Sulfuric Acid
Handling

Identification of Petitioned Substance

Chemical Name:
Sulfuric acid

Other Names:
Dihydrogen sulfate
Hydrogen sulfate
Oil of vitriol
Battery acid
Dipping acid
Electrolyte acid
Matting acid

Trade Names:
None

CAS Number:
7664-93-9

Other Codes:
U.S. EPA PC Code: 078001
EC Number: 231-639-5
RTECS number: WS5600000
DOT number; corrosive material: UN 1830 137
OSHA IMIS Code Number: 2310

Characterization of Petitioned Substance

Composition of the Substance:
Sulfuric acid (H_2SO_4) is a strong acid that is highly soluble in water (HSDB, 2010). A molecule of sulfuric acid consists of two atoms of hydrogen, one atom of sulfur and four atoms of oxygen. The chemical structure of sulfuric acid is provided below as Figure 1.

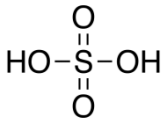

Figure 1. Chemical Structure of Sulfuric Acid (HSDB, 2010)

Properties of the Substance:
Pure H_2SO_4 is a solid with a melting point of 10.31°C (HSDB, 2010). In general, sulfuric acid is used in an aqueous solution and is a colorless to dark brown, oily, odorless liquid. While sulfuric acid itself is not flammable, contact with many organic and inorganic chemicals may cause fire or explosion and contact with metals liberates flammable hydrogen gas. When heated, sulfuric acid can decompose and form toxic gases such as sulfur oxides. Sulfuric acid is highly reactive in water, releasing toxic, corrosive, or flammable gases (HSDB, 2010; CCOHS, 1999).

Sulfuric acid is considered very toxic and may be fatal if inhaled or swallowed. It is corrosive to the eyes, skin, and respiratory tract, and exposure may cause blindness and permanent scarring. Some strong inorganic acid mists containing sulfuric acid are classified as carcinogenic (CCOHS, 1999). As described further under "Specific Uses of the Substance," sulfuric acid is manufactured in a variety of grades for use in a wide variety of applications (ATSDR, 1998).

Sulfuric acid is one of the primary chemical agents of "acid rain" (ATSDR, 2004). Because it is not very volatile, sulfuric acid from sources of air pollution are often found in the air as microscopic liquid droplets or are attached to other small particles in the air (HSDB, 2010). Atmospheric deposition of sulfuric acid from air pollution can lower the pH of surface waters and other environmental media and has a corrosive effect on living and nonliving components of the aquatic and terrestrial environments (USDA, 2006).

Physicochemical properties of sulfuric acid are provided in Table 1.

Table 1. Physical and Chemical Properties of Sulfuric Acid

Physical or Chemical Property	Value
Physical state	Solid below 10.5°C; prepared as aqueous solution
Appearance	Colorless to dark brown, oily
Odor	None
Taste	Marked acid taste
Molecular weight (g/mol)	98.1
Boiling point (°C)	337
Melting point (°C)	10.31
Solubility in water (mg/L at 25°C)	1×10^6; miscible
Corrosivity	Very corrosive
Vapor pressure (mm Hg at 25°C)	5.93×10^{-5}
Density (g/cm^3)	1.8302
pH (in solution of water)	1 N[a] sol. = 0.3; 0.1 N[a] sol. = 1.2; 0.01 N[a] sol. = 2.1

[a]N = normality; normality is equal to molarity multiplied by the valence (or ionic charge) of the anion or cation

Source: HSDB, 2010

Specific Uses of the Substance:

Non-food uses

In the United States, nearly 100 billion pounds of sulfuric acid is manufactured annually. Its production amount is nearly twice that of any other chemical. Sulfuric acid is sold or used commercially at varying concentrations, including technical grades (78–93%) and other grades (96, 98–99, and 100%). In these commercial products, impurities may include metals such as copper, iron, zinc, arsenic, mercury, lead, and selenium; sulfurous acid (as SO_2); nitrates; and chlorides (CCOHS, 1999). The four most common grades of sulfuric acid are commercial, electrolyte (high purity for batteries), textile (low organic content), and chemically pure or reagent grades (ATSDR, 1998). Commercial, electrolyte, textile, and reagent grades contain approximately 98%, 98%, 70%, and 95-98% sulfuric acid, respectively.

Nearly two thirds of the sulfuric acid produced in the United States is used in the manufacture of chemical fertilizers. For example, sulfuric acid is used to treat phosphate rock, an insoluble material containing phosphorous in the form of calcium phosphate (Stoker, 2007). The treatment of phosphate rock with sulfuric acid yields phosphorus acid in the following reaction:

$$Ca_3(PO_4)_2 + 3H_2SO_4 \longrightarrow 3CaSO_4 + 2H_3PO_4$$

The resulting phosphorus acid is used to produce soluble phosphate that acts as a source of phosphorus, which is necessary for plant growth (Stoker, 2007).

Sulfuric acid is also used in explosives, glue, dyestuffs, rayon, film, parchment paper, batteries, electronic chips, electroplating baths, nonferrous metallurgy, and ore processing (e.g., copper leaching). It can also be used to purify petroleum and to remove impurities from metals (i.e., pickling). In laboratories, sulfuric acid acts as a common reagent (ATSDR, 1998; HSDB, 2010). In many of these applications, the sulfuric acid is recovered and reused. There also are numerous household products (e.g., cleaners, detergents, rust dissolvers) that contain sulfuric acid (HHS, 2011).

Sulfuric acid is also considered a pesticide and is used in sprayable potato vine desiccant products. The use of potato vine desiccants benefits tuber appearance, limits tuber size, and improves tuber release from the vine at harvest (University of Florida, 2012).

Food Handling Uses

Sulfuric acid is considered a general purpose food additive and is used in the production of food acids (i.e., citric and lactic acids) and to directly control pH during the processing of foods (particularly packaged foods) and beverages, including seaweed extracts, alcoholic beverages, and cheeses. In the production of citric acid, calcium oxide is added to form an insoluble precipitate, calcium citrate. Citric acid is recovered by adding sulfuric acid to dissolve the precipitate (Kragl, 2005). A small amount of sulfuric acid is used in the production of high fructose corn syrup (Watson, 2002).

Sulfuric acid is used as a food additive to adjust the pH in order to create a more acidic environment that discourages the growth of bacteria and spoilage microbes. The use of sulfuric acid as a pH adjuster is a common practice in the processing of alcoholic beverages and cheese (Watson, 2002). Sulfuric acid washes or sprays are often applied to the surface of meat or poultry products to prevent the growth of spoilage microbes (FDA, 2011).

In its petition to the National Organic Program (NOP), Marinova (an Australian biotechnology company) described the use of sulfuric acid in the process of seaweed extraction. Specifically, sulfuric acid is used to adjust the pH of water used to extract fucoidans from brown algae or brown seaweed. Fucoidan is a sulfated polysaccharide that has been used as an ingredient in food supplements, function foods[1], beverages, and cosmetics. The manufacturer also claims that fucoidans have the ability to act as a viral attachment inhibitor, enzyme inhibitor, and receptor blocker, which makes them useful in many pharmaceutical and nutraceutical applications. The petitioner states that, "sulfuric acid does not impact on the seaweed extract, rather it is used solely as a processing aid," asserting that no residual sulfuric acid remains in the seaweed extraction product. In addition, the petitioner claims that liquid formulations would be overtaken by bacterial growth without this step to reduce pH (Marinova, 2010).

The petitioner manufactures seaweed extracts using sulfuric acid by a method it calls the Maritech® process. Marinova claims this method as proprietary and confidential business information because it was developed in-house by Marinova. Therefore the existence of any chemical changes that may occur during the production process is unknown. Marinova states that this method used to manufacture seaweed extracts is unique in the marketplace (Marinova, 2010).

Approved Legal Uses of the Substance:
Sulfuric acid is regulated as a pesticide under the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) (USEPA, 1993). It is exempt from the requirement of a tolerance for residues when used in accordance with good agricultural practices as a pH control agent in pesticide formulations applied to growing crops or to raw agricultural commodities after harvest (HSDB, 2010). It is also exempt from the requirement of a tolerance for residues when used in accordance with good agricultural practice as an herbicide in the production of garlic and onions and as a potato vine desiccant in the production of potatoes (USEPA, 1993; HSDB, 2010).

Under the NOP Final Rule, sulfuric acid, along with phosphoric acid and citric acid, are approved for pH adjustment in liquid fish products, not to exceed the minimum needed to lower the pH to 3.5 (7 CFR 205.601(j)(7)). Sulfuric acid is petitioned to be used for the same function (i.e., pH adjustment) in the production of seaweed extracts, specifically fucoidans (Marinova, 2010). Sulfuric acid is not permitted in organic livestock production and organic handling/processing, and is not included on the National List at 205.603 and 205.605, respectively.

[1] A function food is a food where a new ingredient(s) (or more of an existing ingredient) has been added to a food and the new product has a new function (often one related to health-promotion or disease prevention) (IFIS, 2009).

Sulfuric acid is categorized by the U.S. Food and Drug Administration (FDA) as generally recognized as safe (GRAS) when used in food according to FDA's good manufacturing practices. According to 21 CFR 184.1095, sulfuric acid may be used as a pH control agent as defined in 21 CFR 170.3(o)(23)[2] and as a processing aid as defined in 21 CFR 170.3(o)(24)[3]. Sulfuric acid is allowed at a maximum amount of 0.014% in alcoholic beverages (as defined in 21 CFR 170.3[n][2]) and 0.0003% in cheeses (as defined in 21 CFR 170.3[n][5]). Sulfuric acid is regulated as a food additive used to manufacture modified hop extract (21 CFR 172.560[b][6]). It is also permitted as a pH reducer for modified food starch (21 CFR 172.892[a]). Additionally, sulfuric acid is permitted for use as an indirect food additive as a component of paper and paperboard in contact with dry food (21 CFR 176.180) and aqueous and fatty foods (21 CFR 176.170).

Action of the Substance:
Sulfuric acid is a strong acid that acts as a pH adjuster. The addition of sulfuric acid lowers the pH of a solution and prevents the growth of spoilage microbes or other bacteria.

Combinations of the Substance:
The process described by the petitioner for the manufacture of fucoidans using sulfuric acid as a handling and processing aid is considered confidential business information. Therefore no mixtures of sulfuric acid have been identified specifically for the petitioned use.

Mixtures of substances including sulfuric acid have been identified for use during common food production practices other than the petitioned use. For example, multiple mixtures have been identified for use in the processing of meat, poultry, and egg products, and these mixtures are primarily used to adjust or control the pH of water used in the processing. Aqueous solutions may combine sulfuric acid with a variety of other components, including copper sulfate, ammonium sulfate, water, sodium bisulfate, citric acid, phosphoric acid, or hydrochloric acid. Substances including peroxyacetic acid, hydrogen peroxide, acetic acid, and 1-hydroxyethylidene-1, 1-diphosphonic acid may be combined with sulfuric acid to create antimicrobial solutions. These antimicrobial mixtures may be added to process water or ice used for washing, rinsing, cooling, or processing whole or cut meat and poultry including parts, trim, and organs (FSIS, 2012).

Status

Historic Use:
Vitriols (i.e., acids, including sulfuric acid) were first discovered in ancient times, and the origin and properties of these substances were first explored by the Greeks. The contact process, the primary means of manufacturing sulfuric acid used in the production of seaweed extracts, was patented in 1831 by Peregrine Phillips (Friedman and Friedman, undated).

OFPA, USDA Final Rule:
Sulfuric acid is currently included on the National List of Allowed and Prohibited Substance (hereafter referred to as the National List) for pH adjustment in liquid fish products, not to exceed the minimum needed to lower the pH to 3.5 (7 CFR 205.601[j][7]). Sulfuric acid is not permitted in organic livestock production and organic handling/processing, and is not included on the National List at 205.603 and 205.605, respectively.

Sulfuric acid is petitioned to be used for pH adjustment in the production of seaweed extracts, specifically fucoidans, a product not included on the National List (Marinova, 2010).

[2] According to 21 CFR 170.3(o)(23), pH control agents are defined as substances added to change or maintain active acidity or basicity, including buffers, acids, alkalies, and neutralizing agents.
[3] According to 21 CFR 170.3(o)(24), a processing aids are defined as Substances used as manufacturing aids to enhance the appeal or utility of a food or food component, including clarifying agents, clouding agents, catalysts, flocculents, filter aids, and crystallization inhibitors, etc.

International:
The Canadian General Standards Board (CGSB) permits the use of fish emulsions to amend and improve soil fertility. Sulfuric acid can be used to adjust pH in liquid fish products, but the amount of acid used cannot exceed the minimum amount needed to lower the pH to 3.5 (CGSB, 2011).

The use of sulfuric acid in the production of organic sugar and gelatin products is permitted by the following international groups/agencies.

- The European Economic Community (EEC) (EEC 889/2008, 2008)
- The International Federation of Organic Agriculture Movements (IFOAM, 2008)
- The Codex Alimentarius Commission (Codex Alimentarius Commission, 2010)
- The Australian National Standard for Organic and Bio-dynamic Produce (AQIS, 2009)
- The Japan Agricultural Standard for Organic Production (JMAFF, 2006)

In 2008, the Australian Quarantine and Inspection Service ruled that fucoidans are to be considered a sugar-based product. Therefore, the use of sulfuric acid for fucoidan processing in Australia would be permitted (Marinova, 2010).

Evaluation Questions for Substances to be used in Organic Handling

Evaluation Question #1: 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)).

Generally, sulfuric acid is manufactured by burning sulfur or a metallic sulfide in oxygen or air to create sulfur dioxide (SO_2), followed by the oxidation of SO_2 to sulfur trioxide (SO_3) and the addition of water to SO_3 to form sulfuric acid (H_2SO_4). There are two processes used to produce sulfuric acid—the nitration or "chamber" process and the catalytic or "contact" process (ATSDR, 1998; Friedman and Friedman, undated).

The chamber process was introduced in 1746 and is sometimes referred to as the nitration process because nitrogen compounds are used to improve the gas-phase reaction of sulfur dioxide with oxygen. The chemical reactions involved in the chamber process are complex and include formation of the intermediate nitrosylsulfuric acid (HNO_5S). This intermediate is then decomposed by water to form sulfuric acid and nitrogen oxide (NO). Nitrogen oxide is regenerated by oxygen or air to nitrogen dioxide (NO_2) and a combination of nitrogen compounds (NO and NO_2 or N_2O_3) is recycled to the sulfur dioxide oxidation step. While this process was once the primary method for sulfuric acid production, it has rarely been used in the United States and Western Europe after 1960 (ATSDR, 1998).

The contact process was first patented in 1831, but was not used to produce commercial quantities of sulfuric acid until the early 1900s. The principal steps in the contact process are: (1) oxidation of sulfur to SO_2 using dry air; (2) cooling of the gases; (3) conversion or oxidation of the SO_2 to SO_3; (4) cooling of the SO_3 gas; and (5) absorption of the SO_3 gas in water to produce sulfuric acid. A key component of the contact process is when sulfur dioxide is converted catalytically to sulfur trioxide. Acceptable catalysts include oxides of iron, chromium, copper, manganese, titanium, vanadium, and other metals (Friedman and Friedman, undated).

The basic three-step reaction used to produce sulfuric acid is shown below:

$$S + O_2 \rightarrow SO_2$$
$$2SO_2 + O_2 \rightarrow 2SO_3$$
$$SO_3 + H_2O \rightarrow H_2SO_4$$

The solution can be diluted with water to obtain the desired concentration of sulfuric acid (ATSDR, 1998).

Sulfuric acid can also be produced from sulfur dioxide collected by pollution control devices (scrubbers) during the smelting of various metal ores and ore concentrates. The sulfur dioxide is captured in the scrubbers to reduce emissions that would otherwise contribute to acid rain. The resulting "scrubber feedstock" is further purified, concentrated, and used for the subsequent production of sulfuric acid (USDA, 2006).

As described in Specific Uses of the Substance, the petitioner manufactures seaweed extracts using sulfuric acid by employing a method called the Maritech® process. The Maritech® process is a cold-water, ethanol-free process to extract fucoidans. This process does not degrade the product unlike alternative processes that are ethanol based. Marinova claims this method as proprietary and confidential business information because it was developed in-house by Marinova over multiple years. Marinova states that this method used to manufacture seaweed extracts is unique in the marketplace. The petitioner provides a Material Safety Data Sheet that specifies that sulfuric acid with a concentration of 50% is used in the Maritech® process (Marinova, 2010).

Evaluation Question #2: 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)).

Sulfuric acid, including food-grade sulfuric acid, is chemically synthesized. See Evaluation Question #1 for a description of its manufacturing processes.

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

Sulfuric acid is chemically synthesized. See Evaluation Question #1 for a description of its manufacturing processes. Nonsynthetic forms of sulfuric acid are not commercially available.

Evaluation Question #4: 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?

Sulfuric acid is considered GRAS when used in food according to FDA's good manufacturing practices, which allows a maximum of 0.014% in alcoholic beverages (as defined in 21 CFR 170.3[n][2]) and 0.0003% in cheeses (as defined in 21 CFR 170.3[n][5]) (21 CFR 184.1095). Sulfuric acid is permitted for use as a food additive used to manufacture modified hop extract (21 CFR 172.560[b][6]). It is also permitted as a pH reducer for modified food starch (21 CFR 172.892[a]). Additionally, sulfuric acid is permitted for use as an indirect food additive as a component of paper and paperboard in contact with both dry food (21 CFR 176.180) and aqueous and fatty foods (21 CFR 176.170).

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)).

Sulfuric acid is not specifically added to food as a preservative. However, in its role as a pH reducer, sulfuric acid creates a more acidic environment that discourages the growth of bacteria and spoilage microbes (e.g., in alcoholic beverages, cheese) and helps maintain the quality of the food (Watson, 2002). Similarly, sulfuric acid washes or sprays are often applied to the surface of meat or poultry products to prevent the growth of spoilage.

Marinova's petition describes the use of sulfuric acid as a pH adjuster during the seaweed extraction process. Marinova asserts that the adjustment of pH is required for the prevention of the growth of spoilage bacteria in liquid formations (i.e., seaweed extraction water). The function of sulfuric acid as a preservative is never specifically discussed in the petition and specific details on the use of sulfuric acid in the manufacturing process are withheld as confidential business information (Marinova, 2010).

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)).

Sulfuric acid is not used to recreate or improve flavors, colors, textures, or nutritive values lost during processing.

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 to indicate that sulfuric acid has any potential effect on the nutritional quality of food when used as a food processing and handling aid.

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)).

While residues and impurities (i.e., copper, iron, zinc, arsenic, mercury, lead, and selenium) have been reported in manufactured sulfuric acid product, no information was found to indicate the levels of these substances in sulfuric acid used for pH adjustment. Therefore it is unknown if these contaminants are in excess of FDA tolerances in sulfuric acid.

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)).

During the manufacturing of sulfuric acid, emissions of sulfuric acid may be released to the air. ATSDR affirms that sulfuric acid manufacturing facilities are among the primary sources of sulfuric acid releases to the air (ATSDR, 1998). In the air, some sulfuric acid reacts with other chemicals (e.g., ammonia, magnesium, calcium), which act to neutralize the acid. Sulfuric acid droplets and particles that are not neutralized may dissolve in clouds, fog, rain, or snow, resulting in very dilute acid solutions that could impact the environment as acid precipitation (ATSDR, 2004). Runoff containing wet and dry acid deposition may impact farming environments and ecosystems. Many lakes and streams examined in a National Surface Water Survey suffer from chronic acidity, a condition in which water has a consistently low pH level. Runoff may combine with existing sources of irrigation and cause contamination on farms. Acid rain causes a large number of effects that harm or kill individual fish, reduce fish population numbers, completely eliminate fish species from a water body, and decrease biodiversity. As lakes and streams become more acidic, the numbers and types of fish and other aquatic plants and animals that live in these waters decrease due to the interdependence of the entire ecosystem (USEPA, 2007). Acid deposition adds hydrogen ions to the soil, which displace nutrients including calcium, magnesium, and potassium. Ions are washed deeper into the subsoil or washed out of the top soil and this process called leaching. If ions are leached from the soil, they are no longer available to the roots of trees and plants and growth is prevented (Ophardt, 2003).

Sulfuric acid contributes to the formation of acid rain and is considered a regulatory and environmental concern.

For the extraction of fucoidan in seaweed, the petitioner uses sulfuric acid in small quantities to lower the pH of the extraction water. The petitioner states that the volume of sulfuric acid used is small (1% by weight; food grade sulfuric acid 50%) and the creation of vapors or mists containing sulfuric acid that could be released into the atmosphere is unlikely. Marinova also notes that the Maritech® process includes a neutralization step, which minimizes the release of sulfuric acid concentrations into the environment (Marinova, 2010).

Evaluation Question #10: 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)).

Sulfuric acid is very corrosive and irritating and can cause harmful effects on the skin, eyes, and respiratory and gastrointestinal tracts of humans (ATSDR, 1998). Exposure to sulfuric acid mist can irritate the eyes, nose, throat and lungs, and, at higher levels, can cause a buildup of fluid in the lungs (pulmonary edema) (ADEH, 2003). Although liquid sulfuric acid is not absorbed through the skin, it is a corrosive chemical that can severely burn unprotected skin and eyes, causing third degree burns and blindness on contact (ATSDR, 2004). Oral ingestion of concentrated sulfuric acid can burn the mouth, throat, and stomach, and can result in death (ATSDR, 2004). EPA has placed sulfuric acid in Toxicity Category I (on a scale of I to IV) for eye and dermal irritations as well as inhalation effects in humans; it is in Toxicity Category II for acute oral toxicity (USEPA, 1993).

The American Conference of Governmental Industrial Hygienists (ACGIH) has classified aerosol sulfuric acid as a suspected human carcinogen because it is carcinogenic in laboratory animals under conditions that are considered relevant to worker exposure (CCOHS, 2003). However, available human studies are considered conflicting or insufficient to confirm an increased risk of cancer in exposed humans. The International Agency for Cancer Research (IARC) has determined that there is sufficient evidence that occupational exposure to strong-inorganic-acid mists containing sulfuric acid is carcinogenic to humans (IARC, 1992). When working with sulfuric acid, it is advised that all workers use appropriate personal protective equipment, including protective gloves and eye protection to avoid dermal exposure and respiratory protection in cases where ventilation is inadequate (CCOHS, 2003).

There are no human dietary concerns from the use of sulfuric acid as a pesticide on potato vines (USEPA, 1993). For this use, sulfuric acid was granted an exemption from tolerance requirements because it "is rapidly degraded in the environment to sulfate salts, which are of no toxicological concern and are GRAS by the FDA." Sulfuric acid is also considered GRAS by FDA for its use as a food additive and processing aid (see Approved Legal Uses of the Substance and Evaluation Question #4).

In its petition, Marinova indicates that the sulfuric acid it uses as a processing aid for seaweed extraction products is neutralized to sulfate salts prior to isolation and purification of the extracts. Marinova asserts that no residual sulfuric acid is present in its final product (Marinova, 2010).

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

No organic agricultural products have been identified as appropriate alternatives for sulfuric acid used in the production of seaweed extracts. The petitioner noted that citric and lactic acids have been used in the process of adjusting the pH of liquid formations produced in seaweed extraction, but concluded that their use was ineffective and impractical for fucoidan extraction (Marinova, 2010). The method used by Marinova is claimed as proprietary and confidential business information because it was developed in-house by Marinova over multiple years. Marinova states that this method used to manufacture seaweed extracts is unique in the marketplace.

References:

ADEH (Australia Department of Environment and Heritage). 2003. National pollutant inventory: Sulfuric acid. Retrieved February 8, 2012 from http://www.npi.gov.au/substances/sulfuric-acid/health.html

AQIS (Australian Quarantine and Inspection Service). 2009. National Standard for Organic and Bio-dynamic Produce (Ed 3.4). Retrieved January 19, 2012 from http://www.daff.gov.au/__data/assets/pdf_file/0018/126261/national-standard.pdf

ATSDR (Agency for Toxic Substances and Disease Registry). 1998. Toxicological profile for sulfur trioxide and sulfuric acid. Retrieved January 9, 2012 from http://www.atsdr.cdc.gov/toxprofiles/tp117.pdf

ATSDR (Agency for Toxic Substances and Disease Registry). 2004. ToxFAQs™ for sulfur trioxide and sulfuric acid. Retrieved January 9, 2012 from http://www.atsdr.cdc.gov/tfacts117.html

CCOHS (Canadian Centre for Occupational Health and Safety). 1999. Basic information on sulfuric acid. Retrieved January 9, 2012 from http://www.ccohs.ca/oshanswers/chemicals/chem_profiles/sulfuric_acid/basic_sa.html

CCOHS (Canadian Centre for Occupational Health and Safety). 2003. Working safely with sulfuric acid. Retrieved February 8, 2012 from http://www.ccohs.ca/oshanswers/chemicals/chem_profiles/sulfuric_acid/working_sa.html

CGSB (Canadian General Standards Board). 2011. Organic Production Systems Permitted Substances List. CAN/CGSB-32.311-2006. Amended October 2008, December 2009, and June 2011. Retrieved April 5, 2012 from http://www.tpsgc-pwgsc.gc.ca/ongc-cgsb/programme-program/norms-standards/internet/bio-org/documents/032-0311-2008-eng.pdf

Codex Alimentarius Commission. 2010. Guidelines for the Production, Processing, Labelling, and Marketing of Organically Produced Foods. GL-32-1999. Retrieved January 11, 2011 from http://www.codexalimentarius.net/web/more_info.jsp?id_sta=360

EEC (European Economic Community). 2008. Commission Regulation (EC) No 889/2008. Retrieved January 11, 2012 from http://eur-lex.europa.eu/JOHtml.do?uri=OJ:L:2008:250:SOM:EN:HTML

FDA (U.S. Food and Drug Administration). 2011. GRAS Notification for Sulfuric Acid and Sodium Sulfate Blend Used as an Anti- Microbial in Meat and Poultry Processing. Retrieved January 10, 2012 from http://www.accessdata.fda.gov/scripts/fcn/gras_notices/GRN000408.pdf

Friedman, L.J. and S.J. Friedman. Undated. The history of the contact sulfuric acid process. Acid Engineering and Consulting, Inc., Boca Raton: FL. Retrieved February 7, 2012 from http://www.aiche-cf.org/Clearwater/2008/Paper2/8.2.7.pdf

FSIS (Food Safety Inspection Services). 2012. FSIS Directive: Safe and suitable ingredients used in the production of meat, poultry, and egg products. Retrieved January 19, 2012 from http://www.fsis.usda.gov/OPPDE/rdad/FSISDirectives/7120.1.pdf

HHS (U.S. Department of Health and Human Services). 2011. Household products database: Sulfuric acid. Retrieved January 19, 2012 from http://householdproducts.nlm.nih.gov/cgi-bin/household/brands?tbl=chem&id=1576&query=sulfuric+acid&searchas=TblChemicals

HSDB (Hazardous Substances Data Bank). 2010. Sulfuric acid. Retrieved January 9, 2012 from http://toxnet.nlm.nih.gov

IARC (International Agency for Research on Cancer). 1992. IARC Monographs on the Evaluation of Carcinogenic Risks to Humans Volume 54: Occupational Exposures to Mists and Vapours from Strong Inorganic Acids; and Other Industrial Chemicals. Lyons, France.

IFOAM (International Federation of Organic Agriculture Movements). 2008. IFOAM Indicative List of Substances for Organic Production and Processing. Retrieved January 11, 2012 from http://www.ifoam.org/about_ifoam/standards/pdfs/20080423_IFOAM_Indicative_List.pdf

IFIS (International Food Information Service) 2009. IFIS Dictionary of Food Science and Technology. Wiley-Blackwell.

JMAFF (Japanese Ministry of Agriculture, Forestry and Fisheries). 2006. Japanese Agricultural Standard for Organic Processed Foods, Notification No.1464.

Kragl, U. 2005. Technology transfer in biotechnology. Springer, Berlin, Germany.

Marinova, 2010. Petition for non-agricultural substances allowed in or on processed products labeled as organic: Sulfuric acid (food grade 30-50%). Retrieved January 10, 2012 from http://www.ams.usda.gov/AMSv1.0/getfile?dDocName=STELPRDC5086279

OMRI (Organic Materials Review Institute). 2012. Online Database of OMRI Lists. Available at http://www.omri.org/omri-lists.

Ophardt, C.E. 2003. Elmhust College Virtual Chembook: Acid rain soil interactions. Retrieved April 30, 2012 from http://www.elmhurst.edu/~chm/vchembook/196soil.html

Stoker, S.H., 2007. General, organic, and biological chemistry. Houghton Mifflin Company, Boston, MA. Retrieved January 10, 2012 from http://books.google.com/books?id=6vy8MZeIcowC&pg=PA141&dq=sulfuric+acid,+fertilizer&hl=en&sa=X&ei=C1gMT-qsCYPMhAfom7nHBA&ved=0CE4Q6AEwAQ#v=onepage&q=sulfuric%20acid%2C%20fertilizer&f=false

University of Florida. 2012. Potato vine killing or desiccation. Retrieved April 27, 2012 from http://edis.ifas.ufl.edu/hs181

USDA (U.S. Department of Agriculture). 2006. Technical report for sulfuric acid, crop use. Retrieved January 10, 2012 from http://www.ams.usda.gov/AMSv1.0/getfile?dDocName=STELPRDC5057639

USEPA (U.S. Environmental Protection Agency). 1993. R.E.D. FACTS: Mineral Acids. EPA-738-F-93-025. Office of Prevention, Pesticides and Toxic Substances. Retrieved January 10, 2012 from http://www.epa.gov/oppsrrd1/REDs/factsheets/4064fact.pdf

USEPA (U.S. Environmental Protection Agency). 2007. Effects of Acid Rain. Retrieved February 8, 2012 from http://www.epa.gov/acidrain/effects/

Watson, D.H. 2002. Food Chemical Safety: Volume 2, additives. Woodhead Publishing Limited and CRC Press, Boca Raton, FL. Retrieved January 10, 2012 from http://books.google.com/books?id=Kpwqehy6hawC&pg=PA55&dq=sulfuric+acid,+food+additive&hl=en&sa=X&ei=uIQMT9fMMM6eOqXxpJYH&ved=0CE8Q6AEwAzgK#v=onepage&q=sulfuric%20acid%2C%20food%20additive&f=false