Agar-Agar

Handling/Processing

Identification of Petitioned Substance

Chemical Name:
Agar-agar

Other Names:
Agar
Agar-agar flake
Agar-agar gum
Vegetable gelatin
Agaropectin mixed with agarose
Japan isinglass
Gelose

Trade Names:
None

CAS Numbers:
9002-18-0 (agar-agar)
9012-36-6 (agarose)
9046-34-8 (agaropectin)

Other Codes:
EINECS No. 232-658-1

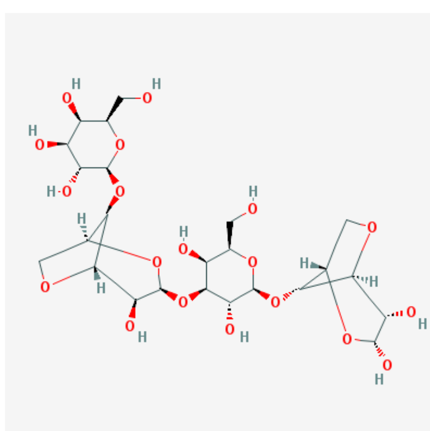
Characterization of Petitioned Substance

Composition of the Substance:

Agar-agar is a term referring to a family of linear galactan polysaccharides (i.e., complex sugars made up of linked galactose molecules) that accumulate in the cell walls of red algae (Class *Rhodophyceae*). The marine algae that produce agar-agar are widely distributed throughout the world and several different species are utilized for extraction. Most commercial agar-agar is extracted from *Gelidium* and *Gracilaria* species, but other commonly used species include *Pterocladia* and *Gelidiella* (Imeson, 2009).

Agar-agar is comprised of the two different compounds—agarose and agaropectin. Agarose is a firmly gelling complex sugar that makes up the majority of agar-agar. Agaropectin is a weakly gelling charged polymer which contains the same basic sugar molecules as agarose in addition to ester sulfate, pyruvic acid, and D-glucuronic acid side groups (Imeson, 2009; Venugopal, 2011). The specific composition of the agaropectin in agar-agar depends on the species of algae and the environmental conditions in which it exists. The molecular structure of agarose is shown in Figure 1. The structure of agaropectin contains a carbohydrate backbone similar to that of agarose with additional side groups such as sulfate ester groups (ChemIDplus, 2011). The total sulfate content of agar-agar is typically 1.5 to 2.5% by weight (Imeson, 2009).

Figure 1. Repeating Molecular Structure of Agarose



Source: PubChem, 2011

Properties of the Substance:

Agar-agar is available as powder, flakes, or strips. The commercial product is white to pale yellow, shiny, semitransluscent, tasteless (or with a slight mucilaginous taste), and odorless (or with a slight characteristic odor) (Venugopal, 2011; Burdock and Fenaroli, 2005). Agar-agar is insoluble in cold water, but dissolves in boiling water (Burdock and Fenaroli, 2005; U.S. Pharmacopeia, 2010). It forms a gel when cooled to a temperature between 32° to 43°C, which does not melt until heated to 85°C or higher (McHugh, 2003). Agar-agar is a neutral polymer chain that has limited reactivity with other materials (Imeson, 2009). The specific chemical characteristics of a solution of agar-agar, including its viscosity, gelling temperature, gel strength, and gel clarity, vary depending on the particular source of the agar-agar (Burdock, 1997).

Specific Uses of the Substance:

Agar-agar has been used as a food additive since its discovery over 350 years ago (Imeson, 2009). It is currently used in foods as a stabilizer, thickener, gelling agent, texturizer, moisturizer, emulsifier, flavor enhancer, and absorbent (Imeson, 2009; Venugopal, 2011). It is used in bakery products (e.g., pie fillings, icing or glazes for pastries and cakes), confections (e.g., candies, fruit jellies, nougat, candy fillings), jellies and jams, water gel desserts, dairy desserts, dairy products (e.g., yogurt, ice cream, sherbets, cream cheese), canned meat and fish products (including pet food), vegetable and meat aspics, and vegetarian meat substitutes (Imeson, 2009; McHugh, 2003). Agar-agar has also been used to clarify wines (McHugh, 2003). There is no indication in the literature that the food uses of agar-agar have changed substantially since the first National Organic Standards Board (NOSB) review of agar-agar in 1995.

In addition to uses in the food industry, agar-agar is used in the fields of microbiology (media for culturing microorganisms), dentistry (dental impression materials), and medicine (bulk-forming laxatives, pharmaceuticals) (HSDB, 2002).

Approved Legal Uses of the Substance:

Agar-agar is classified by the U.S. Food and Drug Administration (FDA) as a direct food substance affirmed as Generally Recognized as Safe (GRAS) (21 CFR 184.1115). It is permitted in foods up to the maximum levels of 0.8% in baked goods, 2.0% in confections and frostings, 1.2% in soft candy, and 0.25% in all other food categories. Agar-agar is also affirmed as GRAS by the FDA for use as a stabilizer in animal drugs, feeds, and related products when used in accordance with good manufacturing or feeding practices (21 CFR 582.7115). The FDA has permitted the use of agar-agar in over-the-counter (OTC) drug products used as bulk laxative, however, the data are currently inadequate to establish general recognition of the safety and effectiveness of agar-agar for this specific use (21 CFR 310.545).

Action of the Substance:

Agar-agar helps to thicken and provide texture to food by forming gels in foodstuffs. The gels formed by agar-agar are the result of a network of agarose molecules bonded with hydrogen (Imeson, 2009). Agarose molecules in solution are random coils of linear polysaccharides. Upon cooling, the coils form helices and these helices then aggregate to form the structure of the gel (Imeson, 2009). The gelation process is reversible; however, gels formed by agar-agar can withstand high temperatures and therefore help to stabilize foods (Imeson, 2009; Venugopal, 2011). Some gels formed by agar-agar are said to be "sugar reactive," meaning sugar (sucrose) increases the strength of the gel (McHugh, 2003). Agar-agar helps to provide moisture to foods such as baked goods due to enhanced water retention by the polysaccharides (Venugopal, 2011). Because agar-agar is practically tasteless and does not require the addition of cations to form gels, it does not interfere with the taste of foods unlike some other natural thickening agents that require the addition of calcium or potassium salts to form gels (McHugh, 2003).

Combinations of the Substance:

Agar-agar may be used in foods in combination with other thickening or gelling agents (e.g., pectin, xanthan gum, gellan gum, gelatin, water-extracted gums, tragacanth gum, konjac flour, and starches) that are included on the National List of Allowed and Prohibited Substances (hereafter referred to as the National List). Agar-agar derived from *Gelidium* species displays synergy with locust bean gum forming more elastic, cohesive gels than those obtained with *Gelidium* agar-agar alone (Imeson, 2009). Agar-agar is sometimes added to sherbets or ice creams in combination with tragacanth gum, locust bean gum, or gelatin (Belitz et al., 2009). No other specific examples were found of common combinations of agar-agar with other substances included on the National List.

Status

Historic Use:

Agar-agar has been used as a food additive since its discovery in Japan in the 1650s. It was introduced into Europe and the United States from China in the 19th century (HSDB, 2002). The FDA classified food uses of agar-agar as GRAS in 1972 (Imeson, 2009).

Agar-agar is currently permitted for use in organic agriculture handling/processing and is included on the National List.

OFPA, USDA Final Rule:

Agar-agar identified in the NOP final rule as a nonagricultural (nonorganic), nonsynthetic substance allowed as an ingredient in or on processed products labeled as "organic" or "made with organic (specified ingredients or food group(s))" (7 CFR 205.605(a)). There are no annotations or restrictions regarding its origin or use under the NOP final rule (7 CFR 205).

International:

Agar[1] is permitted for use in organic production by the Canadian General Standards Board (CGSB) as a nonorganic ingredient classified as a food additive in organic processing; however, its origin must be from water, alcohol, acid, or base extracts that are also permitted by the CGSB (CGSB, 2011). Additionally, it is permitted for use in organic crop production, for use in initial mushroom spawn production only (CGSB, 2011).

Agar is also permitted for use in organic production by the Codex Alimentarius Commission as a food additive of nonagricultural origin with no specific conditions (Codex Alimentarius Commission, 2007).

Agar is permitted by the Commission of the European Communities for use in the processing of organic food as a food additive in the preparation of foodstuffs of plant origin and animal origin (milk-based and meat products only) (Commission of the European Communities, 2008).

Agar is included on the International Federation of Organic Agriculture Movements (IFOAM) list of approved food additives for use in organic processing with no limitations noted (IFOAM, 2006).

[1] The terms "agar" and "agar-agar" are interchangeable. "Agar-agar" is used by regulatory agencies in the United States (7 CFR 205, 21 CFR 184.1115, 21 CFR 582.7115, 21 CFR 310.545), whereas several international agencies and commissions use the name "agar" (CGSB, 2011; Codex Alimentarius Commission, 2007; Commission of the European Communities, 2008; IFOAM, 2006).

Neither agar nor agar-agar is specifically listed as allowed food additives in organic processed foods in the most recent revision of the Japanese Agriculture Standard for Organic Processed Foods (Japanese Ministry of Agriculture, Forestry and Fisheries, 2006).

Evaluation Questions for Substances to be used in Organic Handling

<u>Evaluation Question #1:</u> Describe the most prevalent processes used to manufacture or formulate the petitioned substance. Further, describe any chemical change that may occur during manufacture or formulation of the petitioned substance when this substance is extracted from naturally occurring plant, animal, or mineral sources (7 U.S.C. § 6502 (21)).

The first step in the production of agar-agar is the harvesting of red algae. The most important sources worldwide include the coasts of Japan, Spain, Portugal, Morocco, Senegal, Chile, Mexico, the southern United States, India, the Philippines, Madagascar, South Africa, Egypt, and New Zealand although many other countries also supply algae used to make agar-agar (Imeson, 2009; Stanley, 2006). *Gelidium* and *Gracilaria* are the main species harvested for production of agar-agar; however, several other related species are also used including *Pterocladia* (Imeson, 2009; Stanley, 2006). Although most agar-agar is produced from algae that grow naturally, *Gracilaria* algae are also cultivated on a commercial scale by some countries (Imeson, 2009). Naturally-growing algae are collected from rocks by skilled divers or manually harvested during very low tides (Imeson, 2009; Venugopal, 2011). In other cases, storm-cast algae are gathered from shores or the sea floor using nets or suction tubes that draw the macroalgae up into a boat (McHugh, 2003). Cultivation of *Gracilaria* has occurred in open waters (e.g., bays, estuaries, reef flats); on lines, ropes or nets; in ponds; and in tanks (McHugh, 2003). There is no indication in the literature that the sources of agar-agar have changed substantially since the first NOSB review in 1995.

After harvesting, the algae are cleaned with fresh water, dried in the sun, pressed into bales, and shipped to processors for agar-agar extraction (Burdock, 1997). One source reports that the algae are partially bleached before being shipped to processors, however this source does not indicate if the process involves chemical bleaching or bleaching in the sun (Venugopal, 2011). Upon receipt at a processor, the algae are washed with fresh water to remove sand and other impurities (McHugh, 2003). Prior to agar-agar extraction, *Graciliara* species are usually subjected to alkaline pretreatment (heated in a sodium hydroxide solution) followed by rinsing with water and sometimes a weak acid (e.g., acetic acid) to neutralize the alkali (McHugh, 2003; Imeson, 2009). Alkaline pretreatment is used to bring about a chemical change in the polysaccharides (L-galactose-6-sulfate groups are converted to 3,6-anhydro-L-galactose) (Imeson, 2009). This chemical change produces agar-agar with increased gel strength (McHugh, 2003). Without this pretreatment, the gels extracted from *Graciliara* species would be too weak for most food applications (McHugh, 2003; Imeson, 2009). *Gellidium* species may be pretreated with an acid to improve water penetration during the extraction process (McHugh, 2003; Imeson, 2009).

Following pretreatment, the algae are placed in tanks for extraction of agar-agar. The algae are exposed to hot water under pressure for 2 to 4 hours and then the solution is filtered to remove insoluble material (McHugh, 2003; Imeson, 2009). The result is a 1–2% agar-agar solution in water which may also contain salts, coloring matter, and soluble carbohydrates (Imeson, 2009; McHugh, 2003). The agar–agar solution is cooled to form a gel, which is then cut into strips. Sometimes, the gel is treated with bleach to reduce the color of impurities and then washed with water to remove the bleach and soluble salts (McHugh, 2003). The next step in agar-agar production is to remove water from the gel in order to concentrate the agar-agar and remove soluble impurities. This is accomplished in one of two ways. The first method is referred to as the freeze-thaw process. In this process, the agar-agar gels are slowly frozen, producing large ice crystals, and then thawed allowing the water to drain away during the thawing phase (McHugh, 2003; Imeson, 2009). This process may be repeated and pressure may be applied to the gels to increase the volume of water expelled (Imeson, 2009). The resulting gels have an agar-agar concentration of 10 to 12% (Imeson, 2009). The second method of removing water takes advantage of a natural phenomenon called syneresis, which is the separation of a liquid from a gel (McHugh, 2003). During this process, mechanical pressure is applied to the agar-agar gels to increase the rate of separation (Imeson, 2009). The polymer chains that make up agar-agar associate together and water is expressed from the gel. The resulting gels have an agar-

agar concentration of about 20% making this method much more efficient than the freeze-thaw process (Imeson, 2009). Furthermore, energy consumption is much less for this method because no refrigeration is required and the gels are easier to dry (McHugh, 2003). After the agar-agar gels are concentrated, they are dried with hot air and then the flakes or strips are ground into a powder for sale (Imeson, 2009). There is no indication in the literature that the manufacturing methods for agar-agar have changed substantially since the first NOSB review of agar-agar in 1995.

'Natural' agar refers to products sold in strips or squares that are produced on a small scale using traditional methods for extraction and freezing (McHugh, 2003; Imeson, 2009). First, the algae are boiled in water for several hours, sometimes in the presence of vinegar or dilute mineral acid (McHugh, 2003). Then the extract is filtered through a cotton cloth and poured into wooden trays to cool. The resulting gel is cut into strips that are placed outside to freeze at night and thaw during the day, a process that may be repeated. Modern refrigeration is sometimes used as a substitute. Finally, the strips are dried and bleached in the sun (McHugh, 2003). The agar-agar produced by this process has a weak gelling capacity and currently accounts for only ~1.5% of the world's production (Imeson, 2009).

<u>Evaluation</u> <u>Question #2:</u> Is the substance synthetic? Discuss whether the petitioned substance is formulated or manufactured by a chemical process, or created by naturally occurring biological processes (7 U.S.C. § 6502 (21).

Agar-agar is an algal extract, and any form of agar-agar that is produced without chemical modification would be considered nonsynthetic. However, some forms of food-grade agar-agar can be considered synthetic. As discussed in the response to Evaluation Question #1, the production of agar-agar from *Graciliara* species usually involves pretreatment with an alkali to chemically modify the polysaccharides in the algae (McHugh, 2003; Imeson, 2009). As a result, agar-agar produced using this method would be considered synthetic.

<u>Evaluation Question #3:</u> Provide a list of non-synthetic or natural source(s) of the petitioned substance (7 CFR § 205.600 (b) (1)).

All agar-agar is obtained from natural sources. However, industrial manufacturing of food-grade agar-agar may lead to chemical modifications in the algal extract. Whether or not chemical modifications occur depends upon the specific manufacturing processes used by a particular supplier. As described in the response to Evaluation Question #1, agar-agar that is manufactured on a small scale using traditional methods (without chemical modification) is referred to as 'natural' agar. According to Imeson (2009), 'natural' agars are produced mainly in the Far East, including Japan and Korea, and these agars are sold only in small quantities in the West in specialty and health food stores. No further information was found on the availability of agar-agar that is extracted without chemical modification.

<u>Evaluation Question #4:</u> Specify whether the petitioned substance is categorized as generally recognized as safe (GRAS) when used according to FDA's good manufacturing practices (7 CFR § 205.600 (b)(5)). If not categorized as GRAS, describe the regulatory status. What is the technical function of the substance?

Agar-agar is categorized as GRAS by FDA when used as a direct food substance in accordance with 21 CFR 184.1115. Agar-agar has many technical functions in foods that are categorized as GRAS and these include: drying agent, flavoring agent, stabilizer, and thickener in baked goods and baking mixes; flavoring agent, stabilizer, thickener, and surface finisher in confections and frostings; stabilizer and thickener in soft candy; and flavoring agent, formulation aid, humectant, stabilizer, and thickener in all other food categories.

Agar-agar is also affirmed as GRAS by FDA for use as a stabilizer in animal drugs, feeds, and related products when used in accordance with good manufacturing or feeding practices (21 CFR 582.7115).

Evaluation Question #5: Describe whether the primary function/purpose of the petitioned substance is a preservative. If so, provide a detailed description of its mechanism as a preservative (7 CFR § 205.600 (b)(4)).

Agar-agar may act as a preservative in some foods; however, no information was found to indicate that this is its primary function or purpose. Agar-agar may help in the preservation of processed foods because it acts as an antistaling agent in baked goods and confections, helps to preserve color in canned meat products, and serves as a stabilizer and protective colloid in many processed foods (Ash and Ash, 2004; Stanley, 2006). When added to cakes and breads, agar-agar may slow retrogradation of the starch thereby slowing down the staling of the bread (Stanley, 2006). When added to the broth used to can meat, fish, or poultry, agar-agar may prevent damage to the contents of the can during shipping and handling and may also prevent the contents from attacking the lining of the can which could lead to the discoloration of the food product. Agar-agar may be added to sherbets and ice creams to prevent formation of large ice crystals. It can also be used to improve the stability of cheeses and fermented milk products (Stanley, 2006).

Evaluation Question #6: Describe whether the petitioned substance will be used primarily to recreate or improve flavors, colors, textures, or nutritive values lost in processing (except when required by law) and how the substance recreates or improves any of these food/feed characteristics (7 CFR § 205.600 (b)(4)).

No information was found to suggest that agar-agar is used to recreate flavors, colors, textures, or nutritive values lost during processing. It is true that agar-agar functions to enhance the flavor and texture of many foods (Imeson, 2009; Venugopal, 2011). However, there are no indications that its primary function is to restore these characteristics in processed foods.

Evaluation Question #7*:* Describe any effect or potential effect on the nutritional quality of the food or feed when the petitioned substance is used (7 CFR § 205.600 (b)(3)).

No information was found on the potential effects of agar-agar on the nutritional quality of the food to which it is added. Agar-agar is composed of a neutral polymer chain that has limited reactivity with other materials (Imeson, 2009); therefore, it is not likely to affect other chemicals found in foods.

Evaluation Question #8: List any reported residues of heavy metals or other contaminants in excess of FDA tolerances that are present or have been reported in the petitioned substance (7 CFR § 205.600(b)(5)).

Excessive levels of heavy metals or other contaminants have not been reported in agar-agar. No substances listed on FDA's Action Levels for Poisonous or Deleterious Substances in Human Food have been reported as contaminants of concern in agar-agar. FDA regulations state that agar-agar for human consumption must meet the specifications of the "Food Chemicals Codex" (21 CFR 184.1115). The requirements for agar-agar in the 7th edition of the "Food Chemicals Codex" specify that it contain no more than 3 mg/kg arsenic, 5 mg/kg lead, and 1.0% insoluble matter (U.S. Pharmacopeia, 2010).

Evaluation Question #9: Discuss and summarize findings on whether the manufacture and use of the petitioned substance may be harmful to the environment or biodiversity (7 U.S.C. § 6517 (c) (1) (A) (i) and 7 U.S.C. § 6517 (c) (2) (A) (i)).

There is limited evidence to suggest that the harvesting of agarophytes (algae used to make agar-agar) may be harmful to biodiversity. The current world demand for agar-agar is reportedly increasing, which has placed pressure on the overharvested natural sources (Sahu et al., 2010). Buschmann et al. (2008) report that overexploitation of many wild *Gracilaria* strands has resulted in the destruction of some of the larger genetic reserves for the species.

Harvesting of wild agarophytes may also reduce biodiversity on nearby beaches. Beaches that receive significant amounts of macrophyte wrack (marine plants and macroalgae that wash up on shore) support rich communities of crustaceans and insects (Defeo et al., 2009; Colombini and Chelazzi, 2003). The harvesting of marine plants and macroalgae before or after they wash up on shore can have significant ecological consequences, especially in regions with high macrophyte production (Defeo et al., 2009). The removal of macrophyte wrack during beach grooming has been shown to reduce species richness, abundance, and biomass on sandy beaches (Defeo et al., 2009). Wrack-associated species are important prey for higher trophic levels, and reducing their numbers has the potential to affect populations of predators such as birds (Defeo et al., 2009; Colombini and Chelazzi, 2003). No studies were found to indicate whether or not the harvesting of agarophytes in particular is harmful to the biodiversity on nearby beaches or in the algae beds themselves.

The industrial manufacture of agar-agar is a process that requires a large amount of water and sometimes produces alkaline wastewaters, which may pose environmental problems for producers according to McHugh (2003). However, no further information was found on this topic and no other sources were identified that discuss whether the manufacture and use of agar-agar may be harmful to the environment.

<u>Evaluation Question #10:</u> Describe and summarize any reported effects upon human health from use of the petitioned substance (7 U.S.C. § 6517 (c) (1) (A) (i), 7 U.S.C. § 6517 (c) (2) (A) (i)) and 7 U.S.C. § 6518 (m) (4)).

As stated in the response to Evaluation Question #4, agar-agar is a food additive that is affirmed as GRAS by FDA (21 CFR 184.1115). The toxicology of agar-agar has been reviewed by the Joint FAO/WHO Expert Committee on Food Additives, and the acceptable daily intake was categorized as "not limited" (JECFA, 1973). In two studies conducted by the National Toxicology Program, no evidence of cancer was found when agar, extracted from *Pterocladia*, was added to the feed of laboratory animals for the duration of their lifetime (NTP, 1982). Following ingestion, agar-agar passes through the intestinal tract mostly unabsorbed (HSDB, 2002). No reports of harmful effects on human health were found resulting from the use of agar-agar as a food additive.

<u>Evaluation Information #11:</u> Provide a list of organic agricultural products that could be alternatives for the petitioned substance (7 CFR § 205.600 (b)(1)).

Several agricultural products could be used as alternatives for agar-agar depending on the function required for a specific food application as well as compatibility with other ingredients.

Possible agricultural alternatives to agar-agar in food applications include (1) gelling agents, such as pectin (high methoxy), gelatin, unmodified starches, and konjac flour, and (2) thickeners, emulsifiers, and stabilizers, such as vegetable gums (Arabic, locust/carob bean, guar), unmodified starches, tragacanth gum, konjac flour. All of these products are included on the National List as nonorganically produced agricultural products allowed as ingredients in or on processed products labeled as "organic" (7 CFR 205.606). Suppliers of organic forms of these products were found in most cases (as noted below). Nonorganically-produced forms of these products are only allowed when organic forms are not commercially available.

Pectin is a polysaccharide primarily extracted from citrus peel and apple pomace (Brejnholt, 2010). High methoxy pectin refers to pectin with greater than 50% of methyl ester galacturonic acid units. Traditionally, pectin has been used as a gelling agent in jams and jellies, but it is now also being broadly used as a thickener and stabilizer in a variety of processed foods. Pectin is used to thicken and/or stabilize fruit-based products, dairy products, beverages, confections, bakery products, and various fine foods and spreads (Brejnholt, 2010). No specific suppliers were found in a search for organic pectin. The International Pectin Producers Association stated in 2010 that, in its opinion, organically produced pectin raw materials are not currently available to use in the production of commercial pectin products, and it does not see that situation changing over the next five years (IPPA, 2010).

Gelatin is mostly comprised of protein and is obtained from animal connective tissue. It is used as a gelling agent in desserts and confections (e.g., marshmallows and gummy candies) and a binding and/or glazing agent in meats and aspics (GMIA, 2001). No information was found on large-scale suppliers of organic gelatin. Organic gelatin is available to purchase on a small scale from the supplier Anke.ca Organics (Anke.ca Organics, 2011).

Starches are one of the most widely used thickening and gelling agents in the food industry (Sheldrake, 2010). Starches used in food applications are mainly obtained from corn, potato, wheat, or cassava (tapioca) although many other crops are also used. A flexible range of textures can be achieved by adding starches to foods, and some of the uses include as a thickener for soups and sauces, a stabilizer for condiments, and as a gelling agent in dairy desserts, cultured dairy products (e.g., yogurt), cream fillings for baked goods, and spreads (Sheldrake, 2010). Organic corn starches and organic potato starches are available to purchase from the supplier Marroquin Organic International (Marroquin Organic International, 2010).

Konjac flour is obtained from the tubers of plants in the *Amorphophallus* genus and is comprised of a polysaccharide called konjac glucomannan (Parry, 2010). It is used to influence retrogradation and moisture release in soft breads, pastries, and other baked goods; for adhesion of coatings; and for binding in restructured meat or vegetables. It is often combined with carrageenan, starch, or gums to form gels that are used in pastas, restructured foods, meat, and desserts. It is also used to thicken beverages (Parry, 2010). No specific suppliers were found in a search for organic konjac flour.

Gum arabic is the exudate taken from species of *Acacia* trees (Belitz et al., 2009). It is used as an emulsifier and stabilizer in baked products and it helps to retard sugar crystallization and fat separation in confections and ice crystal formation in ice cream. Locust bean gum (carob bean gum) is obtained from the flour of the carob bean endosperm (Belitz et al., 2009). It is used as a thickener, binder, and stabilizer in meat canning, salad dressings, sausages, soft cheeses, and ice creams. Guar gum is obtained from the flour of the seed endosperm of the legume *Cyamopsis tetragonoloba* (Belitz et al., 2009). It is used as a thickening agent and stabilizer in salad dressings and ice creams. Organic gum arabic, locust bean gum, and guar gum are available to purchase from the supplier TIC Gums (TIC Gums, 2010).

Tragacanth gum is the exudate taken from species of *Astragalus* shrubs that grow in the Middle East (Belitz et al., 2009). It is used as a thickening agent and stabilizer in salad dressings and in fillings and icings for baked goods. It is also used to provide a soft texture to ice creams (Belitz et al., 2009). No specific suppliers were found in a search for organic tragacanth gum.

Nonagricultural substances that are included on the National List (7 CFR 205.605) and provide similar functionality to agar-agar include the nonsynthetic ingredients carrageenan and gellan gum (high-acyl form only) and the synthetic ingredients low-methoxy pectin and xanthan gum.

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