National Organic Standards Board
Handling Subcommittee Petitioned Material Proposal
Silver Dihydrogen Citrate
July 3, 2018

Summary of Petition:
Silver Dihydrogen Citrate it being petitioned by Pure Bioscience, Inc. as an antimicrobial processing aid for poultry carcasses and fruits and vegetables (excluding citrus and grapes for winemaking) and as a disinfectant/sanitizer for food contact surfaces and food processing equipment (Petition pg. 1, TR 31-34, 127-132). As such it is being petitioned to be listed on the National List at 7 CFR 205.605(b), synthetic nonagricultural (nonorganic) substance allowed in or on processed products labeled as "organic" or "made with organic (specified ingredients)." The petition was received on 1/18/2017 (referred to as "petition") and amended on 8/1/17 and 6/29/18 (referred to as "addenda"). A Technical Review (TR) was completed and found sufficient on 5/15/2018 (referred to as "TR"). The NOSB is recommending an annotation stating: "limited to particle sizes greater than 300nm"

Summary of Review:
Based on the information provided SDC appears to be of low risk to the environment and human health both in its use and disposal. Alternative materials, natural and synthetic, are available however these substances have limited applications or utilize a similar oxidative mode of action. There is a growing concern about the development of bacterial resistance to oxidative antibacterial agents. The Fall 2018 NOSB meeting will be the first time the NOSB will be adding this petition to our published agenda, as such we have not heard from industry on the need for this substance in light of the alternatives. The NOSB has received some public comment from interest groups that are concerned that the inclusion of SDC will allow the use of nano-silver and that nano-silver is necessary for the sanitizing efficacy of this substance. The petitioner denies nano-silver is a part of this formulation and the technical report speaks to the efficacy of this substance without nano-silver. In the Fall of 2010 the NOSB unanimously voted to prohibit engineered nano-materials of a size of 1-300NM in organic production and handling. In a policy memorandum in response to the NOSB recommendation, dated March 24, 2015, the NOP noted nanomaterials are generally of a size of 1-100 nm and to be used in organic production must be petitioned to the National List. To address public concerns and to stay consistent with previous NOSB actions, the NOSB is recommending this item only if it contains the annotation "limited to particles sizes greater than 300nm".

Category 1: Classification

1. Substance is for: ____X___ **Handling** _______ **Livestock**

2. For HANDLING and LIVESTOCK use:
   a. Is the substance **Agricultural** or ____X___ **Non-Agricultural?**
      Describe reasoning for this decision using NOP 5033-2 as a guide:

"Silver dihydrogen citrate is a synthetic material solely manufactured by a chemical process, not extracted from naturally occurring plant, animal, or mineral sources. Silver dihydrogen citrate is produced electrolytically, through the immersion of silver electrodes in an aqueous solution of citric acid. " (TR 240-242).

b. If the substance is **Non-agricultural**, is the substance _____ **Non-synthetic** or ___X_ **Synthetic?**
   Is the substance formulated or manufactured by a process that chemically changes a substance extracted from naturally occurring plant, animal, or mineral sources? [OFPA §6502(21)] If so, describe, using NOP 5033-1 as a guide:

"Silver dihydrogen citrate is a synthetic material solely manufactured by a chemical process, not extracted from naturally occurring plant, animal, or mineral sources. Silver dihydrogen citrate is produced electrolytically, through the immersion of silver electrodes in an aqueous solution of citric acid. " (TR 240-242)

3. For **LIVESTOCK**: Reference to appropriate OFPA category
   Is the substance used in production, and does it contain an active synthetic ingredient in the following categories: [§6517(c)(1)(B)(i)]; copper and sulfur compounds; toxins derived from bacteria; pheromones, soaps, horticultural oils, fish emulsions, treated seed, vitamins and minerals; livestock parasiticides and medicines and production aids including netting, tree wraps and seals, insect traps, sticky barriers, row covers, and equipment cleansers; or (ii) is used in production and contains synthetic inert ingredients that are not classified by the Administrator of the Environmental Protection Agency as inerts of toxicological concern?

   Not Applicable

Category 2: Adverse Impacts

1. What is the potential for the substance to have detrimental chemical interactions with other materials used in organic farming systems? [§6518(m)(1)]

   "SDC is incompatible with aluminum sulfate, aluminum ammonium chloride, aluminum orthophosphate, chlorides, sequestering agents designed to remove transition metals from solution, EDTA (above 1.5%), and calcium hardness above 300 ppm. These substances are not on the National List. The product is compatible with most metals including stainless steels. Ionic silver rapidly reacts with chlorides and some other anions that will result in low solubility silver salts. This reaction would potentially affect stability of the product. We recognize that two chloride salts, calcium and potassium, are permitted for use in organic processing, but the chloride salts are not expected to be used during the early processing stages. Therefore, the silver dihydrogen citrate would not be anticipated to have the opportunity to react with those substances and adversely impact the stability of the product." (Petition page 4) and (TR 100-103). This product is intended for processing use and not for use on farms or ranches – as such this is "no anticipated effects on soil organisms, crops, or livestock." (Petition Page 6)

2. What is the toxicity and mode of action of the substance and of its breakdown products or any contaminants, and their persistence and areas of concentration in the environment? [§6518(m)(2)]

   The Technical Report describes the mode of action as follows:
   The silver ion is well known to be effective against a broad range of microorganisms. The antimicrobial action of silver ions is multifaceted due to strong interactions with the purine and pyrimidine DNA bases and thiol groups (i.e., -SH or sulfhydryl groups) present in enzymes and proteins within the microorganism (Izatt et al. 1971, Bragg and Rainnie 1974). These interactions

markedly inhibit bacterial growth (Richards et al. 1984). Silver ions inhibit cell division, damage the cellular envelope, and create structural abnormalities that ultimately result in microbial death (Jung et al. 2008).

The citrate counter ion also significantly contributes to the efficacy of the silver ions antimicrobial properties. Citrate ions stabilize the ionic form and antimicrobial properties of silver(+1), as they do not show a tendency to be oxidized by silver ions (Ag+) which results in Ago (Djokić 2008). Citric acid is a major constituent of the Kreb's cycle, providing many precursors required for energy metabolism. It is readily recognized by bacteria as either a sole source of carbon and energy or as a co-metabolite in the presence of a food source, such as glucose. Thus, bacteria have both passive diffusional and active transport mechanisms for incorporation of citrate, which increases the permeability of the antimicrobial silver ion when it serves as a citrate cofactor (MacDonald and Gerhardt 1958, Korithoski et al. 2005, Pudlik and Lolkema 2011, Mortera et al. 2013). (TR 165-181)

The Technical Report describes concerns with silver being considered toxic hazardous waste at certain levels:
Silver is classified by the EPA as a toxic hazardous waste if detected at 5 mg/L by Toxicity Characteristic Leaching Procedure-EPA method 1311 (EPA HW No. D011; 40 CFR 261.24). According to the 1992 Reregistration Eligibility Decision for silver (EPA-738-F-93-005), the EPA determined that the available acute toxicity data indicate that silver, which persists in the aquatic environment, is highly toxic to fish, aquatic invertebrates, and estuarine organisms. The active disinfectant ingredient, silver dihydrogen citrate (SDC), has an acute LC50 for freshwater fish that ranges from 3.9 to 280 µg/L (ppb).

According to classification provided to the European Chemicals Agency (ECHA), silver dihydrogen citrate (i.e., citric acid and silver citrate EC List No. 460-890-5) is classified as Aquatic Chronic 1 and very toxic to aquatic life with long lasting effects (ECHA 2017). (TR 328-337)

The Technical Reports describes the other components of SDC as low concern:
The environmental assessments also concluded that the remaining components, citric acid (21 CFR 339 184.1033) and sodium lauryl sulfate (21 CFR 172.822), are of a low order of environmental toxicity and the 340 potential impacts from use of the product in the intended applications are well within safe thresholds. (TR 339-341)

3. Describe the probability of environmental contamination during manufacture, use, misuse or disposal of such substance? [§6518(m)(3)]

The Technical Report describes the environmental contamination during use and disposal as follows: The environmental impacts of the product from its intended uses have been evaluated by both FDA and EPA. FDA reviewed the environmental impacts resulting from use in poultry and produce processing, while EPA reviewed the impacts as part of the pesticide registration process. During the treatment of the process water at on-site wastewater treatment facilities, the silver component is expected to partition to sludge (94 %) and waste water (6 %) with environmental introduction concentrations of 238 nanograms (ng) per liter (L) and 1.5 ng/L, respectively (US FDA 2015). The concentration of silver in the sludge is 20,000 times lower than the level requiring disposal as toxic waste (US FDA 2015). Furthermore, the concentration of silver in waste water is approximately 200 times less than naturally occurring levels of silver in the environment in surface waters (0.2-0.3 µg/L) and is not predicted to impact the natural variation of background silver (US FDA 2015). These environmental assessments, with the FDA's

Findings of No Significant Impact (FONSI) concluded that silver dihydrogen citrate, when used as intended, does not present any significant environmental impacts.

The toxicity of silver in the aquatic environment is a concern with this substance but as described in the TR based on FDA evaluations, the waste water is released at a level below naturally occurring background levels of silver and is not expected to impact levels of silver found in the environment.

The environmental impacts of manufacturing or misuse were not described.

4. Discuss the effect of the substance on human health. [§6517 (c)(1)(A)(i); §6517 (c)(2)(A)(i); §6518(m)(4)].

The Technical Review describes the impacts on human heath as follows:
Antimicrobial agents are used in the production and processing of agricultural products due to their effectiveness to kill or inhibit growth of microorganisms in and on foods. This is done to improve food safety for the consumer, as well as to extend the shelf life of food products. There are no known reported positive or adverse effects on human health from use of silver dihydrogen citrate. The high-grade silver and citric acid (used electrolytically to prepare silver dihydrogen citrate) have some potential adverse effects on human health. Citric acid is an irritant of the skin, eyes, and respiratory tract; and chronic exposure to silver and silver salts is most commonly associated with a permanent grey or blue discoloration of the skin (i.e., argyria) and other organs (ATSDR 1990, White et al. 2003, Drake and Hazelwood 2005), but the EPA considers the effect to be a cosmetic and not a toxicological effect and has approved pesticide registrations on the basis that using the product within safe regulatory levels prevents this effect.

In general, silver has low acute human toxicity. It has been placed in the EPA Toxicity Category III for acute oral and dermal toxicity, but it is not an eye or skin irritant (Toxicity Category IV). Silver is also not a skin sensitizer. Although repeated contact may cause argyria, this is highly unlikely to be a concern at the highly diluted levels used in food facilities. The EPA has summarized its review of the toxicity data for silver and silver compounds as part of a recent re-registration process evaluating the effects on human health from pesticidal use (US EPA 1993). The EPA concluded that no new toxicity studies were required for non-zeolite silver compounds other than a repeat dose inhalation study for silver aerosols. There are also some reports that suggest exposure to high levels of silver salts and other soluble forms of silver may produce other toxic effects, including liver and kidney damage, irritation of the eyes, skin, respiratory, and intestinal tract, and changes in blood cells (Drake and Hazelwood 2005).

The safety of the petitioned substance for use in processing of poultry and produce for human consumption has been evaluated by FDA through FCNs 1768, 1569, and 1600. The product's use in food contact surface sanitization has been evaluated by EPA through the pesticide registration process and through evaluation for the exemption from the requirement of a tolerance of silver in the form of silver dihydrogen citrate. Exposures to silver from the intended use of SDC presents no concern for the safety of human health or the environment, as established by FDA through its review of FCNs 1768, 1569, and 1600. The effective FCNs represent FDA's conclusion that the intended uses of SDC are safe for human health, while FDA's environmental reviews concluded that allowing these FCNs to become effective does not significantly affect the quality of the human environment. A safety assessment for citric acid is not included because FDA has affirmed the substance as generally recognized as safe for direct use in human food under 21 CFR 184.1033. (TR 351-384)

Silver is stated to be low acute human toxicity but has been placed on an EPA list for acute oral and dermal toxicity. It is not an eye or skin irritant. Exposure to chronic high levels of SDC can result in liver and kidney damage, irritation of bodily organs and changes in blood cells. It is unclear from the technical report if usage in described food sanitation applications is likely to result in chronic high level exposure for workers.

5. Discuss any effects the substance may have on biological and chemical interactions in the agroecosystem, including the physiological effects of the substance on soil organisms (including the salt index and solubility of the soil), crops and livestock. [§6518(m)(5)]

   See Questions 2 and 3. Additionally, this product is intended for processing use and not for use on farms or ranches – as such this is "no anticipated effects on soil organisms, crops, or livestock."

6. Are there any adverse impacts on biodiversity? (§205.200)

   See Questions 2 and 3.

Category 3: Alternatives/Compatibility

1. Are there alternatives to using the substance? Evaluate alternative practices as well as non-synthetic and synthetic available materials. [§6518(m)(6)]

   The TR describes sanitations practices and use of SDC as follows:
   When processing agricultural products, biocides like SDC are paramount in ensuring the safety of consumer. There is no reported literature describing other antimicrobial practices that are available for direct and indirect food contact sanitization in the processing of agricultural products other than the application of biocide solutions. (TR 385-388)

   The TR describes alternative materials as follows:
   There are other antimicrobial products available for use in organic agricultural processing and sanitization of food contact surfaces: acidified sodium chlorite (NaClO2), chlorine, ozone, and peroxy derivatives (7 CFR 205.605). (TR 388-390)

Despite available information and government programs' efforts to reduce the incidence of *Salmonella*, it continues to be a concern for the meat and poultry industries. Organic acids are excellent antimicrobials against bacteria including *Salmonella (Mani-López et al. 2012)*. Organic acids offer several advantages as antimicrobials because they are GRAS, have no limited acceptable daily intake, are low-cost, easy to manipulate, and effect minor sensory changes on the product. For example, an application of 2% acetic acid reduced the incidence of *Salmonella* on pork cheek meat in addition to significantly reducing aerobic plate and coliform counts (Frederick et al. 1994) More than one treatment was found to sometimes help on the bacterial reduction and produces lesser effects on food quality. Also, poultry scald water containing 0.1% acetic acid at 52 C decreased levels of *S.* Typhimurium and *Campylobacter jejuni (Okrend et al. 1986).* However, it is important to use these acids according to good manufacture practices to avoid the development of *Salmonella* strains resistant to acidic conditions.

Lactic acid, produced from fermentation, is currently listed on the National List (7 CFR 205.605(a)) as a non-synthetic material with no restrictions on use and is established as GRAS for using lactic acid as an antimicrobial agent as defined in 21 CFR 170.3(o)(2). The use of lactic acid as an antimicrobial agent is limited to meat products. Lactic acid has been found to be more effective than chlorine treatments of raw meat in poultry processing facilities (Killinger et al. 2010). The acidic nature imparts a mellow and lasting sourness to many products including confectionery.

However, on the National List, there are some synthetic substances allowed as disinfectants and sanitizers for use on food contact surfaces. These are listed under the 7 CFR 205.605 which delineates the nonagricultural (nonorganic) substances that may be used as ingredients in or on processed products that are listed as "organic" or as "made with organic [ingredients or food groups]."

For example, peracetic acid can be substituted for SDC (7 CFR 205.605(b)). Peracetic acid is a mixture of acetic acid and hydrogen peroxide. It is a very strong oxidizing agent and has a strong pungent acetic acid odor. The primary mode of action is oxidation, which differs from SDC. In addition, peracetic acid is considered environmentally safe. Acidified sodium chlorite (using citric acid) and chlorine dioxide, which have the same mode of action as peracetic acid, can also substitute for SDC. (See the NOP petitioned substances database.)

However, bacterial resistance to traditional agricultural biocides is of growing concern (SCENIHR 2010). A number of gram-positive, vegetative bacteria have been isolated from equipment that used chlorine dioxide for high-level disinfection, and several strains, *Bacillus subtilis* and *Micrococcus luteus, showed stable high-level resistance to the standard use concentration of chlorine dioxide* (Martin et al. 2008). The *Bacillus* isolate was also cross-resistant to hydrogen peroxide (7.5%) (Martin et al. 2008). Such reports of bacterial resistance have not been reported for the petitioned substance.

The United States Food and Drug Administration (FDA) regulations allow a number of uses for ethanol in food preparation/storage for humans and animals. For humans, FDA considers ethanol to be "Generally Recognized As Safe" (GRAS) when added directly to human food (21 CFR 184.1293). Ethanol is an approved synthetic substance on the National List for organic livestock production as a disinfectant and sanitizer only (7 CFR 205.603). In addition, ethanol is an approved synthetic substance on the National List for organic crop production when used as an algicide, disinfectant, and sanitizer, including the cleaning of irrigation systems (7 CFR 205.601). Alcohols, including ethanol and isopropanol, are capable of providing rapid broad-spectrum antimicrobial activity against vegetative bacteria, viruses and fungi, but lack activity against bacterial spores (McDonnell and Russell 1999). The antimicrobial action of ethanol is due to rapid denaturation of proteins. A study found that a 7% ethanol solution prevented the growth of four common foodborne microorganisms: Listeria monocytogenes, Salmonella typhimurium, Staphylococcus aureus and Escherichia coli O157:H7 (Ahn et al. 1999), however, the CDC recommends against the use of ethanol or isopropanol as the principal sterilizing agent because these alcohols are insufficiently sporicidal (i.e., spore killing) and cannot penetrate protein-rich materials (CDC 2008). Other shortcomings of ethanol are that it can damage rubber and plastic tubing after prolonged use, is highly flammable and must be stored in cool, well-ventilated areas, and evaporates quickly due to its high volatility, which makes extended exposure time difficult to achieve (CDC 2008)

There are no literature reports to our knowledge that directly compare the efficacy of SDC to that of other organically allowed synthetic substances (e.g., chlorine dioxide, acidified sodium chlorite, ozone, etc.). One important distinction of SDC from these common synthetic substances for disinfection of food and food contact surfaces is the action of the substance. Most of the common synthetic substances are strong oxidizers; thus their antimicrobial efficacy generally increase with oxidation potential (i.e., chlorine dioxide < acidified sodium chlorite < ozone). The efficacy of SDC arises from it proceeding from a different mechanism of action, interference with cellular processes. In a closely related study, the antimicrobial effects of chlorine (Cl2), an oxidizer, and Ag+ ions on bacterial biofilms were compared (Kim et al. 2008). The antimicrobial activities on biofilm cells were investigated by three methods, each of which used a different analytical principle for the determination of antimicrobial activity. The study found that the resistance of the biofilm cells to the oxidant, chlorine, was increased almost 250 times compared with the resistance to the Ag+ ion. Thus, due to the different mode of action, Ag+ ions and SDC, in particular, represent a viable alternative for eliminating pathogenic bacteria that demonstrate resistance to common oxidizing antibacterial agents.

In summary, there is no literature that directly compares SDC to other organically allowed synthetic substances. Acetic and Lactic acid were effective in meat environments but lactic acid is solely limited to this manufacturing environment. There are concerns of acid resistant salmonella in certain manufacturing conditions. Chlorine, Peracetic acid and acidified sodium chlorite are effective oxidative alternatives, however there is a growing concern over resistance of bacteria to oxidative reactions. While ethanol and isopropanol are effective against some pathogens they are not effective against bacterial spores – and are not recommended by the CDC as principle sanitizing agents. SDC works using an alternative mode of action to oxidation antibacterial agents – silver compounds so far have not experienced the growing resistance to treatment as seen with oxidation antibacterial agents.

2. **For Livestock substances, and Nonsynthetic substances used in Handling**: In balancing the responses to the criteria above, is the substance compatible with a system of sustainable agriculture? [§6518(m)(7)]

   N/A

Category 4: Additional criteria for synthetic substances used in Handling (does not apply to nonsynthetic or agricultural substances used in organic handling):

Describe how the petitioned substance meets or fails to meet each numbered criterion.

1. The substance cannot be produced from a natural source and there are no organic substitutes; (§205.600(b)(1))

   The substance cannot be produced from natural sources. See Category 1 question 2. Alternatives Substances are discussed in Category 3 Question 1.

   The Technical report discusses other alternative practices as follows:
   While agricultural and/or natural antimicrobials may be effective in one way, they may be ineffective in another and do not possess broad spectrum antimicrobial properties (Sebranek and Bacus 2007). This stresses the necessity of further research in order to ensure that the food safety of these materials is properly assessed. While current research suggests that natural plant extracts can be effective in controlling pathogens in meat products, the most favorable results tend to result from multiple-barrier food preservation systems, which use combinations of agricultural and/or natural antimicrobials and sodium or potassium lactate (or other synthetic

antimicrobial ingredients). However, decreasing the shelf life of a product to accommodate the strict use of natural antimicrobials is another option. A survey of organic agricultural antimicrobials is discussed below.

The USDA organic regulations do not permit the addition of nitrite to organic processed meat. Alternative methods like the use of celery powder, which is listed at 7 CFR Part 205.606 and allowed for use in products labeled as "Organic" only when an organic form is not commercially available, are commonly used in meat products. Trials studying natural antimicrobials for the inhibition of *Listeria monocytogenes* on naturally cured frankfurters have been conducted (Xi et al. 2013). Using celery powder containing 12,000 ppm of nitrite, the concentration of nitrite (when the celery powder was used at 0.4% of the frankfurter formulation) resulted in 48 ppm of nitrite added to the frankfurter mixture. In a conventional curing process, 156 ppm of nitrite is added. The research found that the celery powder achieved the expected color, flavor and other properties of cured meats, but it resulted in lower nitrite levels than occurred with the use of synthetic preservatives.

In the same study by Iowa State University in 2013, powdered concentrates from cranberries, cherries, limes and a blend of cherry, lime and vinegar were evaluated alone and in various combinations for antimicrobial impact on the growth of *L. monocytogenes* in naturally cured frankfurters (Xi et al. 2013). The results showed that cranberry powder at 3% of the formulation, combined with celery powder, achieved inhibition of *L. monocytogenes* following the inoculation of naturally cured frankfurters that was equivalent to that of conventionally cured frankfurters during 49 days of refrigerated storage. Cranberry powder at 1% and 2% in combination with other natural antimicrobials inhibited growth for up to 35 days, while the naturally cured frankfurters without additional antimicrobial ingredients showed growth after 28 days. However, quality assessment of the products showed that 3% cranberry powder was detrimental to the color and sensory and textural attributes of the frankfurters, possibly due to the acidic nature of the cranberry concentrate. It was concluded that, while cranberry concentrate has potential as a natural antimicrobial, it is necessary to develop a means of compensating for the acidic nature of this ingredient to achieve practical applications in organic cured meat products. In addition, for the meat to maintain its organic status, the cranberry powder would also need to be a certified organic ingredient and, per the requirements of 7 CFR 205.606, attempts would need to be made to source organic celery powder.

The effectiveness of essential oils in controlling *L. monocytogenes* has also been investigated (Campos et al. 2011). The results of the study were promising; however, in many instances, combinations of additives or preservative treatments worked best because the efficacy of the antimicrobials can be influenced by the chemical composition and the physical conditions of various foods. Essential oils (EOs) are oily liquid mixes of volatile and complex compounds that are extracted from different parts of aromatic plants. They are synthesized by plants as secondary metabolites and can be obtained mainly by steam distillation or super critical fluid extraction. Essential oils can contain 20-60 components, depending on the material they come from and the extraction method used. Terpenes and terpenoids make up the constitute majority of the components with the remainder consisting of aromatic and aliphatic compounds of low molecular weight.

Essential oil efficacy against Listeria growth in laboratory media was highly variable (Campos et al. 2011). EOs of bay, coriander, cinnamon, clove, licorice, nutmeg, pepper, oregano, winter savory, spruce and thyme showed the highest inhibitory activity. The effectiveness of oils of basil, lemon balm, marjoram, mastic tree, rosemary and sage were lower than those mentioned above, whereas Listeria showed high resistance to EOs of aniseed, caraway, fennel, garlic, ginger, onion and parsley.

According to the research, the antimicrobial activity of EOs is largely dependent on their composition; however, the mechanism of antimicrobial action of EOs is not well understood. Inhibitory actions are mostly related to the identity of the majority terpenes and terpenoid components, but the minor components have a strong influence on the effectiveness of their antimicrobial action. The main components often consist of: carvacrol, thymol, linalool, eugenol, trans-cinnamaldehyde, p-cymene, 1,8-cineole (eucalyptol) and γ-terpinene, and the research suggests that several components of EOs are involved in the fixation on cell walls and cellular distribution. It's reported that EO components may degrade the cell wall, damage the cytoplasmic membrane and proteins of the membrane, leak vital intracellular compounds, coagulate cytoplasm and deplete the proton motive force, and that EOs also interact with one another, potentially leading to synergistic antimicrobial effects between various oils (Campos et al. 2011). For example, the growth of *L. monocytogenes* was suppressed in laboratory media more when a combination of oils was used (oils of oregano and rosemary; oils of basil, rosemary or sage; and oils of rosemary and licorice) than when these oils were used alone.

Further results in various samples suggested that EOs have lower activity in foods with high fat content. This may be due to: (i) EO dissolution in the lipid fraction of the food, decreasing the concentration in the aqueous phase, together with antimicrobial action; (ii) the reduced water content in foods, particularly in fatty foods, in relation to culture media, which may slow down the movement of the preservative to the active site in the microbial cell; and (iii) the presence of fat in the food which may produce a protective layer around the bacteria (Campos et al. 2011).

Storage temperature, pH, physical structure of food, fat, protein, sugar content, and sensory properties all need to be considered when deciding whether EOs will be affective for controlling pathogens. It was reported that chicken frankfurters treated with 2% v/w of clove oil were unacceptable to the consumer, whereas samples with 1% were accepted. The latter level had effective antilisterial activity in the food. It was found that combining EOs would allow the use of lower levels to reduce Listeria growth, minimizing the unacceptable sensory changes in the food. Indirect uses of EOs, for example in water to wash vegetables similar to the use of chlorine, or in the impregnation of porous surface of wood in cheese ripening to improve sanitary safety, are also being considered. (TR 470-552)

2. The substance's manufacture, use, and disposal do not have adverse effects on the environment and are done in a manner compatible with organic handling; (§205.600(b)(2))

   Refer to Question 3 of Category 2.

3. The substance's primary use is not as a preservative or to recreate or improve flavors, colors, textures, or nutritive value lost during processing, except where the replacement of nutrients is required by law; (§205.600(b)(4))

   According to the technical report: "There is no information to suggest that silver dihydrogen citrate is used to recreate or improve flavors, colors, textures, or nutritive values lost in the processing of agricultural products. The petition requests to permit the use of SDC solutions as a processing aid in the wash and/or rinse water for direct and indirect food contact. (TR 290-293)"

4. The substance is listed as generally recognized as safe (GRAS) by the Food and Drug Administration (FDA) when used in accordance with FDA's good manufacturing practices (GMP) and contains no residues of heavy metals or other contaminants in excess of tolerances set by FDA; (§205.600(b)(5))

   According to the technical report, silver dihydrogen citrate is not categorized as generally recognized as safe (GRAS). The USDA Food Safety Inspection Service has reviewed and approved silver dihydrogen citrate for use as a food contact substance in applications for treating poultry (FCN 1569 and FCN 1768) and fruits and vegetables (FCN 1600). The substance has been reviewed and approved by the EPA for use as an antimicrobial, disinfectant, fungicide, and virucide, and food contact surface sanitizer (EPA Registration Nos. 72977-1, 72977-3, 72977-4, 72977-5, and 72977-6). The substance is the subject of an exemption from tolerance for residues of silver in foods from food contact surface and processing equipment sanitizing applications (40 CFR 180.950).

   Silver dihydrogen citrate has been certified by NSF International, an independent public health and safety organization, for use as a sanitizer on all surfaces and as not always requiring a rinse in and around food processing areas (NSF Registration No. 144518).

   The petitioned substance has been added to the list of Safe and Suitable Ingredients Used in the Production of Meat, Poultry, and Egg Products by the USDA (FSIS Directive 7120.1 Rev. 42).

   Citric acid is affirmed by the FDA (21 CFR 184.1033) as generally recognized as safe (GRAS) and may be used with no limitations other than good manufacturing practice. Sodium lauryl sulfate can be introduced intentionally during manufacturing to act as a solution stabilizer and is permitted for direct addition to food for human consumption by the FDA (21 CFR 172.822). (TR 254-272)

5. The substance is essential for the handling of organically produced agricultural products. (§205.600(b)(6))
   The decision here is to balance the environmental and human health impacts from this substances against the food safety benefits considering the alternatives. Overall the environmental and human health risks seem low and with a growing level of resistance to current antibacterial agents on this list, appear to offer unique and necessary food safety attributes. So far, no input has been received from industry on the need or non-need for this substance.

   Concerns have been raised about nanoparticles and this substance. The petitioner states "the product does not contain nano silver (Petition page 7). Additionally the technical review notes that nanoparticles could augment the efficacy of the SDC by increasing the concentration of silver – but that nanoparticles are not necessary for SDC as petitioned to be effective and alternative ways exist to increase silver concentration. (TR 109-121).

6. In balancing the responses to the criteria in Categories 2, 3 and 4, is the substance compatible with a system of sustainable agriculture [§6518(m)(7)] and compatible with organic handling? (see NOSB Recommendation, Compatibility with Organic Production and Handling, April 2004)

   There is little risk with regard to environmental and human health concerns. If nano-particles are prohibited then compatibility with organic systems is also not a concern. The question arises around the essentiality of this substance in light of alternative options and if there is a sufficient need demonstrated for this substance by industry.

Category 5: Additional criteria for <u>agricultural</u> substances used in handling (review of commercial unavailability of organic sources):

This section is not applicable

1. Is the comparative description as to why the non-organic form of the material /substance is necessary for use in organic handling provided?

   This section is not applicable

   Does the current and historical industry information, research, or evidence provided explain how or why the material /substance cannot be obtained organically in the appropriate **<u>form</u>** to fulfill an essential function in a system of organic handling?

   This section is not applicable

2. Does the current and historical industry information, research, or evidence provided explain how or why the material /substance cannot be obtained organically in the appropriate **<u>quality</u>** to fulfill an essential function in a system of organic handling?

   This section is not applicable

3. Does the current and historical industry information, research, or evidence provided explain how or why the material /substance cannot be obtained organically in the appropriate **<u>quantity</u>** to fulfill an essential function in a system of organic handling?

   This section is not applicable

4. Does the industry information about unavailability include (but is not limited to) the following?: Regions of production (including factors such as climate and number of regions);
   This section is not applicable

   a. Number of suppliers and amount produced;

   b. Current and historical supplies related to weather events such as hurricanes, floods, and droughts that may temporarily halt production or destroy crops or supplies;

   c. Trade-related issues such as evidence of hoarding, war, trade barriers, or civil unrest that may temporarily restrict supplies; or

   d. Other issues which may present a challenge to a consistent supply?

5. In balancing the responses to the criteria in Categories 2, 3 and 5, is the substance compatible with a system of sustainable agriculture [§6518(m)(7)] and compatible with organic handling? (see NOSB Recommendation, Compatibility with Organic Production and Handling, April 2004)

   This section is not applicable

Classification Motion:

Motion to classify silver dihydrogen citrate as synthetic
Motion by: Tom Chapman
Seconded by: Lisa de Lima
Yes: 5 No: 0 Abstain: 0 Absent: 2 Recuse: 0

National List Motion:

Motion to add silver dihydrogen citrate, limited to particles sizes greater than 300nm, at §205.605(b)
Motion by: Tom Chapman
Seconded by: Steve Ela
Yes: 5 No: 0 Abstain: 0 Absent: 2 Recuse: 0

Approved by Lisa de Lima, Subcommittee Chair, to transmit to NOSB, August 24, 2018