heartiness to existing soups.

Instant Soup

Legume-based instant mixes offer an easy, practical way to create delicious and nutritious soups that are quick and simple to prepare.

Before legumes can be used in instant dry soup mixes, they must first be pregelatinized or precooked via one of several processes. The most common method involves soaking the pulses, boiling them, making a slurry of the boiled product, drying the slurry in a drum drier, and milling the result to make flakes or powder.

For the best results, food developers should have the final product in mind when selecting the soup ingredients. The following considerations should go into determining which pulses and ingredients to use:

- Performance—Preparation method, rehydration time, further processing, and holding time are important considerations. Pregelatinized powders are best for instant soups, precooked powders for simmer soups, and pulse flours for soups requiring longer cooking times.
- Target appearance—Key to choosing the right ingredients is determining the desired appearance and integrity of the final product. Pulses are available as whole, pieces, flakes, or flour, each of which will impact the final product.
- Performance limiting or enhancing ingredients—Other ingredients like rice, pasta, dehydrated vegetables, seasonings, and thickening agents must be accounted for as they can affect results (e.g., water absorption).

Practical & Nutritious

A great variety of soup formulations can be developed using pulses. Not only practical for today's busy lifestyles, such products also align with the trend toward healthy diets and nutritious alternatives. Given the right flavor, ingredients, and packaging, legume-based soup products can be the perfect choice for today's consumer, suitable for any meal and any time of year. ***See pages 147-150 for sample soup formulations.***

Prepared Soups with Legumes

- Canned/Condensed Soup
- Frozen/Refrigerated Soup
- Specialty/Health Brand Soups
- Dry
  - Soup Kits
  - Soup Mixes
  - Soup Cups

Snacks

Recent reports indicate that the eating habits of the average adult consumer in the U.S. have markedly changed in the last decade. As a consequence of lengthening commute times to work and increasingly irregular work hours, consumers have adopted a more on-the-go approach to meals. This has driven many Americans to fast-food restaurants and store-made, precooked meals.

The result, according to many health care professionals, has been a steady increase in the rates of obesity, diabetes, and heart disease, among other issues. As the media focuses on such issues, consumers are responding. In market research conducted by Tate & Lyle, a leading manufacturer of renewable food and industrial ingredients, 65 percent of consumers are trying to eat healthier, though some 33 percent concede that they don't have the time to prepare or eat healthy meals.

As general market attitudes turn away from traditional salty or fatty-type snacks to healthier, trans-fat-free options, the global volume of international snack foods is expected to continue to increase to meet these demands. Though the U.S. remains the largest single market for such foods, Latin America, Asia Pacific, and Eastern Europe represent the greatest opportunities for manufacturers of snack foods.

With a long history as healthy, nutritionally rich ingredients dating back thousands of years, pulses continue to play an important role in providing consumers with healthy snack food options. Such foods are traditionally prepared by first being cooked and then roasted or fried. The following section explores how this is done.

Roasting

Subjecting legumes to heat for varying periods of time (i.e., toasting and roasting) is widely practiced as a method of food processing. Roasting legumes by subjecting them to high temperatures for a short time has been practiced in Asia, the Middle East, and South America for many years.

The roasting process stabilizes pea flour, partially gelatinizing the starch, denaturing the protein, and inactivating enzymes to increase product shelf life. Roasted pea flour serves as an effective flavor carrier and flavor improver, ideal for making more

nutritious flatbreads, tortillas, pita breads, crackers, cookies, energy bars, and extruded snacks. It also enhances dough yield, firmness, and texture.

The roasted chickpea, called leblebi, is widely enjoyed as a traditional snack food in Turkey, the Mediterranean region, and the Middle East, though the method of preparation can differ from country to country. Roasted chickpeas can also be found in the US. Pacific Horizon packs and distributes the Mi Familia brand of roasted chickpeas with spicy chile and lime flavor coating and can be found in grocers along the West Coast.

In general, leblebi production begins when chickpeas are subjected to heat treatment in several stages after which water is added to increase the moisture content. They are then allowed to rest for several hours before being roasted.

Large-seeded chickpeas are preferred for leblebi. Today, there is no large-scale industrial production of the snack. It is generally produced using traditional methods by small-scale manufacturers.

Materials & Methods

Cleaned chickpeas are graded according to size and subjected to heat in several stages. Studies of raw and roasted chickpeas have revealed that substantial structural changes occur during processing. The raw chickpea is tightly packed and contains no air pockets. A large number of air pockets are, however, formed in the cotyledon of the roasted chickpea.
This change is believed to be the result of the chemical and physical changes that the chickpea undergoes during processing. As noted, after the heat treatment, water is added to increase the moisture content of the chickpeas.

During the roasting process, this water changes from a liquid into vapor inside the chickpea. The chickpea expands, likely the result of the steam generated from the water vapor that then pushes on the compact structure of the chickpea.

Because the majority of the starch granules do not gelatinize during roasting, researchers consider the amount of water as a major factor in swelling and gelatinization.

A study conducted on roasting lentils demonstrated that temperatures as high as 257 degrees F (125 degrees C) were attained in the lentils during processing.

This enables the superheated steam to create voids in the cellular matrix. At the later stages of roasting, the steam exits and the starchy matrix is dehydrated, causing a porous and slightly extruded-like structure.

Color

Raw and roasted chickpeas also differ significantly in color. Roasted chickpeas have a darker color with more yellow and red than raw chickpeas. These changes in color are probably indicative of chemical browning reactions during roasting.

Color is an important consideration in food products as the color and appearance of foods are generally the first impressions consumers have of a specific product. The darker color of roasted chickpeas is generally preferable to that of raw chickpeas.

> "The darker color of roasted chickpeas is generally preferable to that of raw chickpeas."

More Innovation to Come

Legumes are a key piece of a healthy diet as identified in the 2005 USDA food pyramid and highly lauded Mediterranean Diet. Ethnic foods like leblebi have the potential to help consumers more successfully incorporate legumes into their meals. Ongoing research into new and more effective ways to process and prepare these foods is, therefore, a key tool in learning how to continually expand the number of products into which legumes can be successfully added.

Frying

Different varieties of pulses can be fried in oil to manufacture a range of alternative

snack products. It is essential that manufacturers not only have the right equipment to do this properly and safely, but also the technical know-how to produce the highest quality product with that equipment. The processes and supporting technology involved in frying pulses is also critical, whether you're producing fried peas, fried chickpeas, or fried lentils.

Fried Green Peas

Fried peas can be eaten as a snack or consumed as part of a mix of snack food products. The characteristics of a pea perform differently during frying than most other pulses. To fry a pea, therefore, requires a very different process than frying a typical pulse.

The process begins with choosing the appropriate pea variety. It is important that the chosen pea produce the texture sought by the customer. Once dehydrated it may boast a smooth skin, but that does not necessarily mean it is suitable for producing fried peas.

Soaking

The pea is soaked in sodium bicarbonate. The peas are rehydrated in water that is

held at room temperature for approximately eight hours. The soak time is critical. Peas soaked for longer than nine hours tend to produce a higher level of *fines* (i.e., small legume pieces freed during processing) as their skins are removed more easily during the cooking process. Oversoaking will also lead to pea fermentation, rendering them unusable by the manufacturer. Product quality can also be seriously compromised if the peas are allowed to rupture.

Temperature during soaking is important. Too high a temperature will cause the starch within the peas to gelatinize and the protein to *denature* (i.e., to diminish or eliminate some of its original properties, especially its biological activity).

> "Peas soaked in sodium bicarbonate also have a lower bulk density."

During the soaking step, the moisture content of the peas increases up to 57 percent, while expanding the peas to approximately twice their original size. Peas soaked in sodium bicarbonate also have a lower bulk density.

One of the main reasons for using sodium bicarbonate is to trigger a reaction with the acid in the pea. A hydrogen ion from the pea that reacts with a bicarbonate ion, carbon dioxide is then released, thus expanding the peas.

Changes in Coloration During Soaking

Adding the sodium bicarbonate has a demonstrable effect on the color of peas as well. By initially increasing the pH of the soak water (sodium bicarbonate is a mild alkali), it reacts with the chlorophyll to enhance the pigments within the pea. The phytyl and methyl groups are displaced and bright-green water-soluble chlorophyllin is formed. The sodium salts of chlorophyllin give the soaked peas their bright-green coloration. Even greater brightness is achieved with the addition of green food coloring in the soak water.

Increasing the pH of the water ensures that the water absorbed into the pea will have a higher pH than the pea contained when dehydrated. In this way, it also alters the normally intense blue coloration of the dried pea.

Frying

Once the peas have been soaked, they must be fried to reduce the moisture content below 2.5 percent. A fryer designed specifically for frying green peas is preferred. Ideally it should include a single frying pan that holds oil and controls the temperature profile of the oil throughout the fryer. The flexibility to vary the temperature of the frying oil can help improve the product quality of the peas. The quality tends to be better when employing a frying system that uses a lower temperature at the start of the frying process and a higher temperature near the end.

Peas are sensitive to high temperatures. Using a fryer that can control the temperature profile is, therefore, crucial to maximizing quality. Toward that end, considerable attention is paid to the rate at which the fryer temperature increases as this is necessary to ensure that the final moisture content is acceptable. A temperature increase that is too slow will result in a final moisture content that is too high.

This temperature profile produces no surface blistering and less expansion of the pea skin. Peas placed directly into oil at 356 degrees F (180 degrees C) experience surface blistering and greater expansion of the skin surrounding the peas.

Submerging the peas at too high a temperature in the critical early part of the process causes the skin to be dislodged and the cotyledon to be expelled into the oil. Too low a temperature will lower the output, lengthen the fry time, and increase the oil absorption. The best products are those produced via a frying system that is able to leverage both quality and throughput.

> "Managing and minimizing oil deterioration is an important part of promoting the highest quality fried pulses."

The sodium bicarbonate also performs a critical function during frying by softening the texture with the production of carbon dioxide that occurs at temperatures over 248 degrees F (120 degrees C). When the peas are fried, a lighter texture and a better mouthfeel are produced.

Changes in Coloration During Frying

The bright-green coloration of the pea developed during soaking will change during frying. This occurs because when the peas are placed in the fryer at elevated temperatures, their cells are disrupted. The contents of their cells (including organic acids) escape from the *vacuoles* (i.e., a membrane-bound cavity within a cell) into the cell and into the oil.

As the acids contact the chlorophylls they change in such a way that the yellow and orange pigments within the peas are made visible along with the intense green chlorophyll. This combination gives peas an olive-green appearance, a color they will retain even after being fried, unless artificial green coloring not added to the soak water.

Oil Deterioration During Frying

Managing and minimizing oil deterioration is an important part of promoting the highest quality fried pulses. A number of different elements contribute to the deterioration of the frying oil, including UV light, certain

metals (e.g., copper), water, and oxygen. These catalysts should, therefore, have limited contact with the oil.

For a product like fried peas, it is fairly difficult to minimize the contact with water as it is necessary to remove a large quantity of the water present in the peas during the frying process. A good filtration system and the correct frying parameters will help minimize deterioration.

Fines

The life of the oil can be further extended by keeping the level of fines to a minimum during frying; this practice also promotes a better yield and higher quality. Those fines that find their way into the frying oil will remain unless filtered out or removed via a sludge removal conveyer. If they are allowed to accumulate it will cause *hydrolysis* (i.e., chemical decomposition brought on by reacting with water) of the oil.

The oil can be protected if the processor is able to adjust the temperature profile during the frying process. This helps minimize the level of fines produced from ruptured cotyledons or skins being removed from the peas.

Design Features of the Fryer

Continuous frying systems are equipped with a hood, which prevents oxygen from coming in contact with the oil. Such systems also include a damper on the flue (located on the hood) to modulate the level of steam above the oil. Frying oil left open to the atmosphere without a cover will oxidize more quickly. Because oxygen has a lower solubility in oil at a higher temperature, there is less susceptibility for oil oxidation at higher temperatures.

The fryer hood also captures the steam released as the product is frying, while the damper modulates the amount of steam that is released from the hood. With the damper open, more steam is released from above the fryer, helping protect the oil from oxygen and thereby minimizing oxidation.

> "Frying oil left open to the atmosphere without a cover will oxidize more quickly."

Fried Lentils

Soaking

Lentils are first soaked for three hours in water that is held at room temperature for a final moisture content of about 50 percent. As with chickpeas, lentils are then rinsed and drained to remove excess water.

Frying

When fried, lentils perform differently than green peas or chickpeas. Because lentils are not as susceptible to thermal shock when initially placed in the fryer, a single temperature zone is permissible. A temperature of 356 degrees F (180 degrees C) is used to quickly decrease the moisture content in the lentils. Thanks to the lentils' large surface area and the rapid heat transfer into the product, the required frying time tends to be very short.

Centrifuge

The large surface area (when compared to the lentil's total size) also leads to there being a lot of oil that remains on the surface of the lentil. If not removed, this oil will be absorbed as the product cools, increasing the total oil percentage of the product.

Subjecting the lentils to a centrifuge is perhaps the most common means for removing the oil. As it reduces the final oil content in the product, the centrifuge also allows the surface oil to be recirculated back into the fryer. The final moisture content required is 1 percent to 2 percent with an oil content of 20 percent to 30 percent.

Fried Chickpeas

Due to their high protein and low fat content, fried chickpeas are sold as a healthy alternative to other snack foods. To obtain the desired texture in a fried product, the variety of chickpea must be considered. The two principal varieties used to produce fried products are the Kabuli and the Desi, with the preference largely a product of the manufacturer and the costs of the raw material.

The Kabuli, which is more rounded than the Desi, offers a less wrinkled surface and generally requires less time to cook than the Desi. It also contains a seed coat that is very thin, but adheres well to the cotyledons.

Soaking

Chickpeas are soaked for approximately 10 hours in water that is held at room temperature. Soaking increases the moisture content to approximately 53 percent. After soaking, the chickpeas are rinsed and drained to remove any excess surface moisture.

Frying

Chickpeas have an anatomy similar to the green pea and therefore have some of the same challenges during frying. It is necessary, for example, to ensure that the fryer can vary the initial and final frying temperature. Otherwise, the oil has to be set at a low temperature. If the temperature is too high there can be rupturing of the skin and an increased level of fines.

If the temperature is too low, product output will be reduced and more oil absorbed. Allowing the temperature to slowly increase during frying recognizes the vulnerability of the peas to higher temperatures and helps promote increased output while minimizing oil absorption.

A Focus on Leblebi

Roasted chickpeas, called leblebi (leb-lebee), a word that originated from the Persian word *leblebû*, have been a popular traditional snack food in Turkey, the Mediterranean region, and the Middle East for generations. It also has a growing popularity in North Africa, the Middle East, Europe, and Asia.

Production

The steps in leblebi production and the equipment used can be quite different from one location to another and from manufacturer to manufacturer. The steps taken to produce all of the different kinds of leblebi include:

- Cleaning and grading
- Soaking
- Tempering (preheating and resting)
- Boiling
- Resting
- Roasting
- Dehulling

A significant amount of leblebi is still produced in Turkey and exported. Some Middle Eastern countries also produce small amounts, but there is today no large-scale industrial production. Roasted chickpeas are typically produced by traditional means at small-scale family plants, the methods having been handed down from father to son.

Leblebi boasts potential as a healthy snack and a natural ''functional food'' due to its chemical composition: It is high in protein, cellulose, and mineral content, and low in fat and calories. It has a soft, crushable texture, a special roasted flavor, and a sweetish taste. Product diversity can be expanded by covering leblebi during the roasting stage with salt, sugar, chocolate, or spices such as red hot pepper, ginger, cloves, and other edible coatings.

Thanks to its low moisture content, leblebi also has a long shelf life, safely storable for six to 12 months, depending on the packaging.

Quality Criteria for Leblebi Chickpeas

Quality criteria like shape, size, color, and harvesting time all vary depending on the cultivar, helping determine which chickpeas are used for leblebi. Preferred are the large-seeded, lighter-colored, round, smooth Kabuli type. The chickpea must also have a thick seed coat and the hull must be easy to remove during processing.

Harvesting time plays an important role in the tempering process of chickpeas as well as in the quality of the final product. Classification by size is an important stage of leblebi processing as is cleaning them of foreign material and any undeveloped, damaged, shrunken, or broken seeds.

Heating Equipment

There are three types of heating equipment used in leblebi processing:

- The cylindrical drum roaster (CDR)
- Roaster and hull remover (RHR)
- Roaster and speckler (RS)

Liquid petroleum gas (LPG) is used for heating the CDR. This equipment may also be used for tempering chickpeas.

The RHR has a heating pan made of copper or iron. A copper pan is typically preferred due to its higher thermal conductivity. The inside surface of the heating pan is roughened and nicked to increase total roasting area and facilitate removal of the hulls. LPG is used for heating the pan and a gas input meter is used to control heating. The RHR has a paddle made of poplar wood that rotates while pressing the chickpea seeds.

The RHR heating pan usually ranges in temperature from 176 degrees F to 266 degrees F (80 degrees C to 130 degrees C). The main features of the roaster and speckler (RS) are a stainless steel heating pan of about 20 inches (50 cm) diameter, which operates as a heating device, and a motor adapted to a set of specially designed pulleys. The RS also has a paddle made of wood or rubber for mixing the chickpeas. The temperature of the roasting pan is around 212 degrees F to 266 degrees F (100 degrees C to 130 degrees C).

The Processing Steps for Leblebi Production

Step 1: Cleaning and Grading
The grading stage is key as the size of the chickpea impacts the tempering (heating and resting) and roasting treatments during processing. The chickpeas are first cleaned of all foreign material and any undeveloped, damaged, shrunken, or broken kernels. The cleaned chickpeas are then graded according to their seed size. This is done using separators, which are usually comprised of five sieves varying in dimension from 6 mm to 10 mm. Chickpea fractions greater than the size of each sieve are used separately for leblebi production, while seeds greater than the 10 mm fraction have potentially high leblebi quality.

Step 2: Soaking
The most serious shortcoming when it comes to using legumes is their long cooking time, making soaking an important precooking step. Usually done overnight, soaking reduces the time necessary for tenderizing the texture of the chickpea. Several studies have reported the beneficial effects of soaking in salt before cooking or using various salt solutions in the cooking of pulses.

Leblebi Processing Equipment

The processing equipment used for leblebi production includes cleaning and grading equipment and heating equipment. The objective of the cleaning and grading process is to remove all contaminants from the seeds and separate the seeds into different grades by size. The common types of equipment used in cleaning and grading include:

- Aspirators
- Separators
- Roll graders
- Gravity tables
- Stoners
- Color sorters

Step 3: Tempering (Preheating and Resting)
Tempering in leblebi production means holding the seed (resting) after heating to allow moisture penetration and stabilization. The chickpeas are heated for five minutes to eight minutes at around 212 degrees F (100 degrees C) before resting in a food-grade approved container for 12 to 18 hours and up to two days. The chickpeas are then spread on a cooling bed platform for slow cooling. A moistening step is often included as well.

> "Legume seeds are cooked to help produce a tender edible product and develop aroma."

Step 4: Resting
Resting is among the most important steps of leblebi production as many of the changes that take place in roasted chickpea kernels occur during this process. During certain kinds of leblebi processing, the volume of the roasted chickpea kernels increases and swells, while their hulls start to separate from the cotyledons.

Step 5: Boiling
Legume seeds are cooked to help produce a tender edible product and develop aroma. Traditionally, dry or soaked seeds are cooked in boiling water in an open pan for one to two hours or for 10 to 15 minutes under pressure.

Step 6: Roasting
The roasting, or parching, method usually involves whole seed, nondehulled grains being exposed to dry heat. The traditional Turkish household practice includes first sprinkling the legumes with a little water and then mixing them with preheated sand or preheated edible salt in a roasting pan. The pan is kept on an open fire and maintained at a temperature of 392 degree F to 482 degrees F (200 degrees C to 250 degrees C), depending on the legume variety. The roasted legumes are then separated from the sand (or edible salt) by sieving.

Step 7: Dehulling
The dehulling step usually includes two parts: loosening the hull by dry or wet methods and removing the hull and cleaning. Loosening the hull can be achieved by any of the following techniques or a combination:

- Drying in the sun until the hull is loosened
- Applying small quantities of edible oil, followed by several hours or days of sun drying and tempering
- Soaking in water for several hours, followed by coating with red-earth slurry and sun drying
- Soaking in water for several hours to loosen the hull before manufacture of food products

Once the dehulled whole cotyledons are separated, the process is repeated until as many of the legumes are dehulled as possible. Such repetition can, however, cause splitting and breakage of the legumes.

Chemical, Physical, and Structural Changes

During leblebi processing, carbohydrates and proteins are modified as a consequence of the heat treatment, including the carmelization of polysaccharides on the surface of the chickpeas. In addition, some acids are partially decomposed during roasting, while volatile acids are partially lost due to evaporation. Chickpea volume increases during processing at the same time the density and kernel weight decrease. The flavor can also change, especially as a result of the heating processes.

During the resting stage other changes can occur, some positive (e.g., ripening) and some negative (e.g., off flavor). The original raw chickpea is dense and contains no air spaces. But during roasting, the water inside the chickpea changes from liquid to vapor, which, given the compact structure of chickpeas, can cause an increase in the vapor pressure of water so that the steam that is generated triggers expansion during roasting. This can lead to development of a large number of air spaces in the cotyledons and give roasted chickpeas a porous structure and an opaque, chalky appearance.

Canning

Canning and freezing processes vary according to variety, pea size, and period of maturation. Two distinctly different types of canned peas are manufactured: canned fresh peas and canned processed dry peas.

The former are produced exclusively from peas harvested at an early stage of maturity. These peas, called vining peas, are extremely perishable. They must be processed in the cannery within a few hours from the time of harvesting to retain their excellent sensory properties and prevent preprocess microbial spoilage.

Canned processed peas, on the other hand, are manufactured using dry peas that have been allowed to mature fully in the field before harvesting. In the dry state, these peas are perfectly stable and may be held for long periods until canning.

Manufacturers of canned processed peas enjoy certain production advantages not available to those producing canned fresh peas. The stability of dry peas, for example, permits manufacturers to can peas throughout the year. Doubling their weight during processing, dry peas, typically of the round-seeded green variety if grown in the U.S., also offer a comparatively inexpensive raw source of protein and dietary fiber, in addition to being full of flavor.

The Manufacture of Canned Processed Peas

The manufacturing process for canned processed peas is similar to that used for fresh peas, with the exception that a pre-soaking operation is used to rehydrate the dry peas prior to blanching.

USA Dry Round-Seeded Green Peas

To help ensure consistent, acceptable quality, the choice of supplier and the specification of raw materials are of paramount importance. USA dry green peas are the round-seeded, fully mature peas. They

are cleaned and sorted in accordance with specified USDA grades (USDA No. 1 grade peas are recommended for canned processed peas).

The raw materials should be clean and free of foreign material (e.g., stones, metal, dirt, etc.) or extraneous vegetable material (e.g., weeds, berries, or leaf and stalk pieces). The peas should be whole and unbroken, and without stain, blemish, or insect damage. These factors, along with many others, are described in the USDA grade specifications for dry peas. The moisture content is also important because this will affect both the storage of the peas and the rehydration behavior during the canning process. If artificial drying of the peas is necessary, it must be conducted very carefully or the quality of the peas can be compromised.

Once harvested, dry peas are delivered into initial processing at about 10 percent to 13 percent moisture. During storage prior to canning, the moisture content can rise to 14 percent, depending upon storage conditions, before storage performance is significantly affected. Conversely, peas with excessively low moisture may show poor rehydration behavior during the soaking process.

Materials Required for Canning

Materials required for the manufacture of canned processed peas include:

- USA dry round-seeded green peas
- Salt
- Sugar
- Artificial color: (yellow) tartrazine, (blue) Green S or Brilliant Blue (where permitted)
- Water for soaking
- Water for brine preparation
- Water for can cooling
- Cans and can ends

Typical Processor Specifications

The USDA grading system is used for peas with a variety of intended uses. For the successful manufacture of canned processed peas, the following specifications are typical of those used by commercial canners. Dry peas of the green varietal type should meet the following criteria:

- Bleached peas <10 percent unless individually agreed with specific consignment
- Total amount of peas of contrasting classes <0.3 percent; amount of such peas that turn black on canning <0.02 percent
- Shriveled peas <2.0 percent
- Amount of peas showing visible cracks in seed coat <3.0 percent
- Amount of split peas <0.5 percent
- Amount of damaged peas <1.0 percent

- Amount of weevil damaged peas<3.0 percent
- Amount of defective peas <4.0 percent
- Amount of foreign matter <0. 1 percent
- Free of live weevils
- Number of peas containing dead mature weevil: not more than one pea in a sample of 20 pounds
- Moisture content <14 percent by drying at 221 degrees F (105 degrees C)

Sugar

Sugar is used in the brine covering for canned processed peas. It should be of food-grade quality. Canner's grade sugar may also be an option as it has a guaranteed low count of thermophilic microorganisms. (There is an International CODEX Standard for white sugar, CODEX STAN 4-1981, which details quality factors and permissible levels of contaminants.)

Salt

Salt is also used in the manufacture of brine, and like the sugar, it should be of food-grade quality. (There is an International CODEX standard for food-grade salt as well, CODEX STAN 150-1985.)

Coloring

Synthetic and natural coloring choices are important in the production process as well. Blue and yellow are common as a means for producing the appropriate green color; dyestuff companies generally provide a pre-blended mixture to meet individual requirements. As natural colors invariably do not have the heat stability to provide a suitable green color within the finished product, synthetic dyestuffs are preferred. Most countries have legislation controlling such colors.

Water for the Brine

Water used in the brine should be of potable quality as both chemical and microbial contamination are important considerations. Also, the water in the distribution system within the factory should conform with requirements.

In practice, it is important that limits are established for the water in the plant and that any significant variation should be investigated immediately. The hardness of water used in the canning of dry peas is a determining factor in product texture. Softened water (65 ppm to 155 ppm calcium carbonate) is generally used for initial soaking, whereas the normal factory water supply is acceptable for the brine.

Preparation of Dry Peas for Canning

Dry peas purchased in the U.S. have already been cleaned and sorted prior to being sent out. It is nevertheless recommended to include the following items as part of the manufacturing process:

- A form of riffle plate—for stone removal
- A magnet or metal detector—for the removal of metallic debris
- A sorting belt—to observe the quality of peas immediately before filling and to allow the manual removal of any unwanted material

Soaking

Dry peas are soaked for 15 to 24 hours in tanks constructed from stainless or galvanized steel or a suitable plastic material. During the soaking period, the peas swell and absorb enough water to account for 95 percent to 110 percent of the dry pea weight. The water temperature is ideally less than 68 degrees F (20 degrees C). Since wet peas are an excellent medium for microbial growth, warm weather often makes it necessary to change the water once or twice to prevent a souring of the peas.

The peas increase in volume as they absorb water and it is important that they continue to be covered with water for soaking. Note that the soaking tanks should not be so large that the peas at the bottom are compressed and prevented from swelling. About four tons is the maximum recommended tank size.

Hardness of Soaking Water

Excessive calcium levels in the soaking water may cause changes within the pea structure, resulting in excessive hardness of texture. To avoid this, it can be necessary to adjust the calcium carbonate level to 65 ppm to 155 ppm.

Water that is too soft can cause splitting of the peas and mushiness within the can. If a source of soft water is available, it can be mixed with hard water to obtain the desired balance. It is also important to remember that although the majority of water absorption takes place during the soaking process, it does continue to a lesser extent during blanching and sterilization.

Stone Removal

After the pre-soaking operation, peas are normally drained and then transported in a flume of water, across a riffle plate to remove stones, then continue to the blancher. It is important to get the direction of the riffles correct, and their precise angle must account for the rate of water flow to achieve maximum effectiveness.

Blanching

Blanching is an important operation within the manufacture of processed peas, accomplishing the following:

- Cleaning of the peas
- Reduction in microbial count on the peas
- Destruction of enzymes that can promote chemical deterioration of the peas
- Additional soak-up of water prior to filling

The blancher typically comprises a large steel vessel partially filled with hot water. Peas enter at one end and are contained behind a perforated screen running the length of the vessel. They are sent to the outlet end by a rotating helical screw, at a speed which the screw moves to control the blanching time.

Also important is control of the water temperature as too low a temperature can lead to the growth of thermophilic microorganisms and give rise to souring. Typical blanching conditions would subject the peas to water at a temperature of 190 degrees to 199 degrees F (88 degrees to 93 degrees C) for four to six minutes.

Though usually unnecessary, blanching water, as with the soak water, may be partially softened to 65 ppm to 155 ppm calcium carbonate.

Cans

The can and the can end are critical components in the manufacture of canned food that retains product quality during prolonged storage and safety for the consumer. It is essential, therefore, that only reputable can suppliers are used who provide cans of suitable specification and also adequate technical support in case of difficulty.

After unpacking or depalletizing, empty cans should be inverted and internally sprayed with steam or water before entering the filling machine.

Filling

Peas are filled through an adjustable volumetric filler before the addition of brine. National standards and legislation must be consulted with regard to the required fill weight for peas. In many cases, the basis for trade of canned goods is dependent upon drained weights measurable at the time of consumption.

Brine Preparation and Filling

Brine is prepared by dissolving the required ingredients in water in an appropriate, preferably stainless steel, steam-jacketed pan. The temperature should be raised to 203 degrees F (95 degrees C) before the prepared brine is distributed to the filling line. Filling temperature should ideally be above 185 degrees F (85 degrees C).

The holding time of the brine before filling should not exceed 45 minutes or color degradation will result. Brine is generally filled into the cans until the cans are overflowing with brine. This is achieved with the use of a perforated pipe or a series of nozzles under which the cans pass. After filling with brine, the can is tilted to provide a specified headspace before double seaming. The headspace and filling temperature should be sufficient to produce an internal vacuum within the can. The overflowed brine is screened and recirculated.

Double Seaming

Failure to correctly form a double seam can lead to spoilage and either a food poisoning incident, commercial loss, or both. Two important considerations in this step include:

- The can supplier should provide details of the double-seam specification, which should then be adhered to.
- The specification should include acceptable measurements for both seam tightness and the overlap of the end and body hooks.

Sterilization

Cans of peas are packed into crates, which are placed inside a suitable pressure-sterilized *retort* (i.e., a sterilizer of food cans). Sterilization is a crucial step. For all low-acid foods (pH >4.5), it is essential that a thermal process is used that is sufficient to achieve *commercial sterility* (i.e., destruction of all pathogens and all other microorganisms capable of metabolism at the intended product storage temperature).

All commercial processes should be validated by heat penetration tests. Also, if it becomes necessary to reprocess a batch of cans due to steam failure or some other reason, the original process times may no longer be sufficient as the material viscosity within the cans will have markedly changed.

Cooling

After sterilization has been achieved, cooling water is introduced into the retort so that the cans are cooled as rapidly as possible, thereby preventing undue product degradation. Because it is vital that the cooling water is of good microbiological quality, it is normal that the water should be disinfected by the addition of chlorine gas or another suitable chlorine compound.

Immediately after water cooling, the temperature of the cans and their contents should be 104 degrees to 122 degrees F (40 degrees to 50 degrees C). The temperature should be cool enough to inhibit the growth of any surviving thermophilic organisms but warm enough for the cans to dry. Once the crates of cans are removed from the retort, they should be tipped—while still wet—to remove water from the can end.

Under no conditions should wet cans be manually handled due to a heightened risk of infection.

> "All commercial processes should be validated by heat penetration tests."

Good Manufacturing Practice in Canning

Good manufacturing practice (GMP) involves the application of the best available knowledge to ensure that food products are safe for the consumer, conform with their intended end-product specifications, and are produced in an efficient manner. Failure to apply GMP in the production and distribution of low-acid canned foods (i.e., those with pH >4.5) may lead to incidents of food poisoning, commercial spoilage, or both. The ultimate financial cost to the manufacturer can be significant.

Facets of GMP include the following:

- Support and understanding of the senior management of the company of technical issues, and an appropriate executive structure to ensure that policies and procedures are properly implemented
- Suitable premises, particularly in providing separation of pre- and post-sterilization areas
- Adequate water supply, providing water for product make-up, can cooling, and cleaning
- A competent and reliable supplier of raw materials
- A competent and reliable supplier of cans and ends
- Suitable equipment for forming double seams and means for their evaluation
- Adequate understanding of the critical factors affecting the thermal processes for the products manufactured
- Validated sterilization processes, with supporting documentation
- Venting schedule, supported by temperature distribution data
- Suitable sterilization equipment fitted with adequate control and recording instrumentation
- Chlorinated water supply for cooling
- Suitable post-process handling procedures
- Means for product identification and traceability
- Plan for product recall (should this become necessary)
- Clearly defined authorities for product release
- Quarantine procedures
- Emergency procedures
- Documented process records
- Adequately trained staff, with documented training records

The Technical Objectives of the Canning Process

The ultimate objective of the canning process is to provide safe, wholesome food to the consumer at an affordable price. Producers seek to achieve this goal by:

- Placing prepared food within a container
- Closing the container with an hermetic seal
- Supplying heat under controlled conditions to achieve commercial sterility
- Preventing post-sterilization infection

Quality Systems Management

The production management team is responsible for providing an effective system with adequate resources for ensuring the safe production of canned foods. A fully documented quality system should be created in which the authorities and responsibilities are defined for all of the critical aspects of the canning operation, including:

- Raw material and container acquisition
- Product preparation
- Double-seamer operation and double-seam assessment
- Thermal process scheduling and validation
- Sterilization operations
- Product release and product recall

The team is also responsible for providing a system of audit and review to ensure that sound manufacturing practices are fully implemented and operating as intended.

Manufacturing Premises

Premises should be sited with due regard for the operations that are to take place within them. Construction materials should be conducive to good sanitation and suitable for the intended type of food processing. In particular, the site should:

- Provide adequate working space for the various operations performed.
- Prevent confusion or contamination between unsterilized and sterilized material.
- Offer production lines that are easily accessible from all sides to permit inspection, maintenance, and cleaning of equipment.
- Be constructed with fabric and other materials able to prevent entry of pests, flying insects, rodents, etc.

> "Premises should be sited with due regard for the operations that are to take place within them."

Water Supply

The canning process requires considerable quantities of water for product make-up, can cooling, factory cleaning, and personal hygiene. Water may be provided from a town supply or from private sources, but in either case, it is necessary that data is established with regard to the microbiological condition of the water. Additional disinfection may be necessary if the water is to be used for can cooling.

Raw Material Supplier

Consistency of raw material supply is essential if the canner is to produce goods of uniform quality. Apart from the immediate aspects of sensory quality, it is also important that the raw material is clean and does not contain foreign matter.

Also, in the case of dry peas, the soak-up behavior must be predictable. Excessive water up-take during canning could lead to pea disintegration, which could adversely impact the effectiveness of the sterilizing process. U.S. peas must comply with a specification that can then be used by the canner for quality assurance of raw material.

Canning Elements: Cans, Can Ends, and Seams

Cans and ends represent critical elements in the safe production of stable, long-shelf-life foods. Failure of the container integrity at any point may lead to microbial growth and product spoilage. Cans and ends should, therefore, only be purchased from reputable suppliers able to provide competent technical support with regard to the use of their containers. It is important that the can specification is compatible with the product and its intended shelf-life.

The can maker also has the primary responsibility for specifying the correct tolerances for can seam dimensions. Cans should never be used for other purposes than intended.

Double-Seam Formation

The correct formation of double seams requires suitable can and can end components as well as properly maintained and adjusted double-seaming equipment. Specially trained personnel should be responsible both for setting the double-seaming machines and for subsequent evaluation of the seams. Examination of double seams for visual defects should be undertaken throughout production to root out deficiencies.

Samples from each seaming head should undergo detailed examination at regular intervals, including before production begins, after a significant stoppage, or after adjustments are made to the seaming equipment. All pertinent observations and actions should be recorded. The frequency of sampling will depend on individual circumstances but should not normally exceed four hours.

Critical Factors Affecting the Thermal Process

Canned processed peas are a low-acid food (i.e., pH is above 4.5), which means it will support the growth of the most heat-resistant pathogen, (*Clostridium botulinum*). Therefore, it is necessary that the product is made commercially sterile by the application of an adequate heat process at a specified temperature, generally in the range 239 degrees to 257 degrees (115 degrees to 125 degrees C), within a pressure retort.

The effectiveness of the thermal process in consistently achieving commercial sterility—and consumer safety—in every can processed depends upon a number of critical factors. In the manufacture of canned processed peas, the following should be included within the scheduled process specification:

- Dry pea grade and size
- Soak-up ratio of the peas prior to filling
- Container size and shape
- Pea fill weight
- Brine fill weight
- Head space within container
- Brine filling temperature

- Stacking pattern for containers within the retort
- Minimum initial temperature prior to sterilization
- Venting procedure (for steam retorts)
- Process time
- Process (sterilizing) temperature
- Maximum product temperature after water cooling
- Product pH

Validated Thermal Process

An exact knowledge of the time-temperature history of the slowest heating part of the food within the can during the sterilizing cycle is used to determine the sufficiency of the sterilization. Each temperature may be ascribed a lethal rate with respect to microorganisms.

It is also necessary that a company is able to justify to its customers or to public health officials the thermal processes that are scheduled. Heat penetration records, in which the temperatures within a can are logged against time, are used to validate the thermal processes, and such records should be available for each product/container combination.

Venting

In retorts that sterilize foods using saturated steam, the relationship between pressure and temperature is defined (i.e., if temperature is specified, then pressure is also fixed). If air is present within the steam at a given pressure, a reduction in temperature will inevitably occur. For this reason, it is vital that in the operation of steam retorts that all air originally present in the vessel is purged from the system through adequate venting.

Sterilization Equipment

It is essential when manufacturing canned foods to use sterilizing equipment that is capable of consistent and controlled operation within defined parameters for temperature, pressure, and time. The pressure vessel must also comply with safety legislation. The requirements for a static batch retorting system are:

- Pressure vessel, generally with safe working pressure
- Means for locating containers within the retort in a controlled manner
- Heat transfer medium, either saturated steam or superheated water
- Means for venting of steam retorts
- Instrumentation, control and recording equipment

Traditionally, retorts have used saturated steam as the heat transfer medium, which imparts heat to the cans. Many such systems are in use today. Increasingly, however, superheated water retorts, either full immersion, spray, or shower systems, are being used. The principal advantage is that temperature and pressure can be independently regulated.

> "Each temperature may be ascribed a lethal rate with respect to microorganisms."

Retorts should be maintained in good condition and should be operated by suitably trained personnel according to documented factory procedures. Actions taken by the retort operator during sterilization should be fully recorded on a log sheet. This log

should then be reviewed before the product is released.

Chlorinated Water Supply for Cooling

The primary requirement for container cooling water is that it should be free from microorganisms, which can gain access to the cans during the cooling process. *Coliforms* (i.e., any of several bacilli) should not be detected in any sample.

It is normal for chlorination to be used as a means for ensuring the suitability of cooling water. Chlorine gas or chlorine solution that may be injected into the water though calcium or sodium hypochlorite solution may be more convenient. Note, however, that excessive chlorine levels are extremely corrosive to cans and the retorts.

Post-Process Handling

The major cause of spoilage in canned foods is post-process infection in which microorganisms enter through an imperfection in the can or double seam after sterilization. The factors below are commonly the cause of spoilage:

- A source of infection, which typically originates with a human hand
- Water that provides mobility for microorganisms
- A seam or can defect through which microorganisms can enter

To control infection, it is necessary to ensure that:

- Wet containers are not manually handled.
- Containers are dried as quickly as possible.
- Conveying and handling surfaces are routinely cleaned and disinfected to reduce microbial contamination.
- Conveying and handling equipment is designed, installed, operated, and maintained so as to cause minimum physical abuse to the containers.

Post-sterilization can cleaning is regarded as a hazardous operation and will always carry some risk of post-process contamination. It cannot, therefore, be recommended as a routine procedure.

Product Identification and Traceability

It is vital that unsterilized cans never become comingled with sterilized cans. It is also necessary to be able to clearly identify each of the cans from a given lot so that they can be checked against their processing records. Ideally, it should be clear which cans belong to a given retort batch at any stage after sterilization.

During the preparation and sterilizing operations, unsterilized cans should be marked to distinguish them from those that have been sterilized. This information should in-

clude the product, date of manufacture, and preferably batch or time of manufacture.

After sterilization, batches of cans should be checked off against their process records for double-seam evaluation, retorting, and cooling water tests so that they can be positively approved or rejected.

Product Recall Procedure

There should be a predetermined written plan, which is clearly understood by all concerned, for the recall of a product in case of an emergency. A designated person and appropriate backups should be nominated to initiate and coordinate all recall activities and serve as the point of contact with outside parties (health departments, media, customers, etc.).

> "It is vital that unsterilized cans never become comingled with sterilized cans."

Notification of recall should include the following information:

- Name, pack size, and adequate description of the product
- Identifying marks of the batches concerned and their location
- Nature of the defect
- Action required with an indication of the degree of urgency required

Quarantine

If a problem is identified with a batch or lot of canned goods, they must immediately be labeled as quarantined material and preferably isolated in a location dedicated for that purpose. Quarantined material must not be confused with goods of acceptable quality, as the consequences of misidentification could be extremely harmful to the consumer, the company, or both.

Emergency Procedures

It is inevitable, even in the best run facility, that problems will occur from time to time. It is necessary, therefore, that documented procedures are in place. In the case of the sterilizing process, there should be instructions that define the actions to be taken.

If the product has been overprocessed, the issue will normally be one of quality. If underprocessed, the product will need to be further sterilized or destroyed. A full re-process may need to be more severe than the originally scheduled process due to changes in the product that affect heat transfer.

Positive Product Release

It is recommended to operate a positive release system in which approval for release of product is given only after quality checks of both product and process records have been made. Authority for such release should be clearly defined.

Record Keeping

The management of a cannery should be able to prove at any time after manufacture that goods released conformed with specifications required for both processing and quality. In terms of consumer safety, this would include:
s

- Can seam evaluation records
- Retort operator's log
- Automatic recorder chart on each retort (time, temperature, pressure)
- Cooling water chlorination checks

Each of these records should be reviewed before goods are approved for release.
The retort operator should record any instances when processing conditions are outside specification and any actions taken. The recorder chart should be dated and contain sufficient information for product and batches to be correctly identified.

Manufacture of Frozen Peas from USA Dry Peas

The unit operations employed in the manufacture of frozen peas from USA dry peas, though similar in nature to those used in the manufacture of canned processed peas, include a number of essential differences.

Color

If artificially colored peas are required, an appropriate coloring agent can be added to the pre-soaking water and to the water used for cooking the peas.

Cooking

During canning, the texture of the peas is softened by the sterilization process. There is no equivalent to this during the preparation of frozen peas. Consequently, it is necessary to introduce a cooking stage.

This is achieved by extending the blanching to provide a total time of about 25 to 30 minutes at 203 degrees F (95 degrees C). Otherwise, a separate cooking process is introduced. At the end of cooking, using cold water, the peas should be cooled as rapidly as possible to a temperature not higher than 86 degrees F (30 degrees C) prior to the commencement of freezing.

Freezing

The method used for freezing will inevitably depend upon the equipment available. Ideally, a flow freezer will be used so that the end product will be free flowing in nature. Packing, in this case, will take place after the completion of freezing.

Alternatively, cooked and cooled peas may be packed into retail containers and then frozen in a plate freezer or blast freezer. Such aggregation of the peas can, however, impact quality.

Hygiene—Microbial Stability

Frozen foods should be stored at temperatures no warmer than -0.4 degrees F (-18 degrees C) to inhibit microbial growth. Provided due care is taken with regard to

all the aspects of hygienic manufacture, the product will remain safe for the consumer during the storage period. Prolonged storage can lead to deterioration due to chemical rather than microbial reasons.

Distribution

Frozen foods require a frozen distribution system able to help ensure that the products remain safe and meet the desired sensory quality requirements. It is the responsibility of the food manufacturer to guarantee that the distribution system used is adequate for the intended purpose.

Chemical, Physical, and Structural Changes

During leblebi processing, carbohydrates and proteins are modified as a consequence of the heat treatment, including the carmelization of polysaccharides on the surface of the chickpeas. In addition, some acids are partially decomposed during roasting, while volatile acids are partially lost due to evaporation. Chickpea volume increases during processing at the same time the density and kernel weight decrease. The flavor can also change, especially as a result of the heating processes.

During the resting stage other changes can occur, some positive (e.g., ripening) and some negative (e.g., off flavor). The original raw chickpea is dense and contains no air spaces. But during roasting, the water inside the chickpea changes from liquid to vapor. Given the compact structure of chickpeas, this can cause an increase in the vapor pressure of water so that the steam that is generated triggers expansion during roasting. This can lead to development in the chickpea of a large number of air spaces in the cotyledons and give roasted chickpeas a porous structure and an opaque, chalky appearance.

The Growing Role of Legumes

Food legumes are important components in a healthy diet and make major contributions to good health around the world. Whether canned, roasted, fried, or used as an ingredient in soup, pulses offer a welcome alternative to the fast foods that have come to define the diets of so many.

The more we learn about the benefits of pulses and how best to process and prepare them, the greater the number of options will develop for their use. To promote their increased consumption, new and ever-more appealing products are required in the market. Food researchers are employed in just such a pursuit, attempting every day to find new uses beyond regional and ethnic preferences in an effort to introduce consumers around the globe to these delicious, versatile, healthful foods. ***See Appendix C for a collection of sample formulations.***

6
CHAPTER

Traditional, Value-Added Applications of Dry Peas, Lentils & Chickpeas

USA DRY PEA & LENTIL COUNCIL

Wheat flour (white flour) is used to produce a wide range of popular bakery and snack products, including breads, muffins, waffles, pizza crusts, cookies, crackers, and ready-to-eat (RTE) cereals. The wheat flour gives these products their uniform, light-colored appearance and smooth, non-gritty texture.

When the protein found in wheat flour comes in contact with water and heat, it produces the protein gluten (*glutenin*) (i.e., the protein formed when wheat flour is made into batter or dough), which gives baked goods their elasticity, extensibility, and strength. The more gluten in flour, the greater the batter viscosity and the darker and crispier the fried food made with it. The gluten also makes it easier for the flour to build up a tough structure able to trap the waste gases of yeast during kneading. Less gluten, conversely, produces a lighter, less chewy texture such as that found in cakes.

Different types of flour contain varying amounts of protein. The exact amount of gluten in flour depends on how it was milled and the variations in growth of the crop. The strength of the flour depends on the quality of the gluten present. Weak flour contains less gluten than strong flours, with the type of flour used affecting the finished product.

The Health Benefits of Legumes

Increasingly, food industry professionals are looking for ways to make value-added processed foods more nutritious without compromising the taste. Consumers are looking for foods that are more healthful in order to improve their diets. The addition of food legumes such as dry peas and lentils into mainstream diets in the form of flour fits with this aim and is proving a popular approach for consumers and food developers alike.

It is easy to see why. Dry peas, lentils, and chickpeas and other pulses ground into flour are high in complex carbohydrates, fiber, protein, lysine, and other phytochemicals. Pulse hulls boast a nutrient profile similar to wheat bran and an extremely high fiber content. In addition, being low in fat and sodium and rich in Vitamin B folic acid, legumes play a key role in the prevention of many health issues.

Legumes are also high in protein. An essential food component, proteins are important sources of amino acids, are necessary for physical growth and maintenance, and provide functional properties in the foods in which they are incorporated. Peas, and most notably yellow peas, are especially rich in protein, as well as starch and nutrients such as fiber, vitamins, and minerals.

In addition to the nutritional benefits, there are a range of other reasons legume flours are growing in popularity. For people who are allergic to gluten or to wheat itself, legume flour offers an excellent alternative. Non-wheat flours can also provide new and unique flavors and are especially good at thickening liquid mixtures like sauces or soups.

When it comes to baking, however, legume flours can pose some challenges. Because they produce no gluten when mixed with liquid, they require special treatment when intended to be formed into workable dough or batter that will rise, hold its shape, and deliver a pleasing texture.

Successfully incorporating legume flours as ingredients for foods is contingent on the functional characteristics and sensory qualities that the flour brings to the end-product. Functional properties include foaming, emulsification, texture, gelation, water and oil absorption, and viscosity.

Given the unique nutritional and performance attributes of legumes, the specialty diet food market is taking notice and endeavoring to meet the demands of today's health-conscious consumers. In the process, healthful, gluten- and casein-free alternatives are booming as a growing list of products using legume flour makes its way to grocery shelves. ***See Appendix C for a collection of sample formulations.***

The Role of Rheological Testing

A great deal of interest has been shown in recent years regarding fortifying wheat flour with high-protein, high-lysine legume flour. Such a combination increases the protein content and bolsters the essential amino acid balance, especially of baked products like bread.

Pea flour fortification does, however, alter dough rheological properties. The aim of current research is to explore the functionality and characteristics of how pea flour interacts with wheat flour in a range of bakery products. Also being evaluated are the rheological properties of pea flour compared with wheat flour at certain ratios, as well as making a physical assessment of the dough. This is done to better understand the performance of pea flour in dough systems.

Rheological testing has become a preferred approach for examining the structure and fundamental properties of various flour doughs. Due to their characteristics and sensitive response to the structure variation of flour doughs and proteins, rheological properties are considered an effective way for predicting the processing behavior and controlling the quality of food products. This testing simultaneously measures the viscous and elastic characters of dough.

Pea Flour Functionality Features

- Water absorption
- Color
- Flavor
- Foam formation
- Texture
- Solubility
- Viscosity
- Cohesion
- Gel formation
- Emulsification

The rheological characteristics affect both what is referred to as the "machinability" of the dough and the quality of the final product. Influenced by added ingredients, the rheological profile also depends to a great extent on the crop variety, properties, and milling process used.

Gluten

Gluten forms when two of the proteins in the starch in wheat flour, glutenin and gliadin, combine with water. The presence of gluten increases the viscosity of the batter due to the efficient water binding capacity of the gluten protein. When the proteins are surrounded by water and stretched, they interact and form new bonds that are strong and very elastic. Because pea flour contains no gluten, increasing the amount of pea flour in wheat flours decreases the viscosity of the batter.

Though stability decreases significantly as pea flour is added, there does not seem to be much difference in terms of protein weakening. Protein content in pea flour with hulls increases water absorption and helps film formation, which binds large amounts of water and contributes to the viscosity of the batter. This higher water absorption may be due to the higher soluble protein content.

Color

Increasing the amount of precooked pea flour (with or without hulls) leads to progressively darker flours than seen in wheat flour mixed with uncooked pea flour. The reason behind the color change is considered to be the result of protein and carbohydrates in wheat flour undergoing carmelization in what is called the Maillard reaction. A Maillard reaction is a non-enzymatic interaction between lysine in protein and reducing sugar. During cooking, it typically leads to development of a brown color in the pea itself. Carmelization results when carbohydrates or sugar are exposed to high temperature.

An increase in the amount of uncooked pea flour in wheat flour gives the product a slightly yellowish color.

Antinutritive Factors

Antinutritive factors in pea flour such as polyphenols, phytic acid, and trypsin inhibitors, as well as their color and flavor, can limit the use of pea flour as an ingredient in bakery products, meat products, and snack foods. Legumes can, however, be treated to reduce the content of these antinutritive factors as well as to improve the nutritional value of the protein and remove their bean flavor.

Elements of Pea Flour Evaluation

- Water absorption of the flours while mixing
- Protein weakening
- Starch gelatinization
- Cooking stability
- Starch gelling

The ability of flours to absorb and retain water and oil may help improve binding of the structure, enhance flavor retention, improve mouthfeel, and reduce moisture and fat losses of certain products.

Starch Gelatinization

Starch is the most abundant carbohydrate in the legume seed (22 percent to 45 percent).

The total carbohydrate level varies based on the variety. Among dry peas, the Miami and Nitouche cultivars have the highest starch content (44.7 percent and 43.5 percent, respectively), Majoret the lowest (approximately 40 percent).

Starch is composed of two basic molecular components: amylose and *amylopectin* (i.e., the insoluble or gel component of starch). Though identical in their basic constituent (glucose), they differ in their structural organization, or linkages, which impacts their functionality in food applications. In addition, each is hydrolyzed, digested, and absorbed differently.

Both the amylose and amylopectin are located in the starch granules, with the size, shape, and characteristics of the granules varying based on the plant source. The growth and development of the granule originates at the *hilum* (i.e., center of the granule). Under magnification and polarized light, native starch granules typically appear to have a cross-like structure, the size and shape of which varies among starch sources.

Use of Starch in Food Products

Starch is the main carbohydrate found in plants and is a major source of nutrition for humans and animals. As a result of their high amylopectin content, some legume starches demonstrate a restricted swelling and an increased overall stability during processing. This and other beneficial physicochemical properties make them highly suitable for use in a variety of food products.

One of the important functional properties of starch is pasting, which is the formation of a high-viscosity solution after heating in water. This characteristic is exploited in many foods as well as in non-food applications such as adhesives. Another important functional characteristic is starch's ability to form gels, which is also used in a range of food and non-food applications.

As environmental issues have led to a growing interest in renewable raw materials, researchers have sought new sources of starch and development of new methods for its modification. This pursuit has led many to leguminous plants, which are an increasingly sought-after source of starch, thanks to a range of unique benefits.

Legume starch is mainly available as a by-product of protein extraction and is therefore considered a relatively cheap source of starch compared to corn, wheat, and potato starches.

Pea starch offers numerous special features (e.g., formation of high-viscosity pastes, stronger gels, etc.) that can benefit food technology, especially as an alternative to chemically modified starch. The central reason is pea starch's high amylose content.

Increasingly, legume starch is being employed to modify the texture of food products such as frozen foods, extruded snacks, pasta, noodles, cookies, crackers, sauces, and soups. Because of its importance in food processing and consumer acceptance, research into starch characteristics (e.g., pasting profiles, thermal behaviors, thickening and gelling properties, swelling factors, etc.) continues to grow in the U.S. food industry.

"New patents are being developed for products focused on modifying legume starch (mostly pea starch)."

New patents are being developed for products focused on modifying legume starch (mostly pea starch). Among them, a novel starch-based texturizing agent has been produced from high-amylose starch. It was created by dissolving the starch in water under acidic conditions, while agitating it at an elevated temperature and pressure, followed by retrogradation at low temperature and drying.

The aim of texturing agents is to create fat-like attributes such as structure, viscosity, smoothness, and opacity so as to reduce and or replace the actual fat content in foods including pourable salad dressings, yogurt, cottage cheese, sour cream, cream cheese, peanut butter, frosting, cheesecake, mousse, and sauces.

The texturing agent can also be effectively used in full-fat foods as a stabilizer, and as an opacifying agent such as for low-fat and fat-free foods and beverages like coffee creamer, cottage cheese dressing, nutritional drinks, and ice cream.

Additionally, legume starches can be used in the preparation of food with a reduced *lipid* (i.e., an organic compound of the fat group) content. In this case, the lipid portion in the food is replaced by non-gelling, pre-gelatinized starch.

Native and modified legume starches can be used in a range of applications, including preparation of the following:

- Gels (e.g., puddings) that can be prepared with about 50 percent less starch in comparison to corn starch
- Extruded products and instant starches that can be produced without the significant loss in viscosity that occurs with other starches
- Roll-dried starches and fruit and vegetable flakes that have a pulpy texture after rehydration and considerable stability at cooking temperatures
- Pulpy products created via freeze-thaw processing that keep their pulpy texture even after prolonged cooking
- Roll-dried instant starches with cold swelling gelling properties that can be used in instant desserts for a flake-like texture

Extensive research has already been conducted on potato, corn, cereal, and cassava starches as they are used extensively in food and non-food industries. The differences in rheological properties of starches may result from the varied amounts of non-starch components (e.g., proteins and lipids) in each. To continue to find new uses, it remains necessary to extend the use of rheometers to investigate the rheology of gelatinized pea starch.

Gelatinization

What Is Gelatinization?

The amylose and amylopectin of the starch are tightly packed in granules marked by a high degree of molecular order. Insoluble in cold water, when starch granules are heated in water, beyond a critical temperature their

organized molecular structure is destroyed. As a result, the granule absorbs a large amount of water and undergoes an irreversible swelling to many times its original size. This transformation is referred to as gelatinization.

More specifically, starch gelatinization is an order-to-disorder phase transition that starts in the amorphous regions of starch granules because of the presence of weak hydrogen bonds. These intermolecular hydrogen bonds break down in the presence of water and high temperatures. The heating immobilizes the *glucan* (i.e., a polysaccharide that is a polymer of glucose) chain segments of the granule and allows water absorption, which leads to the reduction of the ordered structure, amylose leaching, and the destabilization of the amylopectin.

During pea starch gelatinization, the molecular disruption begins from the hilum area and then spreads quickly through the central part of the granule, causing the central part of the granule to swell. Not until higher temperatures are reached is the outer part of the granule disrupted and gelatinization completed. In the presence of sufficient starch concentration, the amylase will then form an elastic gel upon cooling.

Temperature

The differences in gelatinization temperatures among the flours may be attributed to differences in size, form, and distribution of starch granules in the flours, and to the internal arrangement of starch within the granule. Low-protein and high-amylose starches require high inputs of energy to undergo starch gelatinization. Low-amylopectin starch has a higher gelatinization temperature, and is more resistant to enzyme and acid digestion compared to other starches.

> "The presence of lipids, for instance, affects water absorption, which impacts gelatinization."

Smooth pea starches, for example, are packed with a higher energy capacity but have been shown to also have higher gelatinization temperatures. The process of gelatinization occurs at about 149 degrees to 158 degrees F (65 degrees to 70 degrees C) for smooth pea and chickpea starches. Pea starch, being higher in amylose content, requires temperatures greater than 212 degrees F (100 degrees C).

Impediments to Gelatinization and Digestibility

Non-starch components such as sugars, salts, proteins, and lipids influence starch gelatinization and, by extension, starch's behavior in food applications. The presence of lipids, for instance, affects water absorption, which impacts gelatinization. This influences the formation of resistant starch and the starch's susceptibility to enzymatic digestion.

In many common plant foods the starch is only partly gelatinized because of limited water content during processing. The starch granules swell only slightly, while the internal structure remains partly intact.

For example, some baked products and breakfast cereals contain incomplete gelatinized starch granules due to lower water absorption. If such products, or certain precooked convenience foods, are produced under more severe conditions (elevated temperatures and pressures, and using extrusion cooking or popping), they typically achieve full gelatinization despite the low water content.

The cell walls may also inhibit starch gelatinization by limiting both the degree of swelling of the starch granules and the movement of water. By grinding the raw legumes to break down the cell walls, and then cooking them, swelling of the granules can be increased. Researchers hypothesize that such a practice could also increase the rate of starch digestion and the glycemic response.

The difference in the degree of legume gelatinization after processing has been put forth as a possible explanation for the observed differences in starch digestibility. It is suggested that the low metabolic response and in-vitro starch digestibility of legumes might be caused by the entrapment of starch in the cells.

The effect of complete gelatinization on metabolic response has been, and continues to be, studied in humans, both in diabetic and nondiabetic subjects, as well as in animals. Starch from potatoes and corn, for example, give much lower postprandial glucose and insulin responses in raw form than after cooking. Raw corn starch has, in fact, been used clinically to provide glucose with prolonged absorption in the treatment of type 1 glycogenosis (i.e., an inherited disorder of glycogen metabolism that results in excess accumulation of glycogen in various organs of the body).

A Subject of Ongoing Research

Starch is an excellent raw material for modifying food texture and consistency, and for improving nutritional values, among other benefits. Research devoted to gathering information on starch properties, such as thermal behavior, rheological properties of pasting, thickening and gelatinization, is therefore of continuing significance to food processors and consumers alike.

7

CHAPTER

Dry Peas, Lentils & Chickpeas as Functional Ingredients

USA DRY PEA &
LENTIL COUNCIL

In the U.S. and elsewhere, the rates of obesity, diabetes, and heart disease have reached what many healthcare professionals have referred to as epidemic levels. These unhealthy weight-related trends have prompted a surge in consumer demand and regulatory pressure for healthier food alternatives. In the face of these developments, commercial food manufacturers are finding it necessary to pursue new, more healthful products.

Many in the food industry are increasingly turning to the power of pulses as a solution. The dietary significance of pulses dates back almost 10,000 years when their rich nutritional characteristics were central to human health and the very viability of civilization itself. Today, legumes are actually listed twice on the USDA's Food Guide Pyramid, once each in the protein and vegetable categories, and important features in the much-lauded Mediterranean Diet.

Food scientists are rediscovering the fact that natural legumes like dry peas, lentils, and chickpeas are highly functional ingredients, adding both flavor and robust nutritional benefits to many dishes. Comprised of natural dietary fiber—both soluble and insoluble—as well as resistant starch and high-quality protein, they offer a health profile that is hard to match.

As a result, specialty and commercial bakers and pasta processors, among others, are looking to pulses and their derivatives as a means for meeting consumer demand while securing a portion of a functional food market that is expected to grow to $40 billion by 2011.

Nutritious and Delicious

Roasted (precooked) pea flour, or *pease-meal*, is perhaps the most commonly called upon legume in developing food formulations. Made from milled yellow peas, pea flour and its components contribute to healthier products without impacting traditional appeal. It is stabilized by roasting and/or steam precooking. Either process partially gelatinizes the starch, denatures the protein, and inactivates enzymes, thereby increasing product shelf life. Use of dry or wet milling produces different pea flour purities, each with applications suitable to specific food functions.

> "Many in the food industry are increasingly turning to the power of pulses as a solution."

The fiber alone of such products can be enough to capture consumer interest and loyalty. Though the USDA reports that only one in five Americans consumes the recommended daily amount of fiber, in a survey conducted by the 2008 International Food Information Council 77 percent of

Americans claimed to be committed to improving their fiber intake. Offering more than 10 grams of natural dietary fiber per ¼ cup, pulse flour can be an easy and effective way to achieve the daily recommended level.

Protein content marks another notable advantage to be gained when incorporating pulses into recipes and formulations. Pea protein concentrates and isolates are functional, bio-available, and loaded with lysine, making them an excellent alternative to soy flour. Such flours are also highly soluble with superb water-holding capacity. Pea protein's promising potential as an egg replacer is also currently being explored.

Complementing pulse's fiber and high-quality protein characteristics is the fact that roasted pea flour is an excellent flavor carrier and flavor improver. Its mild, toasty taste can enliven recipes and dishes, without adversely impacting the appearance or texture of the food. Together, this combination of attributes makes pulses uniquely well suited for inclusion in low-fat or fat-free food product applications, including:

- Special pastas
- Specialty foods
- Dry soups
- Sauces
- Dry food preparations
- Special dietetic food
- Crackers
- Snack bars
- Breads
- Breading and batters

A recent creation by Canadian food scientists underscores what can be gained by adding pulses. By substituting 50 percent pea fiber, the Canadian team developed a lemon blueberry muffin with half the calories, a third the sugar, a fifth the sodium, and 8 grams of fiber, 2 grams more than a comparable raisin bran muffin. And it still earned high marks for taste.

An Array of Other Benefits

In addition to instantly enriching a product's fiber and protein content, other benefits of incorporating pea and lentil flour include a pleasant light-golden appearance, a very fine ground, and positive blending and mixing attributes. Pulses also boast no additives or allergens, are GMO and cholesterol free, and offer a low glycemic index, extended shelf life, preserved flavor, and simple, clean labeling potential thanks to their natural ingredients. What is more, precooked flour supplies superb stability, comparable to that of wheat flour, and is microbially safe.

Starch is another consideration when adding pulses. At approximately 98 percent purity, pea starch isolates are distinctive for their excellent gel strength and bland taste. Such features, along with the ability to contribute to increased volume and expansion in extruded products and puffed snacks, make pea flour perfect for inclusion in cookie and cracker formulations as well as Asian-style noodles.

The use of pulses is also economical, especially when compared with fiber-fortifying gums or soy protein products. Pulses actually improve the soil by replenishing the soil's natural nitrogen as they grow. Few other ingredients have a better environmental story to tell, with pulse crops requiring less water and minimal chemical fertilizers during production.

The Call for Gluten-Free Products

Consumers and food producers are increasingly taking note of another significant characteristic of pulses: They are gluten-free. In the U.S., one in 133 people is allergic to gluten, a natural protein found in wheat, rye, oat, and barley. The intolerance to this protein, called celiac disease, is diagnosed in more than 7,000 people every year and is predicted to increase. This is driving global food manufacturers to bolster their product offerings with gluten-free snacks, a market that the USDA expects to surpass $1.7 billion by 2010.

Pulses give food producers a ready solution in their pursuit of gluten-free foods. Legumes also serve as an effective way to add structure and enhance the nutrition of products made with other gluten-free ingredients such as rice, tapioca, or potato starches.

(per 100 grams)	Chickpea Flour	Lentil Flour	Split Pea Flour	Pinto Bean Flour	Soy Flour (full fat)	Soy Flour (defatted)	Dry Whey (sweet)	Whole Wheat Flour
Calories	382	370	370	389	436	327	353	339
Protein (g)	23	25	26	22	35	51	12.93	13.7
Fat 1.87	6	2.5	2.1	2.8	21	1	1.07	1.87
Carbohydrate	59	62	62	67	35	34	74.46	72.57
Fiber	13	20	17	14	10	15	0	12.2

Nutrient Comparison (processed flours)

A Changing Market

The interest in eating healthy has never been higher. Evidence continues to mount linking serious health issues with the prevailing on-the-go eating habits evident in many countries. Such news comes at the same time as health care costs continue to escalate, motivating consumers to rethink how and what they eat.

But challenges remain. Many still contend that they do not have the time to fix, buy, or eat more healthful foods. One of the difficulties can be credited to the ever lengthening commutes experienced by a growing number in U.S. and Europe. Marketing companies predict that time spent in the car or on a train traveling to and from work will only increase in years to come.

Many in the food industry see a significant opportunity ushered in by these trends. They are looking to respond by formulating foods that fit consumers' hectic schedules and cater to their growing interest in exotic flavors, while also satisfying their desire to eat more healthfully.

The opportunity for such products appears to be sizable, with estimates for the international market for snack foods alone expected to increase in volume by more than 9.8 million U.S. tons by 2012 as consumers turn away from traditional salty and fatty-type foods. Add to this the high cost of cereal grains in recent years and it is little wonder manufacturers are working hard to develop value-added pulse-based foods.

U.S. food manufacturers are well-positioned to satisfy this growing need as local, U.S.-grown peas make excellent roasted pea flour. They are dried naturally in the sun, harvested only when completely mature, and contain low levels of foreign matter. The consequent pea flour can then be stored at ambient temperature for three months with no resulting color loss, oxidation, or off flavors. Kept cool, under 80 degrees F (26 degrees C), and dry, the flour can achieve a one-year shelf life.

As explored below, examples of the new and novel pulse-based creations growing out of these developments are numerous and varied. They run the gamut from flatbreads to nutrition bars. Reinterpretations of traditional dishes are booming as well with new formulations being developed every day for everything from soup to pasta to baby food.

Nutrition Bars

Among the more popular legume-based food applications are nutrition bars, an exploding category that offers busy consumers a convenient, functional food option. According to Packaged Facts, a leading publisher of market research in the food and beverage sectors, pulse-fortified nutrition bars were consumed by 13 percent of the population by 2008. The market is fore-

cast to exceed $5 billion by 2010, evolving away from the "sweet" formulations offered by candy and cereal companies to more functional meal-replacement products.

The bars typically include a 30 percent to 40 percent combination of dehydrated lentil flour and yellow pea flours, with "legume powder" being identified as the primary ingredient on packaging. With more than 1 ounce of legumes, the bars also qualify as a "serving" of protein or vegetables in many school nutrition programs.

These healthier, all-natural bars are moist and deliver an appealing flavor profile that fits the demands for breakfast or snack food. Breakfast bars containing up to 30 percent pea flour deliver great taste in a nutritional template of high fiber, vegetable protein, oligosaccharides, *isoflavones* (i.e., one of a family of a naturally occurring plant compound called *phytoestrogen* that acts like estrogen in the body), zinc, selenium, and resistant starch.

> "The bars typically include a 30 percent to 40 percent combination of dehydrated lentil flour and yellow pea flours."

The bars also provide a "whole food" combination of benefits, including serving as non-dairy and non-gluten ingredients. They also boast Omega 3 fatty acids as well as cholesterol-reducing properties. ***See pages 144-146 for sample nutrition bar formulations.***

Power Soups

Soups are part of what is commonly referred to as the "fast casual" segment of the food service industry. As a category, it has doubled in revenue since 2001 to $11 billion, playing an important part as an accompaniment to sandwiches and salad. Legume-based soups provide welcome new varieties, while delivering added health benefits without sacrificing taste.

Often called a "power food," legume soups provide a convenient way for consumers to meet their nutrition needs for vegetables, protein, and many micronutrients. By providing extensions or variations of popular, well-established recipes, pulse-based soups provide new variety and health appeal for a range of styles, including Italian, Hispanic, or Asian-inspired recipes seeking to incorporate emerging flavors.

Examples of this trend include filling out a traditional Italian vegetable and pasta stew with an "autumn blend" of lentils, chickpeas, and lentil-fortified pasta or thickening a cream of wild mushroom soup with legume powder. Such soups are eligible for a "good source of" claim for both protein and fiber. ***See pages 148-150 for sample soup formulations.***

Sauces

As healthy foods fortification grows in popularity and market share, commercial food producers are focusing more on "putting in" than "taking out" when it comes to their sauces. For many companies this has meant incorporating pulses into contemporary sauce flavors and recipes in an effort to attract health-conscious consumers.

As with other pulse-fortified products, the benefits of such a move include greater servings of protein and fiber, no gluten, essential amino acids, and other important nutrients.

This might take the form of an "authentic" Italian or Mediterranean recipe that now incorporates legumes, such as Sicilian lentil pasta sauce enhanced with a blend of "al dente-cooked" lentil varieties and classic Italian herbs and spices. Such a dish would qualify as high protein (6g), high fiber (6g), and fat-free (<0.5g) (based on a ½ cup serving). ***See pages 151-153 for sample sauce formulations.***

Heat-and-Eat Rice/Starch Mixes

Food producers are also pursuing shelf-stable, value-added rice and pasta-based dry mixes for placement in both specialty (natural) and mainstream grocery channels. These products offer exotic "Mediterranean" flavor and ingredient variety that is both easy to prepare and still familiar.

Fortifying these mixes with lentils or peas is an easy and flavorful way to enhance the protein and fiber content of popular side dishes. Introducing Mediterranean lentils to a mix, for example, enables consumers to enjoy an exotic, more healthful dish that does not require any extra effort to prepare. The lentils hydrate quickly so that every component (lentils, rice, couscous, etc.) of the dish is thoroughly cooked.

Common legume-based side dish formulations contain 44 percent to 71 percent whole or crushed dehydrated lentils. ***See pages 154-156 for sample formulations.***

> "Legume flours are often used as the basis for formulations that are extruded in low-pressure systems."

Extruded Snacks

Extrusion is a mechanical process in which certain materials are forced, under pressure, through a die opening to create products of a desired shape, size, and/or texture. In the case of food production, if the food is heated by external heaters during the process, it is referred to as extrusion cooking, a relatively new and advanced food processing technique. Due to its processing flexibility, extrusion cooking produces an incredibly broad range of food products, most notably in the cereal, dairy, bakery, and confection industries.

Legume flours are often used as the basis for formulations that are extruded in low-pressure systems. The flour is mixed with water and other ingredients like rice flour and spices to achieve a level of dough stickiness that is suitable for extruding and will produce a texture and taste that is acceptable to consumers.

The moisture content of the dough varies depending on manufacturer requirements. The extruded flour produced from chickpeas is approximately 11 percent moisture, 23 percent protein, 5 percent fat, and 59 percent carbohydrates. Pea flour is also commonly used as a base ingredient.

The nutritional, tasty, and convenient extruded pulse-based products offer a crunchy texture, usually in the form of snacks and breakfast cereal-type foods, are rich in protein and dietary fiber, very low in sodium and fat, and are cholesterol and gluten free.

The extrusion processing method is not currently being commercially used for pulse-based foods due to the perception that such foods do not expand well in extrusion. The rise in consumer demand for convenience foods with a more healthful nutritional profile has led researchers Dr. Jose De J. Berrios of ARS' Western Regional Research Centre in Albany, Calif., and Dr. Juming Tang and Dr. Barry Swanson at Washington State University to pursue development of healthful, crunchy, great-tasting expanded snack-type foods from dry peas, lentils, chickpeas, and beans.

Though extrusion technology is not new, scientists are only now beginning to determine the processing speeds, heating temperatures, moisture levels, and formulations necessary to create consistent, desirable textures and tastes from every batch of pulse flour. Several breakfast-cereal-type foods and snacks in a variety of shapes have already been developed with other products sure to follow.

Extruded Legume-based Foods

Per serving of 15g % Daily Value (DV):

- Protein – 6 percent
- Dietary fiber – 6 percent
- Total carbohydrates – 3 percent
- Fat – 0 percent
- Folate – 5 percent
- Thiamin – 4 percent
- Vitamin B-6 – 4 percent
- Niacin – 2 percent
- Riboflavin – 1 percent
- Pantothenic acid – 1 percent
- Iron – 5 percent
- Potassium – 3 percent
- Calcium 1 percent
- Zinc – 3 percent
- Copper – 7 percent
- Sodium – 7 percent

Baked Goods

Dry peas offer twice the protein of cereal grains, delivering 8 grams of high quality, low-fat, all-vegetable protein per ¼ cup. Rich in *lysine* (i.e., a basic amino acid), dry peas and pea flour provide an amino acid balance that complements cereal grain proteins. Because of such benefits, pea flour and pea protein isolates and concentrates are ideal additions to protein-enriched baking applications.

Pea flour is also rich in slowly digestible starch and resistant starch, which contributes to its low glycemic index. In addition, this quality contributes to its strength as an ingredient in baked foods aimed at fighting obesity and meeting the needs of diabetics and those at risk for diabetes and heart disease.

Bakers are interested in pulse flours for another reason as well: as a natural, more economical and nutritious alternative to gums. Pea fiber fortifications not only enhance dough yield, they can also modify texture, create a full-bodied mouthfeel, improve uniformity and consistency, and reduce product breakage.

Its high water binding capacity, fat absorption, and dough conditioning properties also contribute to making pea fiber perfect for many baked products, especially low-fat or color-sensitive applications. By increasing wheat flour's water absorption and easily substituting for up to 25 percent of wheat flour in baked foods like cakes, cookies, and muffins, pea flour makes possible the development of products with up to 4 grams of fiber per serving.

Proprietary processes for producing insoluble pea fiber from the seed's interior are also available. The resulting white powder, which is made up of 70 percent fiber, has emulsifying and gelling properties that make it especially useful when enriching white bakery products, without affecting color or flavor.

Also among the list of attractive benefits offered by pulses is the ingredient's folate content. Typical of all legumes, pea flour can significantly reduce the need for additional folate fortification in baking formulations, with a single cup providing 37 percent of the recommended daily allowance. Because of its important role in preventing birth defects, folate enrichment is now a requirement for many U.S. baked products, including bread.

At just 2.5 percent fat—highly unsaturated fat—pea flour manages to be cholesterol free. This enables it to lend bakery products an enhanced nutritional value and structure, including improved crispness, loaf volume, and appearance. Finally, and of great importance to consumers, precooked pulse flour can be an excellent way to improve the flavor in baked goods.

Given the myriad benefits, it should be no surprise that pulses and their derivatives are increasingly finding their way into a diverse array of baked goods, from cookies to crackers, *naan* (i.e., a leavened, often tear-shaped Indian flatbread) to noodles.

The Legume-based Extrusion Process

- Raw materials
- Homogenizing
- Grinding
- Mixing/Blending
- Extrusion cooking
- Cooling/drying
- Coating
- Packaging

Tortillas

Tortillas are proving a suitable application for processed legumes. A growing category, from 1994 to 2004 sales of tortillas doubled to approximately $6 million, a level fresh bread did not reach until 2005. The growth has been driven in part by the desire among American consumers for fast, healthier foods. The market has also been tirelessly pursuing new and exotic foods and flavors. A concentration on ethnic foods and low-carb options has further galvanized interest.

To meet this demand, producers are constantly innovating, creating a market defined by novel, creative tortilla formulations. More and more, consumers are able to choose from flavored, colored, and healthier tortilla options. Some tortilla alternatives include spinach, tomatoes, jalapenos, basil, cilantro, chilies, wheat, and other unique ingredients. One producer, WrapOlé, boasts some 16 different varieties.

Processed lentil flour and dehydrated lentil granules are being used, as are yellow pea and chickpea flour. As with other baked goods, the nutrition data illustrates distinct calorie, carbohydrate, protein, and fiber advantages from such additions.

Each pulse brings a slightly different flavor and color influence. Lentils provide a distinct flavor and color enhancement, while those with yellow peas are notable for their slight yellow color and greater sweetness. Chickpea flour, meanwhile, does not noticeably alter the color or flavor.

Given their familiar, neutral nature, tortillas give producers the opportunity to more effectively showcase the flavor, color, and texture improvements brought about by the addition of pulses.

Pulses are able to deliver heightened nutritional value without compromising the appearance, texture, or taste. Legume-enriched tortillas are also stable, durable, shippable, and not prone to rapid degradation. ***See pages 164-167 for sample tortilla formulations.***

Ethnic Flatbreads

The expanding popularity of tortillas has helped spawn consumer interest in flatbreads. In some Middle Eastern breads, pulses are actually already part of the traditional recipes. With other flatbreads, pulses can contribute to improvements in a range of varieties, from crispy to bubbly to bready. Styles include *lavosh*, *pita*, *focaccia*, *naan*, *arepa*, *paratha*, *bammi*, *barbari*, *gorditas*, *horo*, *injera*, *chapati*, and *sopes*.

Like tortillas, pulse-fortified flatbreads benefit from a more balanced macronutritional profile (e.g., carbohydrates, protein, fat, etc.) than equivalent products and provide superior fiber and protein content. Pulses also contribute additional flavor and a degree of ingredient authenticity when incorporated into the production of naan and cracker flatbread. ***See pages 168-169 for sample flatbread formulations.***

Rolls and Biscuits

Incorporating pea flour is an effective way to bolster the fiber and protein content in quick breads, rolls, and buns. In one example, U.S. food technologists added 30 percent pea flour to a conventional commercial burger bun formula and then optimized for moisture. The result was a bun with 4 grams of fiber and 7 grams of protein. The product also achieved a delicious

flavor while maintaining the product's traditional texture and appearance. ***See pages 170-71 for sample formulations.***

Other baking examples:

Crackers
See a sample formulation on page 172.

Cookies
See sample formulations on pages 173-174.

See pages 157-163 for other sample baking formulations.

Pasta/Noodles

Legume flours continue to be explored as a fortifying ingredient in pasta and noodle products, especially instant noodle formulations. Food producers and researchers have found that increasing pea flour in noodle products can increase elasticity, boost dough strength, and enhance the texture of noodles, while promoting the softness and chewiness found in traditional noodle formulations.

Pea flour has also been shown to impact the flavor profile and aroma of such products. Recent studies have suggested that an 80 percent pea flour, 20 percent wheat flour combination provides the optimal balance for taste, texture, and aroma.

The Benefits of Pea Fortification in Pasta

- Better protein quality
- Lower glycemic index
- Full amino acid profile (unlike wheat products)
- Provides many functional properties
- Cooks faster
- Leads to firmer products

The amount and type of pea flour used directly impact the flour's effects on the final product. For example, sensory qualities like flavor and texture tend to decrease with the use of cool season peas. ***See page 175 for a sample pasta formulation.***

Baby/Weaning Foods

In recent years, pulse-based fortifications are being considered an innovative and potentially beneficial ingredient in baby foods for children aged 1 to 3 years old. Typically a soup- or porridge-like product, the formulations are naturally fortified with the vitamins A, D, E, iron, folic acid, and other important nutrients from pulses, while providing a balance of essential amino acids.

Such baby foods increase the daily intake of carbohydrates and protein, with product protein in some preliminary studies reaching 15 percent. Producers are similarly quick to point out the important role such products can play as an alternative for those children who are lactose intolerant or allergic to soy products.

The low cost of dry peas, in combination with rice, leads to overall lower product cost, making the foods an attractive option to manufacturers and consumers. This is especially true when the lower costs are considered alongside dry peas' nutritional and microbiological benefits, and their long shelf life (up to 19 months with some products). ***See page 176 for a sample cereal formulation.***

Fortified Beverages/UHT Ready-to-Drink

As market trends continue to point to a growing interest in more healthful food choices, commercial food processors, as well as private volunteer organizations (PVOs), are now attempting to bring pulses to beverage formulations as well.

Three Benefits of Legume-based Weaning Products

- Offers an alternative for children with lactose intolerance or allergies to soy products
- Increases daily intake of protein and energy
- Makes feeding of solid foods to weaned children easier

Always looking for easy and effective ways to fill the gaps in their diets and daily nutrient requirements, health-conscious consumers are being introduced to a new generation of pulse-fortified beverages. The combination in these drinks of pulses and rice as the main raw materials results in a product with a balance of essential amino acids, as well as folic acid and other important nutrients.

In addition, the versatility and low cost of dry peas, lentils, and chickpeas allow the drink products to be used as an inexpensive extender or replacement for milk, soy, and other drinks that are already well-established in the market. These ready-to-drink products also provide a welcome convenience to today's busy consumer by virtue of their easy portability. Sterile, UHT packaging, meanwhile, allows for simple, low-cost storage and a long shelf life.

See Appendix C for a collection of all sample formulations.

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Appendix B
Production Tables
Dry Pea, Lentil & Chickpea Statistics (2008)

USA DRY PEA & LENTIL COUNCIL

2008 USADPLC CROP PRODUCTION REPORT
TOTAL U.S. PRODUCTION

REGULAR GREEN PEAS

Year	Acreage	Hectares	lbs/acre	Pounds	Metric Ton
2008	308,429	124,914	1,475	454,848,250	206,318
2007	331,247	134,155	1,798	595,666,181	270,192
2006	382,406	154,874	1,542	589,801,822	267,532
2005	391,664	158,624	1,676	656,522,845	297,797
2004	276,456	111,965	2,467	682,052,193	309,377
2003	232,007	93,963	1,590	368,843,629	167,306
6 Year Average	320,368	129,749	1,758	557,955,820	203,498

SMALL SIEVE GREEN PEAS

Year	Acreage	Hectares	lbs/acre	Pounds	Metric Ton
2008	2,639	1,069	2,060	5,437,040	2,466
2007	2,666	1,080	1,713	4,565,921	2,071
2006	2,960	1,199	2,042	6,043,003	2,741
2005	3,652	1,479	1,859	6,788,589	3,079
2004	4,754	1,925	2,365	11,241,771	5,099
2003	3,566	1,444	1,480	5,278,705	2,394
6 Year Average	3,372	1,366	1,920	6,559,172	2,975

LARGE LENTILS***

Year	Acreage	Hectares	lbs/acre	Pounds	Metric Ton
2008	32,322	13,090	822	26,557,024	12,046
2007	35,298	14,296	1,319	46,567,997	21,123
2006	19,280	7,808	1,162	22,406,300	10,163
2005	20,329	8,233	1,002	20,365,039	9,238
2004	5,319	2,154	2,225	11,832,954	5,367
5 Year Average	20,057	8,123	1,427	25,293,073	11,473

SMALL CHICKPEAS

Year	Acreage	Hectares	lbs/acre	Pounds	Metric Ton
2008	8,398	3,401	1,730	14,526,035	6,589
2007	15,065	6,101	1,110	16,726,000	7,587
2006	31,978	12,951	1,125	35,970,119	16,316
2005	10,760	4,358	1,427	15,357,975	6,966
2004	1,540	624	652	1,003,738	455
5 Year Average	13,548	5,487	1,209	16,716,773	7,583

MEDIUM LENTILS**
Reported as "Regular Lentils" before 2004

Year	Acreage	Hectares	lbs/acre	Pounds	Metric Ton
2008	143,047	57,934	986	140,979,638	63,948
2007	186,635	75,587	1,293	241,381,853	109,490
2006	295,509	119,681	1,174	346,914,397	157,359
2005	303,043	122,732	1,267	384,090,129	174,222
2004	259,598	105,137	1,191	309,240,698	140,271
2003	76,671	31,052	861	65,999,436	29,936
6 Year Average	210,751	85,354	1,129	248,101,025	112,538

YELLOW PEAS

Year	Acreage	Hectares	lbs/acre	Pounds	Metric Ton
2008	528,089	213,876	1,285	678,631,812	307,825
2007	548,600	222,183	1,955	1,072,502,616	486,484
2006	581,134	235,359	1,434	833,541,060	378,092
2005	403,762	163,524	1,945	785,322,022	356,220
2004	226,383	91,685	1,706	386,248,087	175,201
2003	72,580	29,395	1,790	129,912,434	58,928
6 Year Average	393,425	159,337	1,686	647,693,005	293,792

AUSTRIAN WINTER PEAS

Year	Acreage	Hectares	lbs/acre	Pounds	Metric Ton
2008	11,504	4,659	1,271	14,621,871	6,632
2007	25,220	10,214	1,253	31,606,527	14,337
2006	49,066	19,872	924	45,354,050	20,572
2005	7,170	2,904	1,145	8,210,131	3,724
2004	17,486	7,082	1,565	27,357,702	12,409
2003	18,650	7,553	1,280	23,879,468	10,832
6 Year Average	21,516	8,714	1,240	22,737,083	11,417

LARGE CHICKPEAS****

Year	Acreage	Hectares	lbs/acre	Pounds	Metric Ton
2008	65,327	26,458	1,396	91,196,956	41,367
2007	115,997	46,979	983	114,002,016	51,711
2006	112,751	45,664	1,048	118,211,146	53,620
2005	85,738	34,724	982	84,194,649	38,190
2004	20,198	8,180	1,277	25,787,441	11,697
2003	28,546	11,561	953	27,209,441	12,342
6 Year Average	71,426	28,928	1,107	76,766,942	34,821

SMALL LENTILS*
Reported as "Other Lentils" before 2004

Year	Acreage	Hectares	lbs/acre	Pounds	Metric Ton
2008	72,756	29,466	1,094	79,603,188	36,108
2007	91,168	36,923	1,229	112,047,206	50,824
2006	104,986	42,519	950	99,737,766	45,241
2005	68,808	27,867	958	65,939,078	29,910
2004	72,702	29,444	1,037	75,364,122	34,185
2003	158,983	64,388	1,115	177,343,425	80,442
6 Year Average	94,901	38,425	1,064	101,672,464	46,118

2008 U.S. PRODUCTION SUMMARY TABLE

	Acres	lbs/acre	Pounds	Metric Ton
Green Peas	311,068	1,480	460,285,290	208,784
Yellow Peas	528,089	1,285	678,631,812	307,826
AWP	11,504	1,271	14,621,871	6,632
Lentils	248,125	996	247,139,850	112,102
Chickpeas	73,725	1,434	105,722,991	47,956

* Pardina, Morton, Eston Varieties
** Brewers, Richlea, Merrit, red Chief Varieties
*** Mason, Pennell, Palouse, VanGard, Laird Varieties
**** US Large Chickpeas includes CA Production

Notes:
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Acreage data for 2008 has been amended since posting of the Industry Seeded Acreage Report, July 2008.

USADPLC 2008
PRODUCTION REPORT - PNW

REGULAR GREEN PEAS

Year	Acreage	Hectares	lbs/acre	Pounds	Metric Ton
2008	81,524	33,017	1,649	134,411,267,	60,969
2007	79,587	32,233	1,557	123,950,881	56,224
2006	89,364	36,192	1,506	134,580,322	61,045
2005	114,659	46,437	1,370	157,082,830	71,252
2004	121,307	49,129	1,978	239,984,275	108,856
2003	112,107	45,403	1,281	143,613,629	65,143
6 Year Average	99,758	40,401	1,557	155,603,867	70,582

SMALL SIEVE GREEN PEAS

Year	Acreage	Hectares	lbs/acre	Pounds	Metric Ton
2008	2,639	1,069	2,060	5,437,040	2,466
2007	2,666	1,080	1,713	4,565,921	2,071
2006	2,960	1,199	2,042	6,043,003	2,741
2005	3,652	1,479	1,859	6,788,589	3,079
2004	4,754	1,925	2,365	11,241,771	5,099
2003	3,566	1,444	1,480	5,278,705	2,394
6 Year Average	3,378	1,366	1,920	6,559,172	2,975

LARGE LENTILS***

Year	Acreage	Hectares	lbs/acre	Pounds	Metric Ton
2008	2,631	1,066	925	2,433,832	1,104
2007	3,205	1,298	824	2,642,447	1,199
2006	1,400	567	653	913,700	414
2005	4,329	1,753	442	1,915,039	869
2004	5,319	2,154	2,225	11,832,954	5,367
5 Year Average	3,563	1,443	1,036	4,326,035	1,962

SMALL CHICKPEAS

Year	Acreage	Hectares	lbs/acre	Pounds	Metric Ton
2008	3,006	1,217	1,680	5,049,475	2,290
2007	5,565	2,254	1,116	6,211,000	2,817
2006	10,014	4,056	1,181	11,829,300	5,366
2005	4,760	1,928	1,178	5,607,975	2,544
2004	1,540	624	652	1,003,738	455
5 Year Average	5,470	2,215	1,032	6,163,003	2,796

MEDIUM LENTILS**
Reported as "Regular Lentils" before 2004

Year	Acreage	Hectares	lbs/acre	Pounds	Metric Ton
2008	39,811	16,123	981	39,061,090	17,718
2007	43,795	17,737	972	42,587,853	19,318
2006	48,059	19,464	1,098	52,753,702	23,929
2005	72,039	29,176	918	66,141,917	30,002
2004	79,109	32,039	1,114	88,146,884	39,983
2003	75,671	30,647	855	64,696,436	29,346
6 Year Average	59,747	24,198	990	58,897,980	26,716

YELLOW PEAS

Year	Acreage	Hectares	lbs/acre	Pounds	Metric Ton
2008	10,591	4,289	1,924	20,375,299	9,242
2007	12,200	4,941	1,690	20,621,681	9,354
2006	7,754	3,140	1,417	10,987,560	4,984
2005	13,096	5,304	1,558	20,397,994	9,252
2004	10,122	4,099	1,873	18,954,321	8,598
2003	12,510	5,067	1,406	17,589,934	7,979
6 Year Average	11,046	4,473	1,644	18,154,465	8,235

AUSTRIAN WINTER PEAS

Year	Acreage	Hectares	lbs/acre	Pounds	Metric Ton
2008	3,947	1,599	1,557	6,147,306	2,788
2007	7,720	3,127	1,184	9,139,962	4,146
2006	14,787	5,989	1,054	15,581,200	7,068
2005	7,170	2,904	1,145	8,210,131	3,724
2004	7,754	3,140	2,087	16,183,482	7,341
2003	9,250	3,746	1,256	11,614,468	5,268
6 Year Average	8,430	3,418	1,381	11,146,091	5,056

LARGE CHICKPEAS

Year	Acreage	Hectares	lbs/acre	Pounds	Metric Ton
2008	52,258	21,164	1,270	66,342,176	30,093
2007	79,247	32,095	914	72,462,016	32,869
2006	80,875	32,754	1,039	84,032,326	38,117
2005	58,738	23,789	925	54,332,649	24,645
2004	20,198	8,180	1,277	25,787,441	11,697
2003	17,030	6,897	883	15,040,241	6,822
6 Year Average	51,391	20,813	1,051	52,999,475	24,041

* Pardina, Morton, Eston Varieties
** Brewers, Richlea, Merrit, red Chief Varieties
*** Mason, Pennell, Palouse, VanGard, Laird Varieties

Notes:
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SMALL LENTILS* Reported as "Other Lentils" before 2004					
Year	Acreage	Hectares	lbs/acre	Pounds	Metric Ton
2008	44,594	18,061	1,201	53,548,917	24,290
2007	61,501	24,908	1,183	72,780,106	33,013
2006	71,801	29,079	857	61,498,566	27,896
2005	63,808	25,842	934	59,614,078	27,041
2004	72,702	29,444	1,037	75,364,122	34,185
2003	81,623	33,057	964	78,655,425	35,678
6 Year Average	66,005	26,732	1,029	66,910,202	30,351

USADPLC 2008
PRODUCTION REPORT - MIDWEST

REGULAR GREEN PEAS					
Year	Acreage	Hectares	lbs/acre	Pounds	Metric Ton
2008	226,905	91,897	1,412	320,436,983	145,349
2007	251,660	101,922	1,874	471,715,300	213,969
2006	292,912	118,629	1,553	454,961,500	206,369
2005	277,005	112,187	1,803	499,440,015	226,545
2004	155,149	62,835	2,849	442,067,918	200,521
2003	119,900	48,560	1,878	225,230,000	102,164
6 Year Average	220,589	89,338	1,895	335,998,453	182,486

LARGE LENTILS***					
Year	Acreage	Hectares	lbs/acre	Pounds	Metric Ton
2008	29,691	12,025	812	24,123,192	10,942
2007	32,093	12,998	1,369	43,925,550	19,924
2006	17,880	7,241	1,202	21,492,600	9,749
2005	16,000	39,520	1,153	18,450,000	8,369
4 Year Average	23,916	17,946	1,134	26,997,836	12,246

SMALL CHICKPEAS					
Year	Acreage	Hectares	lbs/acre	Pounds	Metric Ton
2008	5,392	2,184	1,758	9,476,560	4,299
2007	9,500	3,848	1,107	10,515,000	4,770
2006	15,737	6,373	980	15,423,019	6,996
2005	6,000	2,430	1,625	9,750,000	4,423
2004	1,889	765	453	855,000	388
5 Year Average	7,704	3,120	1,185	9,203,916	4,175

MEDIUM LENTILS** Reported as "Regular Lentils" before 2004					
Year	Acreage	Hectares	lbs/acre	Pounds	Metric Ton
2008	103,236	41,811	987	101,918,548	46,230
2007	142,840	57,850	1,392	198,794,000	90,172
2006	247,450	100,217	1,189	294,160,695	133,430
2005	231,004	93,557	1,376	317,948,212	144,220
2004	180,489	73,098	1,225	221,093,814	100,287
2003	1,000	405	1,300	1,300,000	590
6 Year Average	151,003	61,156	1,245	189,202,545	85,822

YELLOW PEAS					
Year	Acreage	Hectares	lbs/acre	Pounds	Metric Ton
2008	517,498	209,587	1,272	658,256,513	298,583
2007	536,400	217,242	1,961	1,051,880,935	477,130
2006	573,330	232,199	1,435	822,468,500	373,069
2005	390,666	158,220	1,958	764,924,028	346,967
2004	216,261	87,586	1,698	367,293,766	166,603
2003	60,070	24,328	1,870	112,322,500	50 ,949
6 Year Average	382,371	154,863	1,699	629,524,374	285,550

AUSTRIAN WINTER PEAS					
Year	Acreage	Hectares	lbs/acre	Pounds	Metric Ton
2008	7,557	3,061	1,121	8,474,565	3,844
2007	17,500	7,088	1,284	22,466,565	10,191
2006	34,138	13,826	866	29,547,250	13,403
2005	12,000	4,860	1,050	12,600,000	5,715
2004	9,732	3,941	1,148	11,174,220	5,069
2003	9,400	3,807	1,305	12,265,000	5,563
6 Year Average	15,055	6,097	1,129	16,087,933	7,298

LARGE CHICKPEAS					
Year	Acreage	Hectares	lbs/acre	Pounds	Metric Ton
2008	7,129	2,887	1,570	11,192,780	5,077
2007	29,750	12,049	1,001	29,780,000	13,508
2006	19,876	8,050	874	17,379,820	7,883
2005	17,000	6,885	1,106	18,802,000	8,529
2004	5,128	2,077	1,020	5,228,600	2,372
2003	11,516	4,664	1,057	12,169,200	5,520
6 Year Average	15,065	6,102	1,104	15,758,733	7,148

SMALL LENTILS*					
Year	Acreage	Hectares	lbs/acre	Pounds	Metric Ton
2008	28,162	11,406	935	26,054,271	11,818
2007	29,667	12,015	1,324	39,267,100	17,811
2006	33,185	13,440	1,152	38,239,200	17,345
2005	5,000	2,025	1,265	6,325,000	2,869
2004	0	0	0	0	0
2003	77,360	31,331	1,276	98,688,000	44,765
6 Year Average	28,896	44,108	992	34,762,262	15,768

* Pardina, Morton, Eston Varieties

** Brewers, Richlea, Merrit, red Chief Varieties

*** Mason, Pennell, Palouse, VanGard, Laird Varieties

Notes:
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2008 USADPLC PRODUCTION REPORT: STATE BY STATE COMPARISON

ACREAGE											
State/ Year	Green Peas	Small Sieve	Yellow Peas	AWP	Large Chickpeas	Small Chickpeas	Large Lentils	Medium Lentils	Small Lentils	Red Lentils	Total Pulse Acres
ID 08	29,360	1,364	2,919	1,841	23,641	1,669	1,316	7,141	22,052	1,635	92,938
ID 07	19,550	1,378	2,680	4,600	37,905	4,215	1,700	11,335	28,272		11,635
WA 08	51,549	1,275	7,474	1,147	28,617	1,337	1,315	25,089	22,542	5,196	145,541
WA 07	58,907	1.288	9,320	1,220	38,542	1,350	1,505	31,710	33,229		177,071
0R 08	615	0	198	959	0	0	0	750	0	0	5,522
OR 07	1,130	0	200	1,900	2,800	0	0	750	0		6,780
CA 08	0	0	0	0	5,940	0	0	0	0	0	5,940
CA 07	0	0	0	0	7,000	0	0	0	0		7,000
MT 08	43,890	0	209,608	4,590	4,038	1,900	9,504	39,798	11,138	8,841	333,306
MT 07	49,500	0	209,000	15,000	12,250	1,500	12,000	57,000	14,000		370,250
ND 08	183,015	0	307,890	0	3,092	3,492	20,187	44,429	17,025	9,176	588.307
ND 07	190,960	0	320,000	0	13,500	6,000	20,093	78,640	15,667		644,860
SD,NE MN 07	3,083	0	4,535	2,967	3,610	1,805	0	5,926	971	992	23,889
SD, NE MN 07	11,200	0	7,400	2,500	4,000	2,000	0	7,200	0		34,300

PRODUCTION											
State/ Year	Green Peas	Small Sieve	Yellow Peas	AWP	Large Chickpeas	Small Chickpeas	Large Lentils	Medium Lentils	Small Lentils	Red Lentils	Total Production
ID 08	48,628,212	2,810,293	5,618,151	3,314,520	28,960,652	2,804,155	1,217,115	7,141,050	26,480,234	1,635,480	128,609,862
ID 07	32,816,502	2,828,871	4,349,681	6,114,962	36,019,996	6,211,000	1,102,292	13,916,537	30,325,875		133,683,716
WA 08	84,798,599	2,626,747	14,386,888	2,065,338	37,381,524	2,245,320	1,216,717	25,088,952	27,068,683	5,195,608	202,074,376
WA 07	89,269,879	1.737.050	15,902,000	630,000	35,874,020	0	890,155	28,021,316	42,318,481	NR	214,642,902
OR 08	984,456	0	370,260	767,448	0	0	0	0	0	0	2,122,164
OR 07	1,864,500	0	370,000	2,395,000	566,000	0	0	650,000	135,750		5,963,250
CA 08	0	0	0	0	13,662,000	0	0	0	0	0	13,662,000
CA 07	0	0	0	0	11,760,000	0	0	0	0	NR	11,760,000
MT 08	39,501,000	0	188,647,200	5,508,000	3,230,000	1,805,000	5,702,400	35,818,200	8,910,000	6,630,525	295,752,325
MT 07	84,122,500	0	323,256,327	19,500,000	12,250,000	1.575,000	16,800,000	82,650,000	18,900,000	NR	559,053,827
ND 08	277,853,365	0	465,074,583	0	4,352,780	5,866,560	18,420,792	49,760,383	16,173,675	8,717,461	846,219,599
ND 07	368,552,800	0	715,674,608	0	13,770,000	6,540,000	27,125,550	110,096,000	20,367,100		1,262,126,058
SD, NE MN 08	3,082,618	0	4,534,730	2,966,565	3,610,000	1,805,000	0	0	970,596	991,979	17,961,489
SD, NE MN 07	19,040,000	0	12,950,000	3,875,000	3,760,000	2,400,000	0	6,048,000	0		48,073,000

2008 STATE PRODUCTION SUMMARY TABLE (lbs)					
	Green Peas	Yellow Peas	AWP	Lentils	Chickpeas
Idaho	51,438,505	5,618,151	3,314,520	36,473,879	31,764,807
Washington	87,425,346	14,386,888	2,065,338	58,569,960	39,626,844
Oregon	984,456	370,260	767,448	0	0
California	0	0	0	0	13,662,000
North Dakota	277,853,365	323,256,327	0	93,072,310	10,219,340
Montana	39,501,000	188,647,200	5,508,000	57,061,125	5,035,000
Others	3,082,618	4,534,730	2,966,565	1,962,575	5,415,000
Total	460,285,290	536,813,556	14,621,871	247,139,850	105,722,991

Small Lentils - Pardina, Morton, Eston Varieties
Medium Lentils - Brewers, Richlea, Merrit, Varieties
Large Lentils - Mason, Pennell, Palouse, VanGard, Laird Varieties
Red Lentils - Red Chief, Red Robin, Crimson, Morton

Notes:
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Appendix C
Dry Pea, Lentil & Chickpea Formulations

USA DRY PEA & LENTIL COUNCIL

CINNAMON APPLE BAR

INGREDIENT	SUPPLIER	GRAMS	%
BAR COMPONENT			
Dehydrated lentil flour	Inland Empire Foods	225.00	35.61
36/43 Corn syrup	ADM	150.00	23.74
Rolled oats	Bob's Red Mill	75.00	11.87
Supro nuggets 60 isolated soy protein T120000627	The Solac Company	60.00	9.50
Air-dried 3/8 diced chewy apples	Van Drunen Farms	50.00	7.91
Corn sweet 55	ADM	35.00	5.54
Select grade golden fine milled flaxseed	Pizzey Milling Company	15.00	2.37
Clintose brand dextrose CD5-M06-008	ADM	5.00	0.79
Fibersol-2 CY3D12031	Matsutani America Inc.	5.00	0.79
Glycerin 9055	Ashland	3.50	0.55
Natural apple flavor 576893T	Firmenich	2.50	0.40
Cinnamon ground CK9414	Elite Spice	2.00	0.32
Reducol	Phyto Source	2.00	0.32
Canola oil	Wesson	1.50	0.24
Citric acid	Ashland	0.15	0.02
Lecithin beakin lv 3	ADM	0.15	0.02
TOTAL		631.80	100.00
COATING COMPONENT			
Yogurt coating	Mid America Food Sales	225.00	99.78
Cinnamon, ground CK9414	Elite Spice	0.50	0.22
TOTAL		225.50	100.00
ASSEMBLY			
Bar component	TSG	40.00	98.16
Yogurt component	TSG	0.75	1.84
TOTAL		225.50	100.00

PROCESSING PROCEDURE

1. Combine corn sweet, lecithin, glycerin, Fibersol, apple flavor, citric acid and canola oil. Mix by hand and reserve.
2. Combine all dry ingredients, except dextrose and corn syrup, in Kitchen Aid mixer. Mix on speed one for one minute.
3. While mixing on speed one, add corn sweet mixture to dry mixture. Mix on speed one for 45 seconds and reserve.
4. Preheat corn syrup in microwave for one minute. Stir in dextrose. Place in sauce pan over medium heat. Bring to 210ºF.
5. While mixing on speed one, add hot syrup to reserved ingredients. Mix for 45 seconds or until completely incorporated.
6. Transfer to sheet pan and press out to ½" thick. Allow to completely cool.
7. Cut cooled bars into 1 ¼" wide by 3 ½" long pieces. Place in a 110ºF convection oven on low fan for 30 minutes. Allow to cool.

Coating

1. Chop yogurt coating into approximately 4" blocks. Place in mixing bowl with cinnamon over double boiler until melted.
2. Drizzle 0.75 grams of yogurt coating over each cooled bar. Allow to set up, package and reserve.

PEANUT BUTTER PRETZEL BAR

INGREDIENT	SUPPLIER	GRAMS	%
BAR COMPONENT			
36/43 Corn syrup	ADM	200.00	24.52
Yellow pea flour 7013536-17	Inland Empire Foods	125.00	15.33
Dehydrated lentil flour 700703-08	Inland Empire Foods	125.00	15.33
Peanut butter creamy	Jif	100.00	12.26
Rolled oats	Bobs Red Mill	78.00	9.56
Peanut butter drops, chopped	Blommer Chocolate Co.	60.00	7.36
Supro nuggets 60 isolated soy protein T120000627	The Solae Company	50.00	6.13
Corn sweet 55	ADM	40.00	4.90
Select grade golden fine milled flaxseed	Pizzey Milling Co.	15.00	1.84
Fibersol-2 CY3D12031	Matsutani America Inc.	6.00	0.74
Clintose brand dextrose CD5-M06-008	ADM	5.00	0.61
Glycerin 9055	Ashland	4.00	0.49
Natural peanut butter flavor WonfFAF1903	Wild	4.00	0.49
Reducol	Phyto Source	2.00	0.25
Canola oil	Wesson	1.50	0.18
Lecithin beakin lv 3	ADM	0.15	0.02
TOTAL		815.65	100.00
PRETZEL COMPONENT			
Pretzel sticks	Snyders	110.22	100.00
TOTAL		110.22	100.00
COATING COMPONENT			
Peanut butter drops	Blommer Chocolate Co.	17.00	100.00
TOTAL		17.00	100.00
ASSEMBLY			
Bar component	TSG	37.00	86.55
Pretzel component	Snyders	5.00	11.70
Coating component	TSG	0.75	1.75
TOTAL		42.75	100.00

PROCESSING PROCEDURE

1. On parchment paper-lined sheet tray, lay pretzel sticks in a row, side to side, and reserve.
2. Combine corn sweet, lecithin, glycerin, finersol, and canola oil. Mix by hand and reserve.
3. Combine all dry ingredients except dextrose and corn syrup in mixer. Mixed on speed 1 for 1 minute.
4. While mixing, add corn sweet mixture to dry mixture. Mix on speed 1 for 45 seconds and reserve.
5. Preheat corn syrup in microwave for 1 minute. Stir in dextrose. Place in saucepan over medium heat and bring to 210˚F.
6. While mixing on speed 1, add hot syrup to reserved ingredients. Mix for 45 seconds or until completely incorporated.
7. Transfer to reserved pretzel sheet pan and press out to ½" thick. Allow to cool completely.
8. Cut cooled bars into 1¼" wide by 3½" long pieces. Place in a 110˚F convection oven on low fan for 30 minutes. Allow to cool.

Coating

1. Rough chop peanut butter drops. Place in mixing bowl over double boiler until melted.
2. Drizzle 0.75 grams of melted peanut butter drops over each cooled bar. Allow to set up, package and reserve.

STRAWBERRY BAR WITH CHOCOLATE YOGURT COATING

INGREDIENT	SUPPLIER	GRAMS	%
BAR COMPONENT			
36/43 Corn syrup	ADM	275.00	28.27
Yellow pea flour 7013536-17	Inland Empire Foods	200.00	20.56
Dehydrated lentil flour 700703-08	Inland Empire Foods	200.00	20.56
Rolled oats	Bobs Red Mill	75.00	7.71
Sugar infused strawberries	Van Drunen Farms	60.00	6.17
Supro nuggets 60 isolated soy protein T120000627	The Solae Company	50.00	5.14
Corn sweet 55	ADM	45.00	4.63
Strawberry plus IPL 68216 (59-4318)	Quest	20.00	2.06
Select grade golden fine milled flaxseed	Pizzey Milling Co.	15.00	1.54
Fibersol-2 CY3D12031	Matsutani America Inc.	6.00	0.62
B-30 70592	Chr. Hanson	6.00	0.62
Clintose brand dextrose CD5-M06-008	ADM	5.00	0.51
Natural strawberry flavor FAFU338	Wild	4.00	0.41
Glycerin 9055	Ashland	4.00	0.41
Reducol	Phyto Source	2.00	0.41
Canola oil	Wesson	1.50	0.21
Citric acid	Ashland	0.15	0.15
Lecithin beakin lv 3	ADM	0.15	0.02
TOTAL		972.65	100.00
COATING COMPONENT			
Yogurt bar coating	Mid America Food Sales	225.00	95.74
Semisweet chocolate chips	Nestle	10.00	4.26
TOTAL		235.00	100.00
ASSEMBLY			
Bar component	TSG	35.00	97.90
Coating component	TSG	0.75	2.10
TOTAL		35.75	100.00

PROCESSING PROCEDURE

1. Combine corn sweet, lecithin, glycerin, finersol, strawberry flavor and canola oil. Mix by hand and reserve.
2. Combine all dry ingredients except dextrose and corn syrup in mixer. Mixed on speed 1 for 1 minute.
3. While mixing, add corn sweet mixture to dry mixture. Mix on speed 1 for 45 seconds and reserve.
4. Preheat corn syrup in microwave for 1 minute. Stir in dextrose. Place in saucepan over medium heat and bring to 210˚F.
5. While mixing on speed 1, add hot syrup to reserved ingredients. Mix for 45 seconds or until completely incorporated.
6. Transfer to sheet pan and press out to ½" thick. Allow to cool completely.
7. Cut cooled bars into 1¼" wide by 3½" long pieces. Place in a 110˚F convection oven on low fan for 30 minutes. Allow to cool.

Coating

1. Chop yogurt coating into approximately 4" blocks. Place in mixing bowl with semisweet chocolate chips over double boiler until melted.
2. Drizzle 0.75 grams of yogurt coating over each cooled bar. Allow to set up, package and reserve.

ITALIAN VEGETABLE AND PASTA SOUP

INGREDIENT	SUPPLIER	GRAMS	%
PASTA COMPONENT			
Water	Tap	1000.00	76.45
Elbow macaroni	Barilla Plus	300.00	22.94
Salt kosher	Morton	8.00	0.61
TOTAL		1308.00	100.00
AUTUMN LENTIL BLEND COMPONENT			
Water	Tap	500.00	62.17
Autumn lentil blend 8635	Sysco	304.30	37.83
TOTAL		804.30	100.00
SOUP COMPONENT			
Water	Tap	2000.00	27.03
Diced tomato	Hunt's	1548.00	20.92
Zucchini small diced	Fresh	650.00	8.78
Garbanzo beans drained	Bush's	600.00	8.11
Autumn lentil blend component cooked	TSG	600.00	8.11
Pasta component cooked	TSG	600.00	8.11
Carrots small diced	Fresh	425.00	5.74
Red bell pepper chopped	Fresh	230.00	3.11
Artichoke hearts diced	Roland	230.00	3.11
Yellow onions chopped	Fresh	175.00	2.37
Tomato paste	Hunt's	125.00	1.69
Olive pomace oil	Sysco	70.00	0.95
Salt kosher	Morton	55.00	0.74
Flax Bev Grad	Pizzey's Milling Company	50.00	0.68
Garlic minced	Fresh	20.00	0.27
Basil chopped 10690	SupHerb Farms	13.00	0.18
Oregano chopped 11740	SupHerb Farms	4.00	0.05
Thyme 12220	SupHerb Farms	3.25	0.04
Red pepper crushed PR9244	Elite Spice	1.30	0.02
TOTAL		7399.55	100.00

PROCESSING PROCEDURE

Pasta Component
1. In a 4-quart pot bring salt and water to a boil. Add pasta and cook for 12 minutes or until done.
2. Drain pasta and run under cold water until cool. Reserve.

Autumn Blend Lentil Component
1. In an 8-quart pot combine water and lentils. Bring to a boil and then reduce to a simmer. Cook for 15 to 18 minutes or until done.
2. Drain lentils and run under cold water until completely cool. Reserve.

Soup Component
1. In a 4-gallon pot, heat olive oil over medium high heat. Add onion, garlic and 175-grams of carrots. Sauté for 8 minutes. Add tomato paste and cook an additional 8 minutes.
2. Add water and bring to a simmer. Add remaining ingredients except pasta.
3. Cook for 1 hour. Remove from heat and add pasta. Cool completely in ice bath and reserve under refrigeration.

MOROCCAN LENTIL SOUP

INGREDIENT	SUPPLIER	GRAMS	%
Water	Tap	1053.50	46.17
Chickpeas drained	Bush's	325.00	14.24
Dry red lentils	Sysco	223.30	9.79
Coconut milk	Thai Kitchens	207/40	7.04
Butternut squash ½" x ½" diced	Fresh	160.60	5.01
Onion chopped	Fresh	114.30	3.29
Celery small dice	Fresh	75.00	1.56
Peanut oil	Mrs. Tucker	35.60	1.45
Tomato paste	Hunt's	3.20	0.64
Garlic minced	Fresh	14.60	0.53
Cilantro minced	Fresh	12.00	0.48
Ginger minced	Fresh	11.00	0.41
Salt kosher	Morton	9.40	0.08
Black pepper cracked 16 PE9212	Elite Spice	1.90	0.06
Fenugreek ground FG9423	Elite Spice	1.40	0.06
Curry powder	Monarch	1.30	0.04
Ginger ground GG9425	Elite Spice	0.90	0.02
Nutmeg ground NU9435	Elite Spice	0.50	0.02
Onion powder ONNP514	Elite Spice	0.05	0.02
Cinnamon ground CK9414	Elite Spice	0.40	0.02
Red pepper ground PR9457	Elite Spice	0.20	0.01
TOTAL		2282.00	100.00

PROCESSING PROCEDURE

Soup Component
1. In a 4-quart sauce pot heat oil. Add onion, celery and garlic. Cook until translucent.
2. Add remaining ingredients and bring to a simmer. Cook 20 minutes, remove from stove and cool completely in ice bath. Reserve under refrigeration.

AUTUMN LENTIL CHIPOTLE VEGETABLE CHILI

INGREDIENT	SUPPLIER	GRAMS	%
AUTUMN LENTIL BLEND COMPONENT			
Water	Tap	4665.00	81.56
Autumn lentil blend 8635	Sysco	1054.70	18.44
TOTAL		5719.70	100.00
BROWN LENTIL COMPONENT			
Water	Tap	5420.00	77.43
Brown lentil	Sysco	1580.00	22.57
TOTAL		7000.00	100.00
BELUGA LENTIL COMPONENT			
Water	Tap	4665.00	81.56
Lentil Beluga B58S	Sysco	1054.70	18.44
TOTAL		5719.70	100.00
CHILI COMPONENT			
Tomato juice low sodium	Campbell's	9420.00	25.21
Brown lentils reserved cooking water	TSG	4500.00	12.04
Brown lentils component cooked	TSG	3586.90	9.60
Crushed tomato	Hunt's	3522.40	9.43
Diced tomato	Hunt's	3000.00	8.03
Beluga lentil component cooked	TSG	2263.00	6.06
Zucchini grilled medium diced	Fresh	2242.00	6.00
Autumn lentil blend component cooked	TSG	2194.00	5.87
Garbanzo beans	Bush's	1228.00	3.29
Onion chopped	Fresh	1190.00	3.19
Carrots roasted medium diced	Fresh	1124.00	3.01
Tomato paste	Hunt's	600.00	1.61
Red bell pepper roasted medium diced	Fresh	500.00	1.34
Green bell pepper roasted medium diced	Fresh	500.00	1.34
Yellow bell pepper roasted medium diced	Fresh	400.00	1.07
Chili powder	McCormick	332.00	0.89
Salt kosher	Morton	235.00	0.63
Reducol	Phytosource	100.00	0.27
Garlic minced	Fresh	100.00	0.27
Flax BevGrad	Pizzey's Milling Company	100.00	0.27
Sugar granulated	C&H	75.00	0.20
Sav. roasted vegetable base 9800	Custom Culinary	40.00	0.11
Cumin seed ground 30 CM9420	Elite Spice	35.00	0.09
Olive pomace oil	Sysco	30.00	0.08
Mirepoix base 9801	Custom Culinary	20.00	0.05
Grill scraping flavor 1051	Red Arrow	18.00	0.05
Chili pepper chipotle CX9593	Elite Spice	6.00	0.02
TOTAL		37361.30	100.00

AUTUMN LENTIL CHIPOTLE VEGETABLE CHILI, CONTINUED

PROCESSING PROCEDURE

Dry Autumn Blend Lentil Component
1. In an 8-quart pot combine water and lentils. Bring to a boil over high heat. Turn down heat and simmer lentils for 10-15 minutes.
2. Drain lentils and run under cold water. Reserve.

Brown Lentil Component
1. In an 8-quart pot combine water and lentils. Bring to a boil over high heat. Turn down heat and simmer lentils for 10-15 minutes.
2. Drain lentils and reserve cooking water. Run lentils under cold water. Reserve.

Beluga Lentil Component
1. In an 8-quart pot combine water and lentils. Bring to a boil over high heat. Turn down heat and simmer lentils for 10-15 minutes.
2. Drain lentils and run under cold water. Reserve.

Chili Component
1. Grill carrots, zucchini, red peppers, yellow peppers and green peppers. Reserve.
2. Heat oil over medium high heat; add onions and garlic and sauté until translucent.
3. Add all of the dry seasoning and tomato paste to onion garlic mix; continue to cook for 3 minutes.
4. Add tomato juice, half of the cooked brown lentils and reserved lentil cooking liquid. Bring to a slow simmer.
5. Add remaining ingredients and cook over low heat for 2 hours.
6. Remove from heat and cool completely in ice bath.

SICILIAN LENTIL PASTA SAUCE

INGREDIENT	SUPPLIER	GRAMS	%
AUTUMN BLEND LENTIL			
Autumn blend lentil dry	Sysco	507.30	37.86
Water	Tap	832.52	62.14
TOTAL		1339.82	100.00
SICILIAN SAUCE COMPONENT			
Tomato sauce	Hunt's	1600.00	43.15
Autumn blend lentil component cooked	TSG	1000.00	26.97
Crushed tomato	Hunt's	754.00	20.34
Onion minced	Fresh	100.00	2.70
Sugar granulated	C&H	80.00	2.16
Carrot minced	Fresh	60.00	1.62
Celery minced	Fresh	60.00	1.62
Garlic minced	Fresh	25.00	0.67
Glucon GDL (glucono-delta-lactone)	Purac	17.46	0.47
Salt kosher	Elite Spice	3.25	0.09
Oregano chopped 11740	SupHerb Farms	2.60	0.07
Basil whole BS9106	Elite Spice	1.40	0.04
Oregano whole OM9127	Elite Spice	1.10	0.03
Black pepper ground PB9407	Elite Spice	1.00	0.03
Red pepper crushed PR9244	Elite Spice	1.00	0.03
Thyme Spanish ground 50 TS9546	Elite Spice	0.75	0.02
Bay leaves ground BY9406	Elite Spice	0.25	0.01
TOTAL		3707.81	100.00

PROCESSING PROCEDURE

Autumn Blend Lentil Component
1. In an 8-quart pot combine water and lentils. Bring to a boil over high heat. Turn down heat and simmer lentils for 10-15 minutes.
2. Drain lentils and run under cold water. Reserve.

Sicilian Lentil Soup Component
1. Heat olive oil in 2-gallon pot. Add onion and garlic. Sauté until onion and garlic are translucent.
2. Add remaining ingredients and bring to a low simmer. Cook for 20 minutes.
3. Remove from stove and reserve hot.
4. In a separate pot bring 2 gallons of water to a boil. Place 4 1-quart Ball jars with lids in boiling water, completely submerged, for 20 minutes. Remove jars and fill with reserved 195˚F sauce. Place lid on filled jar tightly and place on table upside down for 1 minute.
5. After 1 minute, place jar in 150˚F water for 20 minutes. Slowly add cold water to pot until jars and sauce are completely cool. Reserve under refrigeration.

SUN-DRIED TOMATO HERB SPREAD

INGREDIENT	SUPPLIER	GRAMS	%
BROWN LENTIL COMPONENT			
Water	Tap	923.14	67.61
Brown lentils dry	Sysco	442.28	32.39
TOTAL		1365.42	100.00
SPREAD COMPONENT			
Brown lentil component cooked	TSG	1000.00	65.19
Sun-dried tomatoes in oil	Melissa's	240.00	15.65
Olive pomace oil	Sysco	220.00	14.34
Garlic minced	Fresh	40.00	2.61
Salt kosher	Morton	26.00	1.69
Pasta and Pizza 10560	SupHerb Farms	8.00	0.52
TOTAL		1534.00	100.00

PROCESSING PROCEDURE

Brown Lentil Component
1. In an 8-quart pot combine water and lentils. Bring to a boil and then reduce to a simmer. Cook for 15 to 18 minutes or until done.
2. Drain lentils and run under cold water until completely cool. Reserve.

Spread Component
1. Combine all ingredients in food processor and blend on high for 3 minutes. Reserve under refrigeration.

WILD MUSHROOM AND LENTIL RAGOUT

INGREDIENT	SUPPLIER	GRAMS	%
BROWN LENTIL COMPONENT			
Water	Tap	451.80	67.60
Brown lentils dry	Sysco	216.50	32.40
TOTAL		668.30	100.00
BLACK BELUGA LENTIL COMPONENT			
Water	Tap	289.00	58.45
Black Beluga lentils dry	Sysco	205.45	41.55
TOTAL		494.45	100.00
RAGOUT COMPONENT			
Diced tomato	Hunt's	754.00	26.06
Brown lentil component cooked	TSG	500.00	17.28
Black Beluga lentil component cooked	TSG	300.00	10.37
Tomato sauce	Hunt's	300.00	10.37
Cabernet Sauvignon	Gallo	225.00	7.78
Button mushroom diced	Fresh	200.00	6.91
Portobello mushroom diced	Fresh	140.00	4.84
Shiitake mushroom diced	Fresh	125.00	4.32
Onion minced	Fresh	100.00	3.46
Tomato paste	Hunt's	80.00	2.77
Oil pomace oil	Sysco	75.00	2.59
Garlic minced	Fresh	50.00	1.73
Salt kosher	Morton	15.00	0.52
Glucon GDL (glucono-delta-lactone)	Purac	12.25	0.42
Basil chopped 10690	SupHerb Farms	9.00	0.31
Oregano 11740	SubHerb Farms	8.00	0.28
TOTAL		2893.25	100.00

Brown Lentil Component
1. In an 8-quart pot combine water and lentils. Bring to a boil over high heat. Turn down heat and simmer lentils for 10-15 minutes.
2. Drain lentils. Run lentils under cold water. Reserve.

Black Beluga Lentil Component
1. In an 8-quart pot combine water and lentils. Bring to a boil over high heat. Turn down heat and simmer lentils for 10-15 minutes.
2. Drain lentils. Run lentils under cold water. Reserve.

Ragout Component
1. In a 2-gallon pot heat olive oil. Add mushrooms, garlic and onion. Sauté for 5 minutes or until soft and starting to brown.
2. Add remaining ingredients and bring to a simmer. Cook for 20 minutes, reserve hot.
3. In a separate pot bring 2 gallons of water to a boil. Place four 1-quart Ball jars with lids in boiling water, completely submerged, for 20 minutes. Remove jars and fill with reserved 195°F sauce. Place lid on filled jar tightly and place on table upside down for 1 minute.
4. After 1-minute place jar in 150°F water for 20 minutes. Slowly add cold water to pot until jars and sauce are completely cool. Reserve under refrigeration.

ITALIAN LENTIL AND BROWN RICE

INGREDIENT	SUPPLIER	GRAMS	%
LENTIL COMPONENT			
Lentil whole 500705	Inland Empire Foods	90.00	47.21
Whole grain instant brown rice	Uncle Ben's	54.00	28.32
Tomato powder TOMP506	Elite Spice	10.00	5.25
Onion chopped 10036	Con Agra	8.00	4.20
Salt kosher	Morton	7.25	3.80
Tomato flake 73400	Con Agra	6.00	3.15
Bell pepper dice 73783	Con Agra	6.00	3.15
Basil whole BS9106	Elite Spice	3.00	1.57
Garlic chopped 20753	Con Agra	3.00	1.57
Parsley crack 10 PF9223	Elite Spice	2.00	1.05
Garlic powder GARP587	Elite Spice	1.00	0.52
Thyme Spanish ground TS9546	Elite Spice	0.40	0.21
TOTAL		190.65	100.00
ASSEMBLY			
Water	Tap	547.00	72.77
Lentil component	TSG	190.65	25.36
Butter	Hiland Dairy	14.00	1.86
TOTAL		751.65	100.00

PROCESSING PROCEDURE

1. Combine all ingredients. Package and reserve.

Preparation
1. Bring water, butter and lentil component to a boil in a 2-quart sauce pot. Turn down heat to a simmer and cook 10 minutes.
2. Allow to sit covered for 1 minute and serve.

MEDITERRANEAN LENTILS

INGREDIENT	SUPPLIER	GRAMS	%
SEASONING BLEND			
Red curry powder 12560A2	Elite Spice	17.30	39.68
Brown sugar	C&H	10.80	24.77
Salt kosher	Morton	5.20	11.93
Chopped onion S162009	Con Agra	3.30	7.57
Curry powder	Onarch	3.00	6.88
Chopped garlic S262009	Con Agra	2.00	4.59
Bay leaf ground BY9405	Elite Spice	2.00	4.59
TOTAL		43.60	100.00
LENTIL COMPONENT			
Lentil whole 500703	Inland Empire Foods	120.00	71.20
Carrot puff ⅜" x ⅜" 72484	Con Agra	10.00	5.93
Seasoning component	TSG	18.50	10.98
Tomato flake ⅜" 73400	Con Agra	6.25	3.71
Bell pepper red dice ¼" 73783	Con Agra	5.00	2.97
Chopped onion 10038	Con Agra	3.00	1.78
Chopped garlic 20753	Con Agra	2.25	1.34
Spinach flake S767060	Con Agra	2.00	1.19
Freeze-dried celery ¼"	Van Drunen Farms	1.50	0.89
TOTAL		662.50	100.00
ASSEMBLY			
Water	Tap		72.45
Lentil component	TSG		25.438
Butter	Hiland Dairy		2.11
TOTAL		662.50	100.00

PROCESSING PROCEDURE

Seasoning Component
1. Combine all ingredients. Reserve lentil component.
2. Combine all ingredients and add 18.5 grams of seasoning component. Package and reserve.

Preparation
1. Bring water and butter to a boil in a 2-quart sauce pot. Remove from heat and stir in lentil component.
2. Allow to sit covered for 7 minutes and serve.

MOROCCAN LENTIL COUSCOUS

INGREDIENT	SUPPLIER	GRAMS	%
LENTIL COMPONENT			
Lentil crushed 500714	Inland Empire Food	78.00	44.58
Couscous dry	Vigo	75.00	42.87
Moroccan seasoning 19910A9	Elite Spice	8.00	4.57
Chickpea flour 7015516-32	Inland Empire Food	5.00	2.86
Salt kosher	Morton	3.50	2.00
Sugar granulated	C	3.00	1.71
Cinnamon 2.5% CK9414	Elite Spice	1.30	0.74
Parsley crack 10 PF9223	Elite Spice	0.75	0.43
Cardamom ground CD9412	Elite Spice	0.20	0.11
NAT lemon crystals 862260	SPM Firmenich	0.20	0.11
TOTAL		174.95	100.00
ASSEMBLY			
Water	Tap	443.00	70.10
Lentil component	TSG	174.95	27.68
Butter	Hiland Dairy	14.00	2.22
TOTAL		631.95	100.00

PROCESSING PROCEDURE

Lentil Component
1. Combine all ingredients. Package and reserve.

Preparation
1. Bring water and butter to a boil in a 2-quart sauce pot. Remove from heat and stir in lentil component.

PAN BREAD

INGREDIENT	GRAMS
High gluten bread flour	100.00
Precooked yellow pea flour	30.00
Shortening	7.80
Salt	1.90
Instant yeast	1.40
Sugar	7.80
Emplex*	0.70
Water	81.10

PROCESSING PROCEDURE

1. Mix to optimum dough development for 5-6 minutes.
2. Scale dough, round, and let rest 10 minutes.
3. Mold the dough and proof for 80 minutes at 35°C and 85% RH.
4. Bake for 22-24 minutes at 400°F.

* American Ingredients. Contains sodium stearoyl lactylate.

PEA BAGEL

INGREDIENT	GRAMS
High gluten bread flour	100.00
Precooked yellow pea flour	20.00
Sugar	7.80
Salt	1.90
Instant yeast	1.40
Water	60.90

PROCESSING PROCEDURE

1. Mix to full development.
2. Scale, round and shape dough pieces.
3. Proof approximately 80 minutes.
4. Boil 90 seconds each side and allow to dry slightly.
5. Bake for 20 minutes at 375°F.

PEA BROWNIES

INGREDIENT	GRAMS
BROWNIES	
All purpose wheat flour	100.00
Precooked yellow pea flour	55.00
Butter	70.40
Sugar	131.00
Eggs	124.20
Vanilla	2.90
Baking powder	1.50
Chocolate syrup	248.00
FROSTING	
Butter	54.80
Sugar	155.30
Whole milk	49.70
Chocolate chips	49.70

PROCESSING PROCEDURE

1. Cream together butter and sugar.
2. Beat the egg in, 100 grams at a time.
3. Add the dry ingredients, mix and stir in syrup.
4. Pour into a jelly-roll pan and bake 35 minutes at 350˚F.
5. Frost.

PEA BUTTERMILK PANCAKES

INGREDIENT	GRAMS
All purpose wheat flour	100.00
Precooked yellow pea flour	33.30
Vegetable oil	18.70
Buttermilk	122.60
Whole milk	93.30
Eggs	40.00
Sugar	19.20
Salt	1.60
Baking powder	3.50
Baking soda	3.10

PROCESSING PROCEDURE

1. Mix ingredients until smooth, approximately 2 minutes.
2. Bake on medium heat until browned on each side.

PEA CARROT MUFFINS

INGREDIENT	GRAMS
All purpose wheat flour	100.00
Precooked yellow pea flour	300.00
Cooking oil	285.00
Sugar	296.00
Eggs	228.00
Vanilla	5.20
Carrot	296.00
Baking soda	11.10
Salt	6.50
Cinnamon	2.90
Pecans	57.00
Raisins	57.00
Pineapple	57.00

PROCESSING PROCEDURE

1. Mix all ingredients until well incorporated.
2. Pour into muffin cup and top with chopped pecans.
3. Bake for 22-23 minutes at 350°F.

PEA DOUGHNUTS

INGREDIENT	GRAMS
All purpose wheat flour	100.00
Precooked yellow pea flour	50.00
Instant yeast	3.50
Shortening	10.00
Eggs	25.00
Whole milk	86.00
Sugar	14.00
Salt	1.80
Nutmeg	0.50
Water	16.00

PROCESSING PROCEDURE

1. Heat milk and shortening; add yeast and let stand 7 minutes.
2. Mix all ingredients 3-4 minutes.
3. Let rise 30 minutes.
4. Cut into doughnut shapes; let rise for an additional 30 minutes.
5. Fry at 365°F for 30-45 seconds per side.

PEA WHOLE WHEAT HEARTH BREAD

INGREDIENT	GRAMS
Whole wheat flour	100.00
Precooked yellow pea flour	5.00
Shortening	6.00
Salt	1.50
Emplex*	0.50
Milled flaxseed	4.00
Water	72.00

PROCESSING PROCEDURE

1. Mix to optimum dough development for 4-6 minutes
2. Scale dough, round pieces and let rest for 10 minutes
3. Bake for 22-24 minutes at 400°F

* American Ingredients. Contains sodium stearoyl lactylate.

CONTROL TORTILLA

INGREDIENT	SUPPLIER	GRAMS	%
All Trump bread flour	Gold Medal	235.28	58.82
Water warm 90˚F	Tap	122.36	30.59
All vegetable shortening	Crisco	23.52	5.88
AZ tortilla base 113617	ADM	18.84	4.71
TOTAL		400.00	100.00

PROCESSING PROCEDURE

1. In a medium electric mixing bowl combine flour, AZ tortilla base, and vegetable shortening. Mix on medium speed with a whip attachment for 2 minutes.
2. Change attachment to dough hook and add water. Mix on low speed 1 minute and high speed 4 minutes.
3. Divide dough into 56-gram balls and let rest, covered with plastic wrap, for 15 minutes.
4. Preheat cast iron griddle over medium heat.
5. Using tortillas press, press dough balls out in to 7-inch discs.
6. Place disc on preheated cast iron griddle 15 to 20 seconds on each side.
7. Cool on cooling rack, package and reserve.

10% LENTIL TORTILLA

INGREDIENT	SUPPLIER	GRAMS	%
All Trump bread flour	Gold Medal	193.00	46.21
Water 90˚F	Tap	140.00	33.52
Dehydrated lentil flour 700703-10	Inland Empire Foods	42.28	10.12
All vegetable shortening	Crisco	23.52	5.63
AZ tortilla base 113617	ADM	18.84	4.51
TOTAL		417.64	100.00

PROCESSING PROCEDURE

1. In a medium electric mixing bowl combine flour, AZ tortilla base, dehydrated lentil flour and vegetable shortening. Mix on medium speed with a whip attachment for 2 minutes.
2. Change attachment to dough hook and add water. Mix on low speed 1 minute and high speed 4 minutes.
3. Divide dough into 56-gram balls and let rest, covered with plastic wrap, for 15 minutes.
4. Preheat cast iron griddle over medium heat.
5. Using tortillas press, press dough balls out in to 7” disc.
6. Place disc on preheated cast iron griddle 15 to 20 seconds on each side.
7. Cool on cooling rack, package and reserve.

20% LENTIL TORTILLA

INGREDIENT	SUPPLIER	GRAMS	%
Water warm 90˚F	Tap	160.00	36.56
All Trump bread flour	Gold Medal	146.28	33.42
Dehydrated lentil flour 700703-10	Inland Empire Foods	89.00	20.34
All vegetable shortening	Crisco	23.52	5.37
AZ tortilla base 113617	ADM	18.84	4.30
TOTAL		437.64	100.00

PROCESSING PROCEDURE

1. In a medium electric mixing bowl combine flour, AZ tortilla base, dehydrated lentil flour and vegetable shortening. Mix on medium speed with a whip attachment for 2 minutes.
2. Change attachment to dough hook and add water. Mix on low speed 1 minute and high speed 4 minutes.
3. Divide dough into 56-gram balls and let rest, covered with plastic wrap, for 15 minutes.
4. Preheat cast iron griddle over medium heat.
5. Using tortillas press, press dough balls out in to 7-inch discs.
6. Place disc on preheated cast iron griddle 15 to 20 seconds on each side.
7. Cool on cooling rack, package and reserve.

20% LENTIL TYPE B TORTILLA

INGREDIENT	SUPPLIER	GRAMS	%
All Trump bread flour	Gold Medal	160.00	37.09
Water warm 90˚F	Tap	140.00	32.46
Lentil flour type B 700706-15	Inland Empire Foods	89.00	20.60
All vegetable shortening	Crisco	23.52	5.45
AZ tortilla base 113617	ADM	18.84	4.37
TOTAL		431.36	100.00

PROCESSING PROCEDURE

1. In a medium electric mixing bowl combine flour, AZ tortilla base, dehydrated lentil flour and vegetable shortening. Mix on medium speed with a whip attachment for 2 minutes.
2. Change attachment to dough hook and add water. Mix on low speed 1 minute and high speed 4 minutes.
3. Divide dough into 56-gram balls and let rest, covered with plastic wrap, for 15 minutes.
4. Preheat cast iron griddle over medium heat.
5. Using tortillas press, press dough balls out in to 7-inch discs.
6. Place disc on preheated cast iron griddle 15 to 20 seconds on each side.
7. Cool on cooling rack, package and reserve.

20% LENTIL TORTILLA CHIPS

INGREDIENT	SUPPLIER	GRAMS	%
Water warm 90˚F	Tap	160.00	36.56
All Trump bread flour	Gold Medal	146.28	33.42
Dehydrated lentil flour 700703-10	Inland Empire Foods	89.00	20.34
All vegetable shortening	Crisco	23.52	5.37
AZ tortilla base 113617	ADM	18.84	4.30
TOTAL		437.64	100.00

PROCESSING PROCEDURE

1. In a medium electric mixing bowl combine flour, AZ tortilla base, dehydrated lentil flour and vegetable shortening. Mix on medium speed with a whip attachment for 2 minutes.
2. Change attachment to dough hook and add water. Mix on low speed 1 minute and high speed 4 minutes.
3. Divide dough into 56-gram balls and let rest, covered with plastic wrap, for 15 minutes.
4. Preheat cast iron griddle over medium heat.
5. Using tortillas press, press dough balls out in to 7-inch discs.
6. Place disc on preheated cast iron griddle 15 to 20 seconds on each side.
7. Cool on cooling rack, package and reserve.

PEA & LENTIL TORTILLA

INGREDIENT	SUPPLIER	GRAMS	%
Water warm 90˚F	Tap	230.00	44.72
All Trump bread flour	Gold Medal	119.00	23.14
Yellow pea flour 7013536-17	Inland Empire Foods	85.00	16.58
Dehydrated lentil flour 700703-10	Inland Empire Foods	38.00	7.39
All vegetable shortening	Crisco	23.52	4.57
AZ tortilla base 113617	ADM	18.84	3.66
TOTAL		514.36	100.00

PROCESSING PROCEDURE

1. In a medium electric mixing bowl combine flour, AZ tortilla base, yellow pea flour, dehydrated lentil flour and vegetable shortening. Mix on medium speed with a whip attachment for 2 minutes.
2. Change attachment to dough hook and add water. Mix on low speed 1 minute and high speed 4 minutes.
3. Divide dough into 56-gram balls and let rest, covered with plastic wrap, for 15 minutes.
4. Preheat cast iron griddle over medium heat.
5. Using tortillas press, press dough balls out in to 7-inch discs.
6. Place disc on preheated cast iron griddle 15 to 20 seconds on each side.
7. Cool on cooling rack, package and reserve.

20% CHICKPEA TORTILLA

INGREDIENT	SUPPLIER	GRAMS	%
Water warm 90˚F	Tap	230.00	44.72
All Trump bread flour	Gold Medal	119.00	23.14
Chickpea flour 7015516-32	Inland Empire Foods	85.00	16.58
All vegetable shortening	Crisco	23.52	4.57
AZ tortilla base 113617	ADM	18.84	3.66
TOTAL		514.36	100.00

PROCESSING PROCEDURE

1. In a medium electric mixing bowl combine flour, AZ tortilla base, chickpea flour, and vegetable shortening. Mix on medium speed with a whip attachment for 2 minutes.
2. Change attachment to dough hook and add water. Mix on low speed 1 minute and high speed 4 minutes.
3. Divide dough into 56-gram balls and let rest, covered with plastic wrap, for 15 minutes.
4. Preheat cast iron griddle over medium heat.
5. Using tortillas press, press dough balls out in to 7-inch discs.
6. Place disc on preheated cast iron griddle 15 to 20 seconds on each side.
7. Cool on cooling rack, package and reserve.

20% YELLOW PEA TORTILLA

INGREDIENT	SUPPLIER	GRAMS	%
Water warm 90˚F	Tap	190.00	40.48
All Trump bread flour	Gold Medal	143.00	30.47
Yellow pea flour 7013536-17	Inland Empire Foods	94.00	20.03
All vegetable shortening	Crisco	23.52	5.01
AZ tortilla base 113617	ADM	18.84	4.01
TOTAL		469.36	100.00

PROCESSING PROCEDURE

1. In a medium electric mixing bowl combine flour, AZ tortilla base, yellow pea flour and vegetable shortening. Mix on medium speed with a whip attachment for 2 minutes.
2. Change attachment to dough hook and add water. Mix on low speed 1 minute and high speed 4 minutes.
3. Divide dough into 56-gram balls and let rest, covered with plastic wrap, for 15 minutes.
4. Preheat cast iron griddle over medium heat.
5. Using tortillas press, press dough balls out in to 7-inch discs.
6. Place disc on preheated cast iron griddle 15 to 20 seconds each side.
7. Cool on cooling rack, package and reserve.

LENTIL BLEND FOCACCIA ROUNDS

INGREDIENT	SUPPLIER	GRAMS	%
SPONGE			
Bread flour	All Trump	340.00	64.09
Water 108˚F	Tap	188.50	35.53
Instant dry yeast	Saf Instant	2.00	0.38
TOTAL		530.50	100.00
BREAD			
Water, 108˚F	Tap	850.00	31.66
Bread flour	All Trump	750.00	27.93
Sponge	TSG	530.50	19.76
Yellow pea flour 7013536-17	Inland Empire Foods	200.00	7.45
Canola oil	Wesson	91.00	3.39
Salt kosher	Morton	28.50	1.06
Control S 113286	ADM	20.50	0.76
KC food yeast 113148	ADM	7.65	0.28
Instant dry yeast	Saf Instant	7.00	0.26
TOTAL		2685.15	100.00

PROCESSING PROCEDURE

Sponge

1. In electric mixer bowl combine flour, water, and instant yeast.
2. Mix on low speed until smooth, approximately 2 minutes.
3. Let rest at room temperature covered for 15 hours.

Bread

1. In a medium size electric mixing bowl combine sponge and remaining ingredients.
2. Mix on low for 3 minutes or until combined.
3. Mix on medium speed for 5 minutes.
4. Cover bowl and let rest for 1 hour at room temperature. Fold dough over and allow to rest for an additional hour, covered, at room temperature.
5. Turn dough out onto lightly floured surface and portion into to 264-gram balls.
6. Rest covered for 20 minutes.
7. Preheat oven to 375˚F.
8. Roll portioned dough out into 8” rounds.
9. Place rolled out dough onto parchment lined sheet tray dusted with cornmeal.
10. Place in preheated oven for 10 minutes or until internal temperature is approximately 205º F.
11. Allow to completely cool on cooling rack and package.

MEDITERRANEAN NAAN FLATBREAD

INGREDIENT	SUPPLIER	GRAMS	%
Water 80˚F	Tap	180.00	32.73
Bread flour	All Trump	119.00	21.64
Yellow pea flour 7013536-17	Inland Empire Foods	82.00	14.91
Lentil type B 700706-15	Inland Empire Foods	62.00	11.27
Sugar granulated	C&H	30.00	5.45
Eggs whole	Creek Farms	25.00	4.55
Milk whole	Hiland Dairy	25.00	4.55
A-Z tortilla mix	ADM	20.00	3.64
Nat. Mediterranean herb and cheese	Wild Flavors	5.00	0.91
Oregano whole OM9127	Elite Spice	2.00	0.36
TOTAL		550.00	100.00

PROCESSING PROCEDURE

1. In a medium electric mixing bowl combine flour, AZ tortilla base, yellow pea flour, lentil flour type B and vegetable shortening. Mix on medium speed with a whip attachment for 2 minutes.
2. Change attachment to dough hook and add remaining ingredients. Mix on low speed 1 minute and high speed 4 minutes.
3. Divide dough into 75-gram balls and let rest, covered with plastic wrap, for 15 minutes.
4. Preheat grill.
5. Roll portioned balls into ⅛" ong pear shape.
6. Place on preheated grill 1-2 minutes on each side.
7. Cool on cooling rack, package and reserve.

PEA MILK BISCUIT

INGREDIENT	GRAMS
Wheat flour	80.00
Pea flour	120.00
Icing sugar	85.00
Shortening	62.00
Butter oil	2.50
Skim milk powder	10.00
Buttermilk powder	10.00
Whole egg powder	2.50
Butter flavor	0.15
Sodium bicarbonate	0.30
Salt	1.90
Lecithin	0.80
Granulated sugar	12.00

PROCESSING PROCEDURE

1. Preheat oven to 400˚F.
2. Weigh all ingredients.
3. Add shortening, icing sugar, butter oil, skim milk powder, whole egg powder, butter flavor, ammonium bicarbonate (with water), sodium bicarbonate (with water), salt (with water), and lecithin together in a bowl.
4. Mix them well, until soft and fluffy, with a slow speed for 1 minute and then fast speed for 5 minutes.
5. Add wheat flour, pea flour, and butter milk powder at slow speed for 2 minutes.
6. To form, use moulding and add some granulated sugar.
7. Bake for 8½ minutes.
8. Remove biscuits onto rack and let cool.

HAMBURGER BUNS

INGREDIENT	GRAMS
High gluten bread flour	100.00
Precooked yellow pea flour	30.00
Shortening	6.00
Salt	1.50
Instant yeast	1.20
Sugar	1.50
Emplex*	0.50
Water	67.00

PROCESSING PROCEDURE

1. Mix to optimum dough development for 6-7 minutes.
2. Scale dough, round pieces.
3. Proof for 60 minutes at 31˚C and 75% RH.
4. Bake for 18-19 minutes at 400°F.

* American Ingredients. Contains sodium stearoyl lactylate.

LENTIL HERB CRACKERS

INGREDIENT	SUPPLIER	GRAMS	%
Flour all purpose	Sysco	535.00	42.30
Water 108˚F	Tap	415.00	32.81
Lentil flour 700703-08	Inland Empire Foods	160.00	12.65
Natural cheese powder 867050	Firmenich	40.00	3.16
Vegetable oil	Wesson	26.00	2.06
Salt kosher	Morton	15.00	1.19
Sugar granulated	C&H	15.00	1.19
Yeast active dry	Fleischmann's	13.00	1.03
Brown Mirepoix 59-4841P	Culinary Advantage	10.00	0.79
Carrot granule 12+40ns S707100	Con Agra	10.00	0.79
Baking soda	Arm & Hammer	6.00	0.47
Niagara vegetable powder V-120	Quality Brands, Inc.	5.00	0.40
Garlic powder Garp587	Elite Spice	5.00	0.40
Onion powder Onnp514	Elite Spice	4.25	0.34
Parsley 10/30 Pf9223	Elite Spice	2.00	0.16
Cumin ground 30 Cm9420	Elite Spice	2.00	0.16
Dill whole Dw9117	Elite Spice	1.25	0.10
Rosemary ground RS9459	Elite Spice	0.25	0.02
TOTAL		1264.75	100.00

PROCESSING PROCEDURE

Dough Assembly
1. Preheat convection oven to 350ºF with baking stone.
2. Combine yeast and warm tap water. Let rest for 5 minutes. Combine with remaining ingredients in heavy-duty mixer.
3. Mix on speed one for 1 minute and speed 2 for 10 minutes. Cover and let proof for 2 hours.
4. Punch down dough and roll out on dough sheeter to #½. Cut into 3"x 7" crackers.
5. Place on preheated baking stone in oven and bake for 3 minutes. Flip crisps over and bake an additional 3 minutes or until crisp.
6. Remove from oven, cool and package.

PEA COCONUT COOKIES

INGREDIENT	GRAMS
Wheat flour	75.00
Pea flour	125.00
Shortening	50.00
Granulated sugar	50.00
Icing sugar	52.50
Butter	5.00
Desiccated coconut	32.50
Buttermilk powder	15.00
AMF	5.00
Whole egg	5.00
Salt	1.90
Ammonium bicarbonate	0.45
Sodium bicarbonate	1.25
Butter flavor	0.25
Water	32.00

PROCESSING PROCEDURE

1. Preheat oven to 375˚F.
2. Weigh all ingredients.
3. Add shortening, granulated sugar, icing sugar, butter, desiccated coconut, andydrous milk fat, whole egg powder, ammonium bicarbonate (with water), sodium bicarbonate (with water), salt (with water), and butter flavor together in the bowl. Mix them well until soft and fluffy with a slow speed for 1 minute and then fast speed for 5 minutes.
4. Add wheat flour, pea flour, and buttermilk powder at slow speed for 2 minutes.
5. Chill dough until firm.
6. Roll dough on floured board to ¼” thickness.
7. Cut dough, using 2-inch circle cutter.
8. Bake for 11 minutes, or until golden.
9. Remove cookies onto rack and let cool.

PEA GINGER COOKIES

INGREDIENT	GRAMS
All purpose wheat flour	100.00
Precooked yellow pea flour	42.00
Shortening	42.00
Sugar	88.20
Eggs	21.00
Molasses	28.50
Baking soda	4.00
Vanilla	1.90
Salt	1.30
Cinnamon	0.80
Ginger	0.30

PROCESSING PROCEDURE

1. Cream together the shortening and sugar.
2. Add the egg and molasses and mix until incorporated.
3. Stir in remaining ingredients.
4. Roll into balls, dip in sugar and bake for 12 minutes at 350°F.

EGG NOODLE

INGREDIENT	GRAMS
Flour	100
Water	32
Egg	10
Salt	3
Sodium	1.5
Carbonate	

PROCESSING PROCEDURE

1. Prepare salt and sodium carbonate solution.
2. Beat eggs and weigh.
3. Mix eggs with salt and sodium carbonate solution.
4. Weigh flour and place in separate mixing bowl.
5. Set the mixer to speed 1 and dry blend all dry ingredients (soy flour and/or egg powder with the wheat flour) for 1 minute.
6. Pour solution slowly into the flour and mix for 1 minute at speed 1. Scrape the mixing bowl. Continue to mix for 4 minutes at speed 2.
7. Remove dough and place into a plastic bag. Using a rolling pin, press the dough in the plastic bag to make a rectangular block. Rest the dough for 10 minutes.
8. Sheet the dough according to the size and shape of noodle strips desired.
9. Boil 2 liters of water.
10. Place 100 grams of noodles in boiling water to cook for 3 minutes.
11. Remove cooked noodles and rinse noodles in cold tap water.
12. Drain noodles and place into a bowl.

PREMIUM BANANA FORMULA

INGREDIENT	GRAMS
Rice	34
Sugar	22
Skim milk	18
Yellow pea	12
Palm oil	4.5
Banana flake	3
Isolated soya protein	2.8
Minerals & vitamins	2.38
Lecithin	1
Flavor	0.32

PROCESSING PROCEDURE

Cereal Base

1. Weigh the rice, sugar, yellow pea, palm oil, Isolated Soya Protein, lecithin, and specified minerals. Add to slurry tank.
2. For wet mixing and cooking, add filtered water and earlier prepared raw materials into the slurry tank.
3. Mix for approximately 15 minutes at 120-140˚F, until homogenous.
4. Using ***drum dryer***, apply the slurry continuously in a thin, uniform layer to a revolving steam heated cylinder (Steam 10 bar).
5. After the liquid evaporates (generally after one rotation at 7 rpm), remove the dried layer/film from the cylinder surface with a scraper knife.
6. Crush the dried film and sift into fine powder (40 mesh).

Formula

1. In defined proportions, blend together cereal base, sugar, flavor, premixed vitamins, and additional minerals until homogenous.

Appendix D
Dry Pea, Lentil & Chickpea Suppliers

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