

**Final Report on:**

**Assessing Market Opportunities for Raspberry and Blackberry Seeds**

**By**

**The Oregon Raspberry & Blackberry Commission**

Submitted by:

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The Oregon Caneberry Commission was established in 1981. The name was changed in 1992 to The Oregon Raspberry & Blackberry Commission to help end confusion over the term "caneberry" The commission is a state agency, comprised of nine members: seven caneberry growers and two caneberry processor representatives representing over 500 caneberry growers in Oregon. The Oregon Department of Agriculture oversees all commission activities, including the marketing programs. The commission promotes all Oregon caneberries, including red and black raspberries, Boysenberries, Marionberries, Loganberries, and other blackberries. The term "caneberry" refers to all those berries grown on a long stout cane.

**Background**

Oregon's Willamette Valley has long been known as the "Berry Capital of the World" due to its wide variety and high production of caneberries. Berry farming has been an internal part of the Oregon heritage, with production of the Loganberry in the late 1800's and on into the early 1900's. Loganberries were grown commercially and used both in a juice and dried form. In the 1930's, Boysenberries made their way to the farms of the Willamette Valley, followed by red and black raspberries and blackberries. In 1956, the Marionberry was bred at Oregon State University and named after Marion County, where it is widely grown. The Marionberry has been getting national attention as the premium quality blackberry or the "Cabernet of blackberries", and production has zoomed to over 30 million pounds. Marionberries are the most highly produced blackberry in the world, with production occurring only in Oregon's Willamette Valley.

Produced in the shadow of the Cascade Mountain range with the fertile soils, nourishing spring rains and cool evenings, Oregon berries are known for their superior color and flavor profiles. They are grown exclusively for the processed market and known worldwide for their quality. Most of the berries are packed as an Individually Quick Frozen (IQF) product and used by food manufacturers in pies, tarts, yogurts and ice cream. However, this market is limited to the firmest, highest quality fruit and there has been increased efforts in recent years to increase markets and value for the B grade fruit. Much of this fruit is processed into jams, seedless or sieved purees, concentrates and/or juices. On low price years, a high percentage of the B grade fruit is left unharvested.

### **Disadvantaged Family Farms**

Oregon's berry farmers are mostly mid-sized family operations, often having been producing berries for three or four generations. Yet in recent years, there has been a large decline in the number of caneberry farms in Oregon and in the production of many caneberry crops. The number of caneberry growers has reduced from over 1,200 in 1989 to about 515 in 2001. This decrease in berry production is due to a number of factors, including increased cost of labor for a labor intensive crop (Oregon has the highest minimum wage in the country). Increased regulation and the associated cost, difficulty in getting a legal workforce, decrease in number of experienced quality pickers available, increased pressure from urbanization and associated higher land prices, more worldwide competition, loss of available pesticides, and generally higher input costs are additional factors. An increase in consolidation in the food processing industry has created a number of powerful agricultural conglomerations with great economic power, motivated by profit and proficient at global least-cost-sourcing. Oregon's berry processing plants have been hard hit, with the number of processing companies dropping in half (>20 to <10) in the last 6 years. Processors are trying to increase their markets for value-added products and by-products and growers are trying to increase their margins to stay in business.

### **Emerging Interest in Nutraceuticals**

Current interest by consumers, media and the medical world in the health benefits and nutraceutical properties of compounds found in fruits and vegetables has created excitement in the berry industry. In recent years, scientific and medical professionals from around the world have delved deeper into the link between diet and health. They have defined a **nutraceutical** as "any substance that may be considered a food or part of a food and provides medical or health benefits, including the prevention or treatment of disease." The nutraceutical industry has grown to well over \$80 billion.

### **Caneberry Health Benefits**

In the past two years the ORBC funded a project in conjunction with matching funds from FSMIP (1999-2000) and was able to document the health and nutraceutical properties of caneberries. The results of this survey are phenomenal. **Berries are a nutritional and nutraceutical powerhouse.** There are over 60 substances in Oregon caneberries that are known to have significant benefits for the human body, including cancer prevention. The naturally occurring phytochemicals (substances found in edible fruits and vegetables that may be ingested by humans and that exhibit a potential for modulating human metabolism favorable for cancer prevention) in caneberries include Anthocyanins, catechins, quercetin, monoterpenes and phenolic acids.

### **Existing University Level Research**

Among the important components we have found in caneberries is ellagic acid, a naturally occurring organic acid that inhibits the initiation of cancer cells induced by certain chemicals. Preliminary studies at Hollings Cancer center at the Medical University of South Carolina show that eating red raspberries appears to inhibit cell division and increase normal cell death, suggesting that it may prevent cancer. Gary D. Stoner of Ohio State University's Cancer Center found that freeze-dried raspberries will inhibit esophageal and colon cancer in rats at a higher rate than the ellagic acid itself, indicating that compounds in the whole berry contribute to the inhibitory effect. Scientific research into the ellagic acid content present in the berry seed is needed, to help pinpoint the source of this benefit. Dr. Stoner's most recent work indicates that colon cancer rates were reduced by 50% in rodents fed on a diet of freeze-dried black raspberries (or berry powder). Since colon cancer is the second leading cause of cancer related deaths worldwide the importance of this study can not be underestimated. Clinical trials are planned to determine whether berries can prevent cancer development in the human esophagus and colon. Dr. Lyndon Larcom of Clemson University is currently investigating additional studies into the ability of berry extracts to inhibit production of cancer initiating mutations in breast and cervical cancer cells. Further fractionation of the berry extracts should lead to identification of the source of the anti-carcinogenic effects.

### **Seed Research**

Research indicates that much of the nutraceutical properties of the berries reside in the seeds. We are presently throwing away a major source of concentrated nutraceutical properties; the seeds. About 30-35% of Oregon's berry crop (B grade) is processed into seedless puree, concentrate or juice stock each year. In the Pacific Northwest alone, it is estimated that there could be as much as 400-500,000 pounds of berry seeds available if a market existed. Presently, seeds are treated as a waste product and removed at a cost to the processor.

If a market could be established for caneberry seeds, it would increase return to growers, at a time when margins have disappeared and berry growers are going out of business daily. Depending on the market, as much as 10% of the B grade fruit is left in the field unharvested. If this fruit could be harvested, it would increase the return to growers. In addition, the B grade fruit market would be of more value, which would pull up the IQF market.

Finally, the seeds are now a waste product which requires inputs of time and resources (water, gas, land fill) for disposal. Creating a market for seeds would create a more sustainable product line and reduce waste and resources.

### **Current Interest**

As a result of the 1999-2000 FSMIP/ORBC project, some of the largest food processing companies in the world have contacted the ORBC requesting specific information on Anthocyanins, antioxidants and other nutraceutical applications of caneberries. Use of value added products such as seeds and seed oil is an area that is of great interest in the manufacturing sector, as noted with the recent rise of grape seed oil. This is an exciting new field that has great potential for berry growers.

## Summation of Work

The Oregon Raspberry & Blackberry Commission has completed the work on the 2001 FSMIP grant. The goals and objectives of this grant were to evaluate existing research and conduct new research on caneberry seeds and seed oil and their nutraceutical properties. Further work was done to identify and assess existing uses for these products and research market opportunities. The research conducted has been in several areas of interest and each topic will be addressed as a separate item.

### **Plan of Work and Results Obtained**

#### **\*Identify Significant Properties:**

The Oregon Raspberry & Blackberry Commission reviewed global research to identify significant properties present in caneberries. Current academic research in the United States is very low in this area. Studies that have been done are found mainly in countries overseas. Several notable studies were reviewed, they include:

Characterization of Seed oils of wild, edible Finnish Berries, A. Johansson,  
This study concentrated on a screening of seed oil fatty acids in wild edible berries of Northern Europe. Included in this study were berries of the Rubus genus, which includes raspberries. This study confirmed that the smaller the seed of a berry the higher the oil content. Typically the most abundant fatty acids found in the berries in this study were linoleic, linolenic, oleic and palmitic acids.

Chemical Composition of Red Raspberry Seed Oil, H. Pourrat, A.Carnet  
A French study that outlines the oxidative stability of raspberry seed oils, finding this to be an outstanding characteristic of this oil. The study also documents the anti-inflammatory properties of raspberry seed oil. Fatty acid profiles were similar to other studies showing linoleic, linolenic and palmitic acid to be present.

Characteristics of Raspberry Seed Oil, D. Oomah  
An extensive Canadian study which confirmed the idea that the linoleic and linolenic fatty acids present in raspberry seed oil represents a combination of polyunsaturates that would have a beneficial physiological effect in the prevention of heart disease and cancer. Additional work showed that the tocopherol content of red raspberries are quite high and hence prevent oxidative stress and may also be beneficial to dermatological conditions.

In addition the commission has made personal contact with Dr. Oomah and consulted with him concerning the seed testing research in this project.

### **\* Caneberry Seed Properties Testing**

The Oregon Raspberry & Blackberry Commission searched nationally to find an appropriate research team. Evaluation of the proposals resulted in contracting with Dr. Steven Knapp, of the Crop and Soil Science Department at Oregon State University, Corvallis. Dr. Knapp is a noted oil seed researcher with extensive experience in the field. He has worked recently with meadow foam seed, a crop produced exclusively for oil, and sunflower seed oil. Dr. Knapp was contracted to identify the nutraceutical components in caneberry seeds and seed oil. Properties to be studied included fatty acid profiles, ellagic acid content, seed preparation and drying, seed oil protein content and amino acid levels in seed meal. Caneberry seeds and seed oils to be studied were Marionberry, Boysenberry, Black raspberry, Evergreen blackberry and Red raspberry. Dr. Knapp collaborated with Dr. Terry Isbell and Mr. Bliss Phillips of the USDA-ARS lab in Peoria, Illinois and Dr. Boxin Ou of Brunswick Laboratory, Warham, Massachusetts.

The Oregon Raspberry & Blackberry Commission contracted with Brunswick Laboratory, Warham, Mass., to re-evaluate the ORAC values of Oregon caneberries using the newest fluorescein testing. The fluorescein method of testing for the anti-oxidant capacity of a substance yields a far higher level of that capacity than was previously available with standardized testing. Caneberries tested included Evergreen blackberry, Chester blackberry, Marionberry, Meeker Red Raspberry, Willamette Red Raspberry, Black Raspberry and Boysenberry. The re-testing yielded significant increases in ORAC values for most berries.

A summary of Dr. Knapp's research follows: a complete copy of his research findings is attached.

Seed processing and cleaning was the first issue addressed by Dr. Knapp's lab. Raw samples of seeds from the five berries tested, Marionberry, Evergreen blackberry, red raspberry, black raspberry and Boysenberry were obtained for analysis. The samples were a mixture of seeds and pulp and were first oven dried and then threshed using a standard laboratory seed thresher and cleaned using a forced air cleaner. The report concludes that seed preparation, as such, should pose no problem to the berry industry.

Seed oil concentrations in caneberry seeds ranged from 11.4 to 18.7% meaning that roughly 72,400 kg of oil might be extracted from 500,00 kg of berry seed. This is a very small yield by commercial oil producing standards. Since most large scale oil producing facilities have much larger daily capacities (in the range of 150 to 250 tons per day) it may mean the market for caneberry seed oil lies with small scale processors producing cold pressed oils for the nutraceutical market.

Protein concentrations of caneberry seed ranged from 6.3% to 7.1%. The meal is similar in fiber to many other generic seed meals like cottonseed and flaxseed meals. The amino acid profile is not unusual. Further testing should be done to assess the suitability of the meal for use in animal feeds.

Fatty acid profiles done on the caneberry seed oils were consistent with other known oils with the exception of several unusual fatty acids,  $\gamma$ -linoleic acid, stearidonic acid and vaccinic acid. The fatty acid profiles of berry seed oils are nutritionally outstanding with very high concentrations of polyunsaturated fatty acids (PUFA's) and low concentrations of saturated fatty acids. The saturated fat content rivals those of sunflower oils and Canola oils. This profile would help berry seed oils to appeal to the health conscious consumer.

The fatty acid profile of berry seed oil was most similar to hemp oil, which has been promoted in Canada and Europe as an Omega-3 oil to compete with flaxseed oil. The high content of linolenic acid in berry seeds rivals or equals that of hemp seed oil with none of the narcotic stigma attached to that crop. Both of these attributes contribute to the nutraceutical profile of caneberry seed oil.

Ellagic acid measurements were taken for the caneberry seed oils due to the high levels of ellagic acid found in the whole berries. This testing was done at Brunswick Lab; the same lab that conducted the ellagic acid testing on the whole berries. Whole berry ellagic acid levels ranged from 47 to 90 mg/g. The levels in the oils ranged from 0.06 to 0.32 mg/g. The presence of ellagic acid in the seed oils is a nutritional positive, although it is low when compared with the whole fruit.

#### **\*Assessing Oil Seed Qualities**

Caneberry seed oil shows promise as a cooking oil. It is low in saturated fats and higher than Canola and sunflower oil in polyunsaturated fats. Its high level of Omega-3 type fatty acids makes it a good candidate for both nutritional supplements and cosmetics. The presence of ellagic acid in the seed oil, even in amounts lower than the whole fruit, could influence both the cosmetic and nutritional supplement sectors to consider berry seed oils.

There is potential for cold pressed berry seed oil to be tinted using natural berry extract during post-press processing. This could result in red or purple colored oil that contained levels of anthocyanins from berry pigment as well as antioxidants and nutraceuticals.

Linoleic acid levels were highest in Marionberries at 63.13 g/kg, followed by Boysenberries at 58.55 g/kg. Black raspberry had 54.05g/kg, red raspberry had 53.73 g/kg and Evergreen blackberry had 52.30 g/kg of linoleic acid. These significant levels could be of interest to manufacturers of nutritional products and cosmetics. Omega-3 fatty oils have been shown to improve heart and circulatory health as well as reduce the physical signs of aging in the skin.

### **\*Market Research**

Market research on the potential uses and applications of berry seeds and seed oils were conducted by Michael Perman of Perman Associates in San Francisco. A summary of his research findings follow: a complete copy of his research findings is attached.

#### *Research Summary*

Seeds are used in the cosmetics industry to provide texture and exfoliating properties to soap, and other bath and body products. Oils are used primarily for their anti-inflammatory and anti-aging properties and are used in sunscreen; toothpaste, shampoos and a variety of personal care items. Mr. Perman researched numerous companies that produce cosmetics using fruit oils and seeds as part of their product line.

Caneberry seeds have some unique properties that may be of interest to cosmeceutical and nutraceutical firms. They contain ellagic acid and high levels of omega-3 fatty acids as well as being shelf stable.

A variety of seed oils and seed meals are currently being studied in the European market as treatment for post surgery edema and circulatory issues.

When used in a cosmetic product that makes claims for medicinal properties seeds and seed oil are not subject to mandatory FDA approval if they claim therapeutic benefits but do not make definitive statements. Large international companies including Bristol Meyer Squibb, Johnson & Johnson, Aveda and Novartis dominate the cosmeceutical marketplace.

The current marketplace for cosmetic and nutraceutical ingredients is already rich with seed oils as byproducts. Competitors for berry seeds and seed oil would be grape seed oil, avocado seed oil, rice bran oil, pomegranate oil and others. This competition would be very stiff since all of these crops produce much larger volumes of oil than berry seed would currently yield. Another factor would be price; grape seed oil is marketed as a cooking oil as well as cosmetic oil and is currently selling for \$4.30 per pound. An estimated price per pound of raspberry seed oil (based on production cost plus high margins to protect against low volume) would be \$13.76 per pound.

In order to effectively market berry seeds and seed oil as a viable product there would need to be compelling evidence that caneberry seeds and oil were a superior alternative to other oils and have a clear sense of specific use. Both GRAS status and kosher certification would need to be obtained a lengthy and expensive process.

Cosmetic and pharmaceutical companies are always looking for the “next thing”. If caneberry seeds and oils are to meet that need there must be clinical proof of their benefits. An interested company or R&D professionals, not the Commission, should conduct these clinical trials and certifications. The ORBC might help by partnering with such a company to encourage participation. Marketing opportunities might be present if clinical evidence is compelling as to the benefits of caneberry seeds and seed oil. If this did occur it would be fast and easy for Oregon processors to gear up for seed drying and extractions to meet a manufacturing demand.

**\*Communication, Printing, Distribution and Seminar**

Copies of all phases of work done under this grant have been collated into a final document that will be available to all interested parties. Copies of the research will be available on the ORBC website, [www.oregon-berries.com](http://www.oregon-berries.com)

A seminar was held for all ORBC processors during which presentations were given by both Jim Crane, Senior Staff Technician in the laboratory of Dr. Steven Knapp and Michael Perman regarding the research as outlined above. A significant number of growers and processors of Oregon caneberrys and interested public and media representatives attended this seminar.

Copies of this report and all supporting documents will be available for use at trade shows attended by the commission and on request from the commission office.