United States Department of Agriculture
Agricultural Marketing Service | National Organic Program
Document Cover Sheet
https://www.ams.usda.gov/rules-regulations/organic/petitioned-substances

Document Type:

☐ **National List Petition or Petition Update**

A petition is a request to amend the USDA National Organic Program's National List of Allowed and Prohibited Substances (National List).

Any person may submit a petition to have a substance evaluated by the National Organic Standards Board (7 CFR 205.607(a)).

Guidelines for submitting a petition are available in the NOP Handbook as NOP 3011, National List Petition Guidelines.

Petitions are posted for the public on the NOP website for Petitioned Substances.

☒ **Technical Report**

A technical report is developed in response to a petition to amend the National List. Reports are also developed to assist in the review of substances that are already on the National List.

Technical reports are completed by third-party contractors and are available to the public on the NOP website for Petitioned Substances.

Contractor names and dates completed are available in the report.

Flavors

Handling/Processing

Identification of Petitioned Substance

Chemical Names:
See *Appendix A* - Natural Flavor Additives

Other Names:
See *Appendix A* - Natural Flavor Additives

Trade Names:
See *Appendix B* - Suppliers of Organic Flavors for a list of handlers identified as selling certified organic flavors.

CAS Numbers:
See *Appendix A* - Natural Flavor Additives. FDA ID codes are included in lieu of CAS Numbers where CAS numbers not assigned by the Chemical Abstract Service.

Other Codes:
See *Appendix A* - Natural Flavor Additives for FEMA Codes.

Summary of Petitioned Use

The National Organic Standards Board (NOSB) has requested a limited scope technical report on flavors as part of its obligation to conduct a sunset review of all substances on the National List of Allowed and Prohibited Substances (National List) portion of the USDA organic regulations every five years [7 U.S.C. 6517(e)].

This limited scope technical report supplies responses to the following focus questions from the NOSB:

1) What flavors are available in organic form?

2) What flavors could be certified organic based on their source and manufacturing process, but are not?

3) What flavors cannot be certified organic based on their source and manufacturing?

In addition, this report includes information about the composition, sources, and manufacturing processes of flavors. Information regarding the international allowances in organic and conventional product formulations is also included.

Flavors appear on the National List for use as nonagricultural nonsynthetic ingredients in processed organic products subject to the following annotation: "Flavors - nonsynthetic flavors may be used when organic flavors are not commercially available. All flavors must be derived from organic or nonsynthetic sources only and must not be produced using synthetic solvents and carrier systems or any artificial preservative" [7 CFR 205.605(a)].

Flavors were one of the substances petitioned for consideration by the NOSB in the original National List. On October 31, 1995, the NOSB (1995) recommended the following for flavors:

> *"Upon implementation, all manufacturers will be required to have certification from the producers of natural flavors that,*
>
> ***For "organic food" (95%-100% organic ingredients):***
> *1) All of the flavor constituents used in the natural flavor are from natural sources and have not been chemically modified in a way which makes them different than their natural chemical state.*
> *2) The natural flavor has not been produced using any synthetic solvents and carrier systems or any artificial preservatives.*

For "foods made with organic ingredients" (50%-95% organic ingredients):

1) *All of the flavor constituents used in the natural flavor are from natural sources and have not been chemically modified in a way which makes them different than their natural chemical state.*
2) *The natural flavor does not contain propylene glycol, any artificial preservatives, and is not extracted with hexane.*

Additionally, manufacturers shall provide written documentation in their Organic Handling Plan showing efforts made toward the ultimate production of an organic natural flavor as listed in the stepwise progression below:

Natural flavor constituents and non-synthetic carrier base and preservative agents (ex. grain ethanol, non-synthetic glycerin and non-synthetic acetic acid).

Organic flavor constituents, organic carrier base, and organic preservative agents.

Organic flavor constituents extracted using organically produced solvents, organic carrier base, and organic preservative agents."

The USDA National Organic Program (NOP) placed "Flavors" on the original National List on December 21, 2000, with the following annotation: "nonsynthetic sources only and must not be produced using synthetic solvents and carrier systems or any artificial preservative" [65 FR 80547]. Flavors meeting the annotation were classified as nonagricultural and nonsynthetic on 7 CFR 205.605(a). The NOSB's recommendation of the stepwise progression to develop organic flavors was not included in the final regulation. On November 6, 2014, the NOP received a petition to amend the National List annotation to require the use of organic flavors when commercially available (OTA, 2014). On October 29, 2015, the NOSB recommended amending the annotation in response to the petition (NOSB, 2015). The NOP acted on that recommendation, ultimately revising the National List annotation for flavors on January 28, 2019 [83 FR 66779].

Characterization of Petitioned Substance

Composition of the Substance:

Foods are complex matrices composed of hundreds of chemical constituents. There are many definitions of what constitutes a "flavor" but one comprehensive description is given in a standard flavor reference (Burdock, 2016):

> *"Flavor is the sum of those characteristics of any material taken in the mouth, perceived principally by the sense of taste and smell, and also the general pain and tactile receptors in the mouth, as received and interpreted by the brain."*

Those constituents impart such sensory qualities that are referred to as "flavors," which in turn will have different legal definitions depending on the jurisdiction. The legal status of flavors is further discussed in the *Approved Legal Uses of the Substance* section below. Food science and flavor textbooks divide tastes into five basic flavors: bitter, sour, sweet, salty, and savory or umami (Attokaran, 2017; DeMan et al., 2018; Lindsay, 2007; Potter & Hotchkiss, 1998). Earlier guides listed only four flavors, excluding umami (Walter, 1916). The historical introduction of umami or savory flavors to the North American palate has been the subject of study (Tracy, 2016).

Flavor is highly subjective and difficult to measure (Drew, 1994; Potter & Hotchkiss, 1998; Shepherd, 2005). The olfactory senses of smell and taste are regarded as the most primitive in human cognition (Shepherd, 2005). Individuals subjectively perceive various combinations of these five basic flavors

differently for complex reasons. Those factors are all subjects of ongoing research in food chemistry, psychology, physiology, and anthropology. The perception of flavor by an eater will depend on several different factors including, but not limited to, the chemical composition of the food (Attokaran, 2017; Auvray & Spence, 2008). Cultural and psychological factors are as much the basis for flavor preferences as chemical sensory stimulation and physical gratification (Al Saqqa, 2022; Downey & Eiserle, 1970; Myers & Sclafani, 2006).

The ability to detect and identify specific chemical substances played a role for evolutionary selection. Studies have shown that flavor is the most fundamental determinant of food preferences, acceptance, and rejection (Baeyens et al., 2001; De Houwer et al., 2001; Myers & Sclafani, 2006; Papies et al., 2022).

Different flavors and other olfactory sensations are culturally and psychologically associated with different foods and non-food substances (Al Saqqa, 2022; Baeyens et al., 2001; Downey & Eiserle, 1970; Myers & Sclafani, 2006; Papies et al., 2022). The perception of flavor is also linked to the other senses, such as feel or texture, sight or color, and sound of the food as it is being prepared or consumed (Attokaran, 2017; Auvray & Spence, 2008; B. Smith, 2012). As such, flavor composition can be viewed from a reductionist perspective of isolating and optimizing individual flavoring substances through analytical and extraction methods. On the other hand, from a holistic perspective, flavor composition is more than a collection of chemicals in a food or ingredient. The identification and naming of substances responsible for different attributes found in foods is confounded by the interactions between different chemical components in the food. The same flavor component may be present in a wide variety of foods, but will have different sensory qualities in each of those foods (Chambers & Koppel, 2013).

Over 3,000 different flavor ingredients are used in food (IOFI, 2022; U.S. FDA, 2022). These may be characterized as individual molecular substances obtained from precursors extracted from agricultural sources, or as concentrated foods. Individual flavors can range from simple single ingredients to formulations that are often chemically complex. The International Organization of the Flavor Industry (IOFI) identifies over 600 source materials or naturally complex substances used for flavoring (IOFI, 2022). Some complex flavorings may have over 100 different identifiable individual substances contained within them (J. B. Hallagan et al., 2020; Somogyi, 2000). Their compositions vary widely depending on their types, origins, precursors, extraction methods, and adjuncts.

The growth of the flavor industry in the second half of the 20th century was driven by several technological advances (Berenstein, 2018). One was the advance in analytical chemistry. Isolating specific flavor chemicals using the techniques available in the 1940s often took very large sample sizes of plant sources (Haagen-Smit, 1949). The ability to identify specific substances that account for flavor is a relatively recent development in food science, going back to the late 1950s with the advent of technology involving gas chromatography and fast-scan mass spectrometry (Lindsay, 2007). These analytical methods allowed for a more efficient and precise identification of specific flavor agents. The rapid advances in the 1960s and 1970s made food scientists hopeful that they would be able to identify, isolate, and extract pure aromas and flavors, despite apparent limitations (Teranishi et al., 1967). Analytical chemistry is now capable of the identification of specific substances that can change a flavor profile at concentrations down to parts per trillion (ppt or 10^{-12}) (Lindsay, 2007).

Source or Origin of the Substance:

Natural flavors can come from a wide variety of sources. The oldest sources are from wild plants and animals. There is evidence that herbs and spices were wild crafted before being cultivated. Flavors can be extracted from wild-crafted plants, moss, algae, fungi, or lichens, as well as animals. Some naturally-occurring algae are potential sources of flavoring compounds (Francezon et al., 2021). Lichens have been used as ingredients in traditional ayurvedic medicines for centuries, and have recently found markets as fragrances and flavors (Upreti et al., 2005). These species also may be either wild-harvested or cultivated.

Most commercial sources of natural flavors originate from agriculturally produced crops and livestock. Food consisted almost entirely of agricultural or wild-harvested ingredients prior to the industrial revolution of the 19th century. The flavor manufacturing industry emerged as a separate entity in food production about 150 years ago. Glucovanillin (imitation vanilla flavor) was first synthesized from coniferin, giving birth to the flavor industry (Guentert, 2007; Haarmann, 1884). Other flavors and fragrances were chemically isolated and synthesized not long afterwards. Some flavors may have natural precursors but are the products of chemical synthesis (van der Schaft, 2007). Flavors that are synthesized but have a molecular structure that is analytically the same as their natural analogs are called "nature identical" in some jurisdictions (Müller, 2007; Somogyi, 2000). The term is not legally recognized in the U.S. by the FDA, and European legislation removed recognition in 2010 [EC 1334/2008]. The term "nature identical" still appears in the Codex Guidelines on food labeling as a valid claim (FAO/WHO Joint Standards Programme, 2018) and may be recognized in jurisdictions outside of North America and Europe.

As methods to identify flavor chemicals improved, the processing methods to extract the identified substances from natural sources evolved. Research and development also resulted in synthesis processes using novel precursors that were intended to replicate the structures and performance of natural flavor analogs. These synthetic chemicals were often chemically identical to their natural analogs, and may have a higher concentration, but were still seen as "impure" compared to the botanical sources. As the flavor industry grew and new synthetic products were introduced, the classifications of flavors as "natural" or "artificial" were often arbitrary and not always consistent (Berenstein, 2018). The term "semi-synthetic" was sometimes used to describe substances synthesized from natural origins (Jacobs, 1947). However, the term is rarely used in the current literature and has lost its original meaning.

From its very beginning, the flavor industry had to balance consumer expectations to make food with familiar flavors derived from natural sources with food consistently produced at a reasonable cost (Jacobs, 1947). The USDA organic regulations reflect the consumer preference for organic and natural sources of ingredients. The demand for organic food took the food and flavor industries to a new level in a search for organic flavors. A review of the literature indicates that those who buy organic food may have a different set of quality preferences from other consumers, with flavor differences being one of the main qualities identified (Schleenbecker & Hamm, 2013). A review of consumer demand for foods labeled "100% organic" or that do not contain nonorganic flavors is beyond the scope of this limited scope technical report.

Certified organic flavors are a relatively recent phenomenon. Flavors sold as "100% organic" consist entirely of organic agricultural ingredients, excluding water and salt [7 CFR 205.301(a)].[1] Flavors labeled as "organic" must contain a minimum of 95% organic ingredients, excluding water and salt, and may contain up to 5% nonorganic ingredients [§ 205.301(b)].[2] The nonorganic ingredients used in an organic flavor may include natural flavors that are not organic [§§ 205.301(b) and 205.605(a)].[3] Certified organic flavors that have flavoring agents other than those claimed on the label may be labeled as "[specific flavor] type. WONF" (With Other Natural Flavors) [21 CFR 101.22(i)(1)(iii)].

Following the lawsuit, *Harvey v. Veneman* [396 F.3d 28 (1st Cir. 2005)], the deciding judge ordered the USDA to clarify that the commercial unavailability of organic ingredients did not create a blanket exemption allowing the use of nonorganic ingredients. The USDA issued that clarification on July 1, 2005 [20 FR 38090]. Certified organic handlers and their certification agents who had misinterpreted the regulations were given until June 9, 2007—two years from the date of the judge's order—to comply. The court also required USDA to notify the public that all agricultural ingredients used in processed products labeled as "organic" must be either organically produced or to appear on the National List of allowed nonorganic ingredients, not to exceed the total amount by weight, net of water and salt. On

[1] § 205.301 Product composition. (a) *Products sold, labeled, or represented as "100 percent organic."*
[2] § 205.301 Product composition. (b) *Products sold, labeled, or represented as "organic."*
[3] § 205.605 Nonagricultural (nonorganic) substances allowed as ingredients in or on processed products labeled as "organic" or "made with organic (specified ingredients or food group(s))." (a) *Nonsynthetics allowed.*

June 7, 2006, the USDA revised the regulations based on the court order to reflect this clarification [71 FR 32803].

In that same clarification, the USDA initiated an emergency petition procedure to add agricultural substances that had been approved by certifying agents for use in organic processed products but did not appear on 7 CFR 205.606.[4] In response, various entities filed over 50 petitions for agricultural items deemed necessary by the petitioners to be added to the National List. The NOSB began their consideration of these materials at the March 2007 meeting [72 FR 10971]. Several agricultural sources of flavors were petitioned, including a petition for "spices, dried" (Kopral & Twieg, 2006). The NOSB recommended some—specifically celery powder, dillweed oil, frozen galangal, hops, frozen lemongrass, chipotle chili peppers, and Turkish bay leaves—to be added to the National List. These substances were added to § 205.606 of the National List on June 27, 2007 [72 FR 35137]. The NOSB did not recommend Poblano peppers, red peppers, or spices (NOSB, 2007). Some agricultural ingredients that serve as flavorings were added as "colors," including saffron, paprika, blueberry, cherry, and turmeric [72 FR 35137].

The NOSB heard testimony at the March 2007 meeting as to whether flavors as a group or individual flavors would be more appropriate for addition to § 205.606 and subject to commercial availability, or if they should otherwise remain on § 205.605. However, the NOSB made no recommendation at that meeting to reclassify flavors as agricultural. Several members of the NOSB stated the opinion that individual agricultural flavors needed to be petitioned to be used from nonorganic agricultural sources in organic processed products (NOSB, 2007). Thus, there appeared to be a consensus that herbs, spices, cultivated plants, and food animals were agricultural.

Table 1 provides a summary of the organic status of various conceptual sources, origins, production, and processing methods of flavor ingredients based on NOP and FDA regulations. Sources can be agricultural or nonagricultural. Production, handling, and processing methods can either comply with the organic regulations or be noncompliant. The final products may be either synthetic or nonsynthetic. Finally, there are methods that are excluded from all organic claims that need to be considered. These combinations of conditions result in four different cases to be considered when evaluating flavor ingredients for use in organic processed products. At one end, flavors that are 100% organic allow for final food products to be labeled as 100% organic. At the other end, excluded flavoring agents prevent processed products from making any organic claim, regardless of the percentage of organic content. The cases presented may not reflect how certifying agents make actual certification decisions for specific flavors or products. This technical report discusses certification best practices and how certifying agents classify ingredients in section *Responses to NOSB Focus Questions*.

Table 1: Flavor Ingredients in Organic Processed Products by Sources and Processing Methods

Case # and Source / Origin	Processing Methods	Organic Status
1. Organic crops and livestock	Processed compliant with organic handling standards (Extracted, isolated, and formulated using methods listed on 7 CFR 205.270—i.e., mechanical or biological methods; not combined/treated with volatile synthetic solvents, processing aids or ingredients not on § 205.605.). Produced and handled without excluded methods or ionizing radiation.	• Organic agricultural. • Allowed in processed products labeled "Organic" or "Made with Organic [specific ingredient(s)]."

[4] § 205.606 Nonorganically produced agricultural products allowed as ingredients in or on processed products labeled as "organic."

Case # and Source / Origin	Processing Methods	Organic Status
2. Nonorganic crops and livestock	Processed compliant with organic handling standards (Extracted, isolated, and formulated using methods listed on 7 CFR 205.270—i.e., mechanical or biological methods; not combined/treated with volatile synthetic solvents, processing aids or ingredients not on § 205.605.). Produced and handled without excluded methods or ionizing radiation. Produced and handled without excluded methods, ionizing radiation or sewage sludge.	• Nonorganic agricultural; Nonsynthetic. • Allowed in processed products labeled "Organic" if on § 205.606 and not commercially available as organic, or in products labeled "Made with Organic [specific ingredient(s)]."
3. Nonagricultural source	Processed compliant with organic handling standards (Extracted, isolated, and formulated using methods listed on 7 CFR 205.270—i.e., mechanical or biological methods; not combined/treated with volatile synthetic solvents, processing aids or ingredients not on § 205.605). Produced and handled without excluded methods or ionizing radiation.	• • Nonagricultural; Nonsynthetic. • Allowed as a flavor in processed products labeled "Organic" if an organic source is not commercially available, or in products labeled "Made with Organic [specific ingredient(s)]."
4. All sources, precursors and derivatives, including organic agricultural ingredients	Processed not compliant with organic handling standards. Extracted, isolated, and formulated using methods not listed on 7 CFR 205.270, combined/treated with volatile synthetic solvents, or made with processing aids or ingredients not on § 205.605. . Specifically, handled not consistent with the annotation at § 205.605(a), or declared "synthetic" by the FDA at 21 CFR 172.515 or § 182.60. Produced and handled using excluded methods, ionizing radiation or sewage sludge.	• Nonagricultural; Synthetic. • Prohibited for use as an ingredient in processed products labeled "Organic" and "Made with Organic" [specific ingredients(s)].

Sources: 7 CFR 205; 21 CFR 182.

A growing number of compounds previously derived from wild sources are being produced synthetically or through the fermentation of genetically modified microorganisms. Developments in biotechnology have enabled aroma and flavor chemicals previously limited to a small number of organisms to be expressed by a wide range of organisms through genetic engineering (R. G. Berger, 2009; Y. H. Hui et al., 2010). The FDA has declined to address the identification and labeling of flavors obtained from genetically modified sources (Hallagan, 2017). Most of these sources would be considered excluded from organic production and handling by the excluded methods prohibition at § 205.105(e). Individual cases are explored further in *Evaluation Question* #2.

Flavors are also derived from animals as both slaughter and non-slaughter products. Various dairy-based flavorings are prepared from milk, which may come from cows, sheep, goats, buffalo, or other mammals. Egg derivatives may be used as flavoring agents as well.

Historically, some animals were hunted, caught, or trapped for their fragrances and flavors. Musk deer (*Moschus moschiferus*) and sperm whales are now protected species, and the muscone and ambergris respectively harvested from them have not been commercially available in any form for many years (Frey, 2005). Archeological evidence shows that First Nations people of Canada used castoreum from

beavers in pre-Columbian America (Helwig et al., 2021). Castoreum from beavers remains one of the few wild-animal derived substances that is GRAS and still used as a flavoring agent (Burdock, 2007).

Two flavoring substances may have identical molecular formulas, but have different molecular structures, known as isomers (Guentert, 2007). The standard textbook example is limonene, with a molecular formula of $C_{10}H_{16}$, but with two isomers or enantiomers. D-limonene, also known (R)-(+)-limonene is the primary isomer extracted from citrus fruit. The L-limonene, otherwise known as (S)-(-)-limonene, is largely absent from citrus fruit but found in other plant sources. Textbooks often claim that one smells like lemons and the other smells like oranges, but recent empirical research showed that this is not the case (Kvittingen et al., 2021).

Approved Legal Uses of the Substance:

Flavors and flavoring agents are regulated by the Food and Drug Administration (FDA) under the authority given to them by the Food, Drug, and Cosmetic Act as amended. Most of the flavors within the scope of this review would fall into the category of "natural flavors" or "natural flavorings" as defined by the FDA:

> *"The term natural flavor or natural flavoring means the essential oil, oleoresin, essence or extractive, protein hydrolysate, distillate, or any product of roasting, heating or enzymolysis, which contains the flavoring constituents derived from a spice, fruit or fruit juice, vegetable or vegetable juice, edible yeast, herb, bark, bud, root, leaf or similar plant material, meat, seafood, poultry, eggs, dairy products, or fermentation products thereof, whose significant function in food is flavoring rather than nutritional. Natural flavors include the natural essence or extractives obtained from plants listed in §§ 182.10, 182.20, 182.40, and 182.50 and part 184 of this chapter, and the substances listed in § 172.510 of this chapter."* [21 CFR 101.22(a)(3)]

Appendix A - Natural Flavor Additives includes the list of ingredients that are included in that regulatory definition derived from the FDA's database "Substances in Food," formerly "Everything Allowed in Food in the U.S. (EAFUS)." This report does not claim *Appendix A* to be an exhaustive list. The Flavor and Extract Manufacturers Association (FEMA) and IOFI lists have substances included that do not meet those criteria.

By contrast, FDA defines artificial flavors and artificial flavorings as follows:

> *"The term artificial flavor or artificial flavoring means any substance, the function of which is to impart flavor, which is not derived from a spice, fruit or fruit juice, vegetable or vegetable juice, edible yeast, herb, bark, bud, root, leaf or similar plant material, meat, fish, poultry, eggs, dairy products, or fermentation products thereof. Artificial flavor includes the substances listed in §§ 172.515(b) and 182.60 of this chapter except where these are derived from natural sources."* [21 CFR 101.22(a)(1)]

FDA also considers spices to be a separate category from flavors:

> "*The term spice means any aromatic vegetable substance in the whole, broken, or ground form, except for those substances which have been traditionally regarded as foods, such as onions, garlic and celery; whose significant function in food is seasoning rather than nutritional; that is true to name; and from which no portion of any volatile oil or other flavoring principle has been removed. Spices include the spices listed in § 182.10 and part 184 of this chapter, such as the following:*
>
> *"Allspice, Anise, Basil, Bay leaves, Caraway seed, Cardamon, Celery seed, Chervil, Cinnamon, Cloves, Coriander, Cumin seed, Dill seed, Fennel seed, Fenugreek, Ginger, Horseradish, Mace, Marjoram, Mustard flour, Nutmeg, Oregano, Paprika, Parsley, Pepper, black; Pepper, white;*

Pepper, red; Rosemary, Saffron, Sage, Savory, Star aniseed, Tarragon, Thyme, Turmeric." [21 CFR 101.22(a)(2)]

Flavors are largely industry self-regulated by the FEMA GRAS Panel (Hallagan et al., 2020; Hallagan & Hall, 1995, 2009). The panel was established following the Food Additives Act (FAA) of 1958 [PL 85-929, effective September 6, 1958]. The FAA established the basis for the FDA to declare food additives as "Generally Recognized as Safe" or GRAS. Also included in the FAA was the Delaney clause, which banned the use in food of any chemical found to induce cancer in people or test animals (Merrill, 1997). FEMA formed its first expert panel to evaluate flavors as GRAS in 1960 (Hallagan & Hall, 1995). In the years since then, FEMA GRAS Panel assessments have resulted in over 800 flavor ingredients voluntarily declared GRAS (Hallagan et al., 2020). While the FDA may issue a "No Questions" letter to the expert panel claiming GRAS status, such action does not mean that the FDA has determined that the substance is GRAS [81 FR 94959, August 17, 2016].

Combinations of the Substance:

Flavor delivery systems vary in their form, functionality, and complexity. Some compounded flavor compositions may have over 100 constituents (Hallagan et al., 2020; Somogyi, 2000). They may come as solid, liquid, or aromatic forms. The simplest flavors consist of a single flavor entity that corresponds to a naturally present material in concentrated form. Some are basic combinations of flavoring agents. Many if not most flavor products will contain non-flavor ingredients that are broadly referred to as "adjuvants" (FEMA, 2011). Adjuvants include carriers, stabilizers, dispersants, emulsifiers, preservatives, and many other substances with different functionalities to deliver, maintain, or enhance a flavor's performance.

Carriers are diluents and solvents for a flavor (Burdock, 2016). These are flavor-neutral and are used to standardize the amount of the active flavoring ingredient and facilitate handling. Liquid flavors are often delivered within the solvent used for extraction. The most common solvent used in certified organic flavors reported by interviewed certifying agents was organic alcohol in the form of an extract or tincture. Nonorganic liquid flavors often contain propylene glycol as the carrier (Burdock, 2016; Jacobs, 1947). The use of propylene glycol or other synthetic carriers does not comply with the current annotation at 7 CFR 205.605(a). Similarly, the use of common synthetic preservatives: sodium benzoate, potassium sorbate, and sulfites (FEMA, 2011), does not comply with the annotation for allowed flavors at § 205.605(a).

Solid formulations may use gums, dextrin, sugar, flour, or starches as carriers (Burdock, 2016; FEMA, 2011). Such carriers are generally agricultural and nonsynthetic. When used in a certified organic flavor, they would also need to be organically produced and handled. When used in a nonorganic flavor they would not need to be organically produced, but presumably would need to document that they are not produced or handled using excluded methods, sewage sludge, or ionizing radiation. There is also a growing interest in new techniques that use synthetic polymers to handle essential oils and other liquid flavor ingredients in a solid form (Castro et al., 2016). Such synthetics carriers do not meet the annotation describing allowed flavors at § 205.605(a).

The actual flavoring components may make up a small percentage of a given flavor delivery system. Many if not most components of flavor delivery systems are prohibited by the annotation in § 205.605(a). Even more are prohibited for use in the production of certified organic flavors. There are processing aids and ingredients that may be used in formulating flavors that would meet the current annotation at § 205.605(a) but would not qualify for organic certification, even if an organic source is used to make the precursor or resulting flavor. For example, nonsynthetic carriers and preservatives would be compliant with the § 205.605(a) annotation for flavors, but if they do not themselves appear on § 205.605(a), would make a flavor ineligible for certification as organic. This is discussed in greater detail in the *Responses to NOSB Focus Questions* section. Flavors may also contain various impurities. For example, hexane-extracted oleoresins may have residual hexane (Attokaran, 2017).

Even within certified organic flavors, certification agents interviewed reported that in many cases, over 95% of a certified organic flavor's formulation is the ingredient delivery system made up of flavor-neutral carriers and less than 5% nonorganic flavoring agents. However, organic carriers may also be used to dilute the nonorganic added components to below 5% net of water and salt to comply with the organic labeling laws.

Status

International

Canada, Canadian General Standards Board—CAN/CGSB-32.311-2020, Organic Production Systems Permitted Substances List

The Permitted Substances List (PSL) Table 6.4 – *Ingredients not classified as food additives* includes (CAN/CGSB, 2021b):

> *Flavours: Derived from biological source (see Table 11 B (1) & (2) Origin and mode of production of CAN/CGSB-32.310), and substances (see Table 6.3 Extraction solvents and precipitation aids).*
>
> *May contain permitted carriers (see Table 6.3 & 6.4 Carriers).*

The publication appears to have a citation error in referring to Table 11 of the Canadian General Principles and Management Standards for Organic Production (CAN/CGSB 32.310), which refers to the substance review criteria for livestock inputs in Tables 5.2 and 5.3 of the PSL. It is Table 12 that refers to substance review criteria for permitted substances in processing of organic food in Tables 6.3, 6.4, and 6.5 of the PSL. Table 12 Part B reads "Origin and mode of production: 1. Shall be found in nature. Substances may be produced using physical (for example, extraction, precipitation), enzymatic or microbial (for example, fermentation) processes, as well as through chemical extractions that do not alter the substance's chemical structure. 2. Preferably from organic sources." (CAN/CGSB, 2021a).

The Table 6.3 listing for "Extraction solvents and precipitation aids" reads (CAN/CGSB, 2021b):

> *The following may be used to derive (extract) substances listed in Tables 5.2, 6.3, 6.4 and 6.5:*
>
> *a) water;*
> *b) culinary steam, as described in 8.1.2 b) of CAN/CGSB-32.310;*
> *c) fats, oils and alcohols other than isopropyl alcohol;*
> *d) supercritical CO2; and*
> *e) substances listed in Tables 6.3, 6.4 or 6.5 of this standard.*
>
> *Precipitation aids derived from biological sources (such as plant proteins, albumin, casein, and gelatin) may also be used. In addition, non-biological precipitation aids, such as bentonite, silicon dioxide, etc., may be used if listed in Tables 6.3, 6.4 or 6.5. If listed in Tables 6.3, 6.4 or 6.5, precipitation aids shall meet any annotation restrictions therein.*

The listings for "Carriers" in Tables 6.3 and 6.4 both read (CAN/CGSB, 2021b):

> *Carriers of non-agricultural origin may be used if listed in Tables 6.3, 6.4 or 6.5. Nonorganic carriers of agricultural origin (such as wheat starch) may be used if ingredients or processing aids containing organic carriers are not commercially available.*

CODEX Alimentarius Commission—Guidelines for the Production, Processing, Labelling and Marketing of Organically Produced Foods (GL 32-1999)

Table 3, Ingredients of non-agricultural origin referred to in Section 3 of these guidelines includes the listing (FAO/WHO Joint Standards Programme, 2008):

> *3.2 Flavourings: Substances and products labelled as natural flavouring substances or natural flavouring preparations are defined in the General Requirements for Natural Flavourings (CAC/GL 29-1987).*

The organic guidelines refer to an obsolete set of guidelines that have been replaced with the Guidelines for the Use of Flavourings (FAO/WHO Joint Standards Programme, 2008).

European Economic Community (EEC) Council Regulation—EC No. 2018/848
Flavoring substances in organic products must be natural or organic under European regulations.

Article 16, *Production rules for processed food* states:

> *"Operators that produce processed food shall comply, in particular, with the detailed production rules . . . The Commission is empowered to adopt delegated acts ... Those delegated acts shall not include the possibility of using flavouring substances or flavouring preparations which are neither natural, within the meaning of Article 16(2), (3) and (4) of Regulation (EC) No 1334/2008 . . .nor organic" (EU Commission 2018).*

Part IV, *Processed food production rules* § 2.2.2 states:

> *"In the processing of food, the following products and substances may be used: . . . substances and products defined in points (c) and (d)(i) of Article 3(2) of Regulation (EC) No 1334/2008 that have been labeled as natural flavoring substances . . . " (EU Commission 2018).*

The referenced regulation offers these definitions [EC 1169/2011, Article 3]:

1) *For the purposes of this Regulation, the definitions laid down in Regulations (EC) No 178/2002 and (EC) No 1829/2003 shall apply.*
2) *For the purposes of this Regulation, the following definitions shall also apply:*
   - *(a) 'flavourings' shall mean products:*
     - *(i) not intended to be consumed as such, which are added to food in order to impart or modify odour and/or taste;*
     - *(ii) made or consisting of the following categories: flavouring substances, flavouring preparations, thermal process flavourings, smoke flavourings, flavour precursors or other flavourings or mixtures thereof;*
   - *(b) 'flavouring substance' shall mean a defined chemical substance with flavouring properties;*
   - *(c) 'natural flavouring substance' shall mean a flavouring substance obtained by appropriate physical, enzymatic or microbiological processes from material of vegetable, animal or microbiological origin either in the raw state or after processing for human consumption by one or more of the traditional food preparation processes listed in Annex II. Natural flavouring substances correspond to substances that are naturally present and have been identified in nature;*
   - *(d) 'flavouring preparation' shall mean a product, other than a flavouring substance, obtained from:*
     - *(i) food by appropriate physical, enzymatic or microbiological processes either in the raw state of the material or after processing for human consumption by one or more of the traditional food preparation processes listed in Annex II; and/or*
     - *(ii) material of vegetable, animal or microbiological origin, other than food, by appropriate physical, enzymatic or microbiological processes, the material being taken as such or prepared by one or more of the traditional food preparation processes listed in Annex II;*
   - *(e) 'thermal process flavouring' shall mean a product obtained after heat treatment from a mixture of ingredients not necessarily having flavouring properties themselves, of which at least one contains nitrogen (amino) and another is a reducing sugar; the ingredients for the production of thermal process flavourings may be:*
     - *(i) food; and/or*

(ii) source material other than food;

(f) 'smoke flavouring' shall mean a product obtained by fractionation and purification of a condensed smoke yielding primary smoke condensates, primary tar fractions and/or derived smoke flavourings as defined in points (1), (2) and (4) of Article 3 of Regulation (EC) No 2065/2003;

(g) 'flavour precursor' shall mean a product, not necessarily having flavouring properties itself, intentionally added to food for the sole purpose of producing flavour by breaking down or reacting with other components during food processing; it may be obtained from:

(i) food; and/or

(ii) source material other than food;

(h) 'other flavouring' shall mean a flavouring added or intended to be added to food in order to impart odour and/or taste and which does not fall under definitions (b) to (g);

(i) 'food ingredient with flavouring properties' shall mean a food ingredient other than flavourings which may be added to food for the main purpose of adding flavour to it or modifying its flavour and which contributes significantly to the presence in food of certain naturally occurring undesirable substances;

(j) 'source material' shall mean material of vegetable, animal, microbiological or mineral origin from which flavourings or food ingredients with flavouring properties are produced; it may be:

(i) food; and/or

(ii) source material other than food;

(k) 'appropriate physical process' shall mean a physical process which does not intentionally modify the chemical nature of the components of the flavouring, without prejudice to the listing of traditional food preparation processes in Annex II, and does not involve, inter alia, the use of singlet oxygen, ozone, inorganic catalysts, metal catalysts, organometallic reagents and/or UV radiation.

3) For the purpose of the definitions listed in paragraph 2(d), (e), (g) and (j), source materials for which hitherto there is significant evidence of use for the production of flavourings shall be considered as food for the purpose of this Regulation.

Flavourings may contain food additives as permitted by Regulation (EC) No 1333/2008 and/or other food ingredients incorporated for technological purposes." [EC 1334/2008].

The European Union's flavor regulations have a more limited number of processes that are acceptable for the production of natural flavors (Müller, 2007; Sabisch & Smith, 2020). Certain processes in Europe lead a substance to be classified as "artificial" that are considered "natural" in the U.S. (Müller, 2007).

Japan Agricultural Standard (JAS) for Organic Production

The Japanese Agricultural Standard for Organic Processed Foods allows "Flavoring" with the annotation: "Limited only to those that are not chemically synthesized" (Japanese Agricultural Standard for Organic Processed Foods, 2020).

IFOAM-Organics International

The IFOAM Standards Appendix 4, Table 1, *List of Approved Additives and Processing/Post-harvest Handling Aids* includes "Flavoring Agents" with the following annotation (IFOAM, 2014):

Operators may use:

- *organic flavoring extracts (including volatile oils), and, if not available,*
- *natural flavoring preparations approved by the control body. Such approval shall include assessment that natural flavors shall meet the following criteria:*
  - *the sources are plant, animal or mineral;*
  - *The process of production is in accordance with a recognized organic standard;*
  - *They are produced by means of solvents such as vegetal oils, water, ethanol, carbon dioxide and mechanical or physical processes."*

Evaluation Questions for Substances to be used in Organic Handling

The authors of this report identified *Evaluation question #2* from the Technical Report template as relevant to addressing the three focus questions asked by the NOSB. That evaluation question, along with response, is included below. Responses to the three focus questions follow.

Evaluation Question #2: 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)). Discuss whether the petitioned substance is derived from an agricultural source.

Flavors come from many origins and the nomenclature varies both by the context of the specific foods, flavors, and labeling laws involved. For this review, the plants, animals, microorganisms, or minerals from which the primary flavoring substances are derived are called "sources." The specific substances derived from them are referred to as "precursors" and the final flavoring substances as "derivatives." Precursors are legally defined in the European regulation but not by the FDA. Sources and precursors are transformed into flavors by many different methods, some of which are biological, some mechanical/physical, and some involve chemical synthesis that may or may not include a biological intermediary.

Some sources (NOP, 2005). Some herbal and fungal precursors are from sources that may be wild harvested and may be eligible for organic certification under the USDA organic regulations for wild crops [7 CFR 205.207].

Flavors may be extracted from wild animals that are hunted or trapped. Examples include castoreum from beavers (Burdock, 2007) and musk tonquin from musk deer (Clarke, 1922). Nonsynthetic, nonagricultural ingredients may also be derived from microbial fermentation, such as yeast flavoring. As discussed below, a growing number of fermentation flavor ingredients are produced using genetically modified organisms, which is prohibited in organic production and handling at § 205.105(e). Yeast and potentially other fermentation organisms can be produced organically.

Some nonagricultural flavors and their formulations are produced from entirely synthetic sources (Fischetti, 2010; Jacobs, 1947). One example is vanillin as a by-product of pulp and paper manufacturing (Hocking, 1997) or from petrochemical-derived guaiacol (Bomgardner, 2016; Ciriminna et al., 2019). Another is pineapple flavor including ethyl butyrate derived from petrochemical precursors (Berenstein, 2018). Such sources would be synthetic and therefore not allowed for use as ingredients in organic processed food.

Some flavors are derived from the fermentation of agricultural substrates using unmodified naturally occurring organisms and are therefore agricultural according to the decision tree in NOP 5033-2 (NOP, 2016c). With that said, a growing number are from genetically modified organisms designed to express flavor chemicals from donor organisms (Hanlon & Sewalt, 2021). One example is vanillin, originally produced from vanilla orchids (*Vanilla spp.*), which can now be produced and extracted from fermented genetically modified yeast (*Saccharomyces cerevisiae*) (Brochado et al., 2010; Ramaen et al., 2018). Another example that may be from organic agricultural sources or from genetically modified organisms is Stevia. Stevia refers generically to steviol glycoside sweeteners originating from a perennial shrub native to South America, *Stevia rebaudiana.* A recently patented process shows that steviol glycosides may also be produced by fermentation of various genetically modified bacterial or microfungal hosts (Philippe et al., 2019, 2020). Meat flavors are also produced from genetically modified organisms (Vrljic et al., 2018).

Extraction and Concentration Techniques

Flavors and their precursors may be extracted or isolated from natural, agricultural sources by several different techniques. The processes used may be physical, mechanical, biological, or chemical.

Cold pressing

One of the oldest and simplest methods used to extract flavors is using pressure. As the name suggests, the liquids from a raw material—juices or oils—are forced through screens. The practice is still used to collect volatile oils from citrus fruits, for example, where flavor is lost through the use of high temperatures or the presence of solvents (R. G. Berger, 2007; Y. H. Hui et al., 2010). The solid mass is removed, and the liquid is collected using gravity. Some traditional processes used sponges to soak up the oils (Arce & Soto, 2008). Enzymes may be used to increase yields (Cakaloglu et al., 2018). The liquid may be further concentrated through centrifugal force (Y. H. Hui et al., 2010). Technological advances have increased the amount of pressure that can be used and expanded the potential to use high-pressure filtration techniques. Cold pressing is receiving renewed attention as processors look for alternatives that require less energy than distillation, and do not involve toxic chemicals (Cakaloglu et al., 2018). Cold pressing is a mechanical, non-chemical process.

Steam distillation and Water vapor stripping

The use of water vapor to extract various aroma and flavor chemicals goes back for centuries. Volatile oils have a higher vapor pressure than water, which means they can be stripped from plants through the application of steam or water vapor (Y. H. Hui et al., 2010). Various apparatuses can use the difference in evaporation temperatures and specific gravity to distill the oils and separate them from the water vapor as it cools. Stripping involves boiling water under pressure and the shooting of a jet of live steam through a plant material matrix, while distillation generally refers to the immersion of the plant material in boiling water (Y. H. Hui et al., 2010). Advances in vacuum technologies increased the effectiveness and yield of steam distillation in the latter half of the 19th century (Walter, 1916). Steam distillation can be regarded as a physical process for extraction and concentration.

Solvent extraction

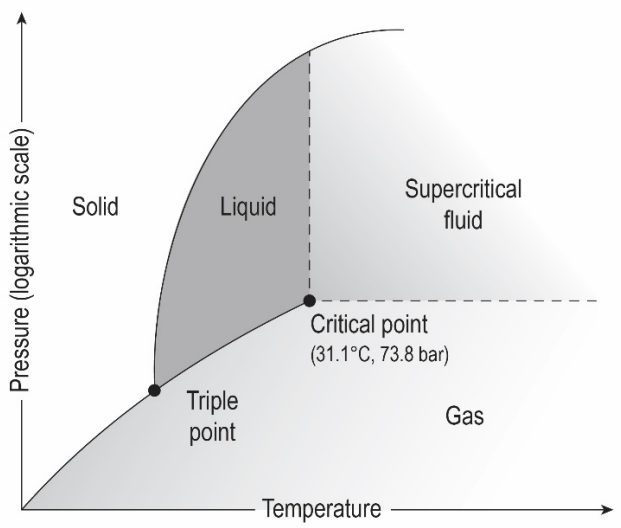
Oils can be extracted by various solvents. Ethanol (sometimes called grain alcohol) was one of the first solvents used to extract essential oils from plants. An early technique involved refluxing ethanol over the raw material at elevated temperatures over a period of time, which was known as "infusion" (Burdock, 2016). A more refined technique involved the percolation of plant raw material in an ethanol solution through a series of vessels in either a continuous process or in batches (Attokaran, 2017). Alcohol extraction with vacuum distillation would be an acceptable method for polar hydrocarbons. Non-polar hydrocarbons are more difficult to extract with alcohol. Ethanol is an acceptable solvent to produce nonorganic flavors used in organic production. Organic flavors would need to be made using organic ethanol, which is commercially available.

Various petroleum-derived solvents became preferred later in the 19th century because they could be used at ambient temperatures and resulted in higher yields of product with fewer off-flavors and impurities. Ethanol had a drawback in that the temperatures needed to effectively extract essential oils were relatively high and yields were relatively low. Early non-polar solvents used included ether and methylene dichloride (dichloromethane) (Y. H. Hui et al., 2010). Later, isopropanol, methanol, hexane, butane, acetone, ethyl acetate, ethylene dichloride, and methylene dichloride became preferred non-polar solvents (Attokaran, 2017; Burdock, 2016). The use of these solvents is considered chemical processing and prohibited, both to make organic flavors per 7 CFR 205.105(c) and non-synthetic non-organic flavors per the 7 CFR 205.605(a) annotation.

Supercritical carbon dioxide

A relatively new extraction technique involves the use of carbon dioxide at various temperatures and pressures. Carbon dioxide is a gas at standard temperature and pressure. Above 73 bar and 31 degrees Celsius (88°F), carbon dioxide becomes a supercritical fluid (Y. H. Hui et al., 2010) (*Figure 1*).

Figure 1: Phase Changes in Carbon Dioxide. Adapted from Bauer et al. (2013).



As a supercritical fluid, carbon dioxide can penetrate solid masses like a gas and dissolve substances like a liquid. Supercritical carbon dioxide can be used as a non-polar solvent to remove various essential oils from plant material. The flavor profiles of supercritical extracted oils and oleoresins rival those of hexane, but at a higher price (R. G. Berger, 2007). Significantly more carbon dioxide is used in the supercritical process than in processes that use other conventional solvents (Attokaran, 2017). Supercritical carbon dioxide has the advantage over hexane, ethylene dichloride, and other conventional solvents, as it does not leave residual contamination. Because carbon dioxide is on the National List in 7 CFR 205.605(b), supercritical extraction is acceptable for both organic flavors and nonorganic flavors used in organic processed products.

Flavor Categories

Flavors can be categorized in many ways. The most fundamental is the distinction between "natural" and "artificial" flavors. These terms have legal meanings defined by the FDA in the U.S. and by other authorities with somewhat different definitions in other countries (Müller, 2007).

The literature often groups certain types of flavors with common characteristics. These groups include spices, essential oils, fruit extracts, vegetable extracts, chocolate, dairy flavors, meat flavors, and coffee flavors. Other specialty flavors are available as well that may have a small market share and difficulty in obtaining organic sources due to the lack of volume.

Herbs and Spices

Herbs and spices are among the oldest of the flavoring ingredients. Both herbs and spices are derived from plants. Herbs consist of plant leaves, stems, and flowers. Spices are obtained from harvesting the seeds, roots, bark, or other plant organs. Herbs are prehistoric in nature, believed by ethnobotanists to originate from traditional pharmacological uses (Wrensch, 1992). Herbs have been wild-crafted or cultivated throughout recorded history. Spices used for culinary purposes were central to the development of various cuisines, and have a long history of cultivation going back to the origins of recorded history thousands of years ago (Parry, 1962). As such, most if not all herbs and spices may be considered agricultural in origin.

Herbs and spices may be used in various forms, such as dried leaf, flake, powder or frozen. Blends of herbs and spices are also prepared for market. Some of these involve proprietary recipes. Herbs and spices may also appear in various tinctures, hydrosols—water-based fractions of aromatic plants resulting from steam distillation—and infusions made with alcohol, water, vinegar, or culinary oils. Such preparations are noted throughout recorded history. Spice oleoresins were a more recent development, with solvent extraction processes developed in the 1940s (Attokaran, 2017).

As noted above, the FDA recognizes herbs and spices as a separate category from natural and artificial flavors. Most of the certifying agents interviewed indicated that these ingredients are treated as agricultural and thus required to be certified organic. However, many herb and spice derivatives are precursors to various natural flavors, in particular essential oils and various specific extracts and isolates. The presence of precursors derived from organic herbs and spices is indicative that their downstream flavor products may also be feasible to produce in a form, quality, and quantity to be commercially available as organic.

The herbs and spices identified by the FDA in 21 CFR 101.22(a) are included here to identify them separately from nonagricultural flavors and to link them to various flavoring agents. Organic cultivation methods are documented for all of them (Kowalchik & Hylton, 1998; V. Parthasarathy et al., 2008). This review is not intended to be an exhaustive list of flavor sources that can be considered agricultural or produced agriculturally, but documents that all officially recognized major herbs and spices are agricultural products that are feasible to produce organically.

Organic spices had sales of about $499 million in 2021, which was about 4.5% less than the previous year (OTA, 2022). The Organic Trade Association (OTA) attributed the decline to supply chain issues. The global market for organic spices is forecasted to continue to grow, with many of the world's largest conventional spice companies increasing their capacity to manufacture and handle organic spices (FMI, 2022).

Allspice

Seeds from the pimento plant (*Pimenta dioica*) are used to make allspice, also known as pimento (Attokaran, 2017; Burdock, 2016). It is an evergreen relative of the laurel that is native to Meso-America (Machuca et al., 2020). It was a traditional crop of pre-Columbian native people in the Caribbean and in the humid tropical forests between the Yucatan peninsula and Costa Rica. Grown there and elsewhere in the tropics, it has complex flavors that bear resemblances to bay leaves, cinnamon, cloves, and nutmeg. It shares many derivatives that can be precursors to flavors identified with other plants, although often in lower concentrations. The wood and leaves may also be used to produce various isolates and extracts recognized as natural flavors by FDA. The primary isolate is eugenol, but others are also produced. A cooperative in Chiapas grows and exports certified organic allspice (Machuca et al., 2020).

Anise and star anise

Licorice and related flavoring substances are derived from sweet anise (*Pimpinella anisum*) or from star anise (*Illicum verum*) (FCC, 2022; Khan & Abourashed, 2010; Kowalchik & Hylton, 1998). Anise also has a wide range of culinary uses. Flavors can be derived from the leaves as well. Anise and star anise are grown in temperate and Mediterranean climates.

Basil

Various species of basil may be used for flavoring (Kowalchik & Hylton, 1998). The main commercial source in the U.S. is sweet basil (*Ocimum basilicum*). Other species used for flavoring and flavor extracts include lemon basil (*Ocimum americanum*), holy basil (*O. sanctum*), African basil (*O. gratissimum*) and camphor basil (*O. kilimandscharium*) (Kowalchik & Hylton, 1998). Holy basil is used to prepare tulsi tea and its oil extract may be present in various herbal preparations. Camphor basil is not used for cooking but may be used as a tea (Kowalchik & Hylton, 1998). Basil oil may be produced by steam distillation (Burdock, 2016). The oleoresin is most commonly extracted by a mixture of acetone and hexane, or by hexane alone (Attokaran, 2017). It is not clear from the literature how basil oleoresins used in organic processed products are extracted. Basil oil is soluble in propylene glycol, but is not soluble in glycerine (Burdock, 2016; FCC, 2022). A substitute for propylene glycol was not found in a search of the literature.

Bay leaves

The evergreen sweet bay laurel (*Laurus nobilis)* has been cultivated for bay leaves since antiquity (Kowalchik & Hylton, 1998). The leaves consist of between 0.3-3.1% volatile oil. The primary constituents of the oil are 1,8-cineole, α-pinene, linalool, and α-terpineol (Khan & Abourashed, 2010). Derivatives

include infusions, fluid extracts, and oleoresins (Burdock, 2016). It is used mainly in soups and meat products, and is a standard in both French and Indian cuisines (Attokaran, 2017).

Caraway seed

Caraway seed is produced from *Carum carvi,* a biennial in the same family as carrots, fennel, cilantro, and parsley (Kowalchik & Hylton, 1998). Carvone is the principle active component in caraway seed (Attokaran, 2017). Derivatives include infusions, decoctions, alcoholic distillate, and water distillate (Burdock, 2016). Caraway seed is seldom made into an oleoresin (Attokaran, 2017). Caraway seed is commonly used in rye bread. It is also used in other baked goods, cheeses, and liqueurs (Attokaran, 2017; Parry, 1962).

Cardamom

Most commercial sources of cardamom are from the species *Elettaria cardamomum*, which is called true or green cardamom (Attokaran, 2017). Black cardamom (*Amomum subulatum*) and white or Siamese cardamom (*Amomum krevanh*) are also cultivated and used as spices and natural flavor derivatives. "White cardamom" can also refer to green cardamom that has been chemically bleached or sulfured (Parry, 1962). Cardamom can be processed into essential oils, tinctures, fluid extracts, and oleoresins (Burdock, 2016).

Celery seed

While most celery (*Apium graveolens*) is cultivated as a vegetable, the seed of this biennial may also be used as a spice (Parry, 1962). The seed can be extracted into oil and flavorings, although sometimes celery leaves and roots are also used for flavor extraction. Pure celery seed extract is regarded as higher quality than extracts from other celery plant organs (Burdock, 2016). Celery seed oleoresin has a more bitter flavor than celery seed extract and is used in some meats and soups (Attokaran, 2017).

Chervil

French parsley or garden chervil (*Anthriscus cerefolium*) is a fine herb that can be grown in temperate climates (Kowalchik & Hylton, 1998). The primary constituent of chervil essential oil is estragole, followed by 1-allyl-2-dimethoxybenzene (K. Başer & DeMirci, 2007).

Cinnamon and Cassia

Cinnamon sold in the U.S. comes from one of three sources. Most spice sold as "cinnamon" on the world market and in the U.S. comes from Chinese cinnamon or cassia (*Cinnamomum cassia*). Cassia accounts for over 90% of what is traded as cinnamon (Madan & Kannan, 2004). Indonesia, China, Madagascar, Seychelles, and Vietnam are the largest suppliers of cassia (Coppen, 1995). The aromatic bark of the true cinnamon tree (*Cinnamomum verum*), also known as Ceylon or Sri Lankan cinnamon (*C. zeylanicum*), is the next most common source. Sri Lanka is the only significant commercial source of true cinnamon. In the U.S., the common name cinnamon also applies to Indonesian cinnamon or korintji (*C. burmannii*) (Khan & Abourashed, 2010) and Saigon cinnamon (*C. loureiroi*) (O'Neil, 2013).

Steam distillation of cinnamon bark varies based on where it was produced and the duration of the distillation process. Distilling 40-50 kg of cinnamon bark for four to five hours yields approximately 0.5-0.7% essential oil on a dry weight basis (Dayananda et al., 2004). Cassia essential oil more often uses twigs and leaves. Cassia leaves and twigs steam distilled in 60-kg batches for three to four hours will yield about 0.31-0.33% dry weight of essential oil (Dao, 2004). Cinnamon and cassia essential oils are both graded based on their cinnamaldehyde—also known as cinnamic aldehyde—content (Dayananda et al., 2004). Cinnamaldehyde content from various cinnamon essential oil sources will range from 60-90% depending on the species, origin, extraction process, and handling (Burdock, 2016; Dao, 2004; Dayananda et al., 2004). Cassia and cinnamon oleoresins are usually extracted by ethylene dichloride or an acetone-hexane mixture (Attokaran, 2017). Other extracts can be obtained using supercritical CO_2 (Attokaran, 2017). Cinnamaldehyde can also be synthesized from benzaldehyde and acetaldehyde (Fischetti, 2010; Richmond, 1950).

Cloves

Cloves are native to Southeast Asia and produced from the tropical evergreen, *Syzygium aromaticum* (V. Parthasarathy et al., 2008). The tree is cultivated in tropical regions worldwide. The world's largest producer is Indonesia, followed by Madagascar, Tanzania, and Sri Lanka (FAO, 2015). The flower buds and twig tips are used as the spice (Attokaran, 2017). Stems and leaves may also be used to produce essential oils, with the main components being eugenol, ß-caryophyllene, and eugenyl acetate (Attokaran, 2017; Burdock, 2016).

Coriander

Coriander generally refers to the fruit and seeds of the cilantro (*Coriandrum sativum*) plant, but the term may include cilantro leaves or flowers (Kowalchik & Hylton, 1998). Cilantro can be cultivated in a wide range of climates and is organically produced. Cilantro fruit is a source of d-linalool (Khan & Abourashed, 2010).

Cumin seed

Cumin (*Cuminum cyminum*) is a small annual that is extensively cultivated throughout the Mediterranean region (Khan & Abourashed, 2010). Cumin was introduced to India about 1,000 years ago (V. Parthasarathy et al., 2008). Black cumin yields about 1% essential oil with steam distillation (Attokaran, 2017). Cumin can also be made into an alcohol tincture, infusion, fluid extract, and oleoresin (Burdock, 2016). The principle component of cumin is cuminaldehyde, which is responsible for cumin's distinct aroma and taste (V. A. Parthasarathy et al., 2008).

Dill seed

Dill (*Anethum graveolens*) is a temperate zone plant that is reported as simple to grow, but as a biennial the seeds are not produced until the second year (Kowalchik & Hylton, 1998). Dill may also refer to Indian dill, *A. sowa* (Attokaran, 2017). Indian dill is grown as an intercrop in South Asian organic farming systems (V. Parthasarathy et al., 2008). For both species of dill seed, the essential oil is obtained by steam distillation (Burdock, 2016). *A. graveolens* oil is over 50% dillapiole, 20% carvone, 16% trans-hydrocarvone, and almost 6% limonene (Burdock, 2016). Oil from *A. sowa* differs from *A. graveolens* oil in physical properties, odor, and flavor (Burdock, 2016).

Fennel seed

Fennel (*Foeniculum vulgare*) is another biennial from the Apiaceae (formerly Umbelliferae) family (Kowalchik & Hylton, 1998). Within fennel species, varieties are divided between common or bitter fennel and sweet fennel based on the concentration of different flavor constituents. Myristicin and apiole are present in sweet fennel and absent in common fennel (Khan & Abourashed, 2010). Common fennel is also reportedly higher in fenchone and lower in anethole than sweet fennel. As with other biennials, fennel seed is produced in the second year. Fennel seed has a licorice flavor profile like anise but is described by some sources as having a slight nut profile. Fennel and sweet fennel oil are used in baked goods, meats, snack foods, gravies, and alcoholic beverages. Sweet fennel is also used in condiments and relishes (Khan & Abourashed, 2010).

Fenugreek

Fenugreek (*Trigonella foenum-graecum*) is a legume that is native to the Mediterranean region, where it has been a staple of Middle Eastern cuisine for centuries (Kowalchik & Hylton, 1998). The main constituent of fenugreek is anethole, but its characteristic flavor and texture comes from a couple of families of saponins (Burdock, 2016). Fenugreek flavor is described as burnt sugar. Fenugreek is a traditional ingredient in curry powders and its derivatives have also long been used as precursors for imitation maple flavoring (Burdock, 2016; Parry, 1962). Steam distillation results in poor yields; volatile hydrocarbon or hydroalcoholic extracts are variable in quality (Burdock, 2016). Ethanol may be used to prepare a fenugreek oleoresin that disperses well without the use of propylene glycol (Attokaran, 2017). Roasting fenugreek increases the yield and improves the flavor.

Ginger

The rhizomes of the ginger (*Zingiber officinale*) plant are native to Southeast Asia and have been introduced to Africa, the West Indies, and Hawaii (V. Parthasarathy et al., 2008). Traditional cultivation practices vary widely around the world (Parry, 1962). Ginger's characteristic aroma is primarily attributed to zingiberol volatile oil (Burdock, 2016). Ginger essential oil is prepared by coarsely grinding with a hammer mill, flattening with a roller mill, then steam distillation at low pressure, yielding about 2% essential oils (Attokaran, 2017). Ginger may be prepared into an alcohol tincture of 20:60-65 or as an oleoresin (Burdock, 2016). Ginger, its derivatives, and its flavoring extracts are used in alcoholic and non-alcoholic beverages, baked goods, candies, confectionaries, sauces, and seafood (Attokaran, 2017; Khan & Abourashed, 2010). Soft drinks will usually be prepared from ginger oleoresin or extract (Khan & Abourashed, 2010).

Horseradish

Horseradish is harvested from the root of a perennial crucifer, *Armoracia rusticana* (Kowalchik & Hylton, 1998). Horseradish is a relative of mustards and is a source of various pungent isothiocyanates (Burdock, 2016). Horseradish may be prepared into an alcohol tincture or steam distilled (Burdock, 2016). While horseradish is related to wasabi or Japanese horseradish (*Wasabi japonica*) and has many of the same flavoring substance, it is a different genus and species with a distinct flavor and aroma profile. Horseradish and wasabi have different ratios of various isothiocyanates they hold in common (Masuda et al., 1996).

Mustard

Several *Brassica* species are cultivated and sold as mustard (Kowalchik & Hylton, 1998). The main commercial varieties are black mustard (*B. nigra*), brown mustard (*B. juncea*), and white or yellow mustard (*B. alba* and *B. hirta*) (Attokaran, 2017). Both mustard seeds and leaves may be used to extract various isothiocyanates that have a characteristic sharp mustard flavor (Burdock, 2016). Allyl isothiocyanate makes up about 90% of mustard essential oil (K. Başer & DeMirci, 2007). Very little mustard is processed into oleoresin, possibly because the extraction process can be difficult when so much water is present in the slurry (Attokaran, 2017).

Nutmeg and mace

The evergreen laurel tree *Myristica fragrans* is cultivated for two spices, nutmeg and mace (V. Parthasarathy et al., 2008). The main producer in the world is Indonesia (Attokaran, 2017). Nutmeg is made from the seeds, which may be sold whole or ground. The seed coating or aril is used to make mace. After the husk splits, the mace is carefully detached and processed separately from the nutmeg (Parry, 1962; Peter, 2001). While they have similar flavors, they are subtly different given their different quantities of aromatic substances. Mace yields about 10-13% essential oils depending on the variety and production region, and nutmeg yields about 6.5-8% essential oils (Burdock, 2016). Nutmeg can be pressed into a semi-solid fixed oil that is called a concrete (Sharangi, 2018). Nutmeg can be made into an ethanol tincture, expressed into a fatty oil, and extracted as an oleoresin. Mace can also be made as a tincture, extract, and oleoresin (Burdock, 2016). The leaf and pericarp of four different *Myristica* species— *M. fragrans, M. beddomei, M. fatua,* and *M. malabarica* – are sometimes also steam distilled into mace volatile oil (Sharangi, 2018).

Oregano and marjoram

The term oregano may be used to refer to various species of *Origanum,* the most common being *O. vulgare* (Kowalchik & Hylton, 1998). Common oregano is also sometimes called wild marjoram. Most commercial marjoram is from the species *O. majorana,* also known as sweet marjoram (Kowalchik & Hylton, 1998). Marjoram is called oregano in some regions. Both marjoram and oregano are dried as culinary herbs and may have extracts that are steam distilled, infused, or made into an alcohol tincture (Burdock, 2016). The alcohol tincture obtained from *O. vulgare* and other *Origanum* species is specified in the *European Pharmacopoeia* to contain at least 60% carvacrol (K. Başer & DeMirci, 2007). Thymol is also a principal component, with many other terpenes and sesquiterpenes reported (Attokaran, 2017). Carvacrol and thymol levels vary widely by species and cultivation conditions (Baser & Buchbauer, 2009).

Paprika and red pepper

The red pepper (*Capsicum spp.*) is a solanaceous genus native to the Americas. The most commonly used form is *C. annuum,* that when used as a spice is best known for a hot, biting flavor (Kowalchik & Hylton, 1998). Paprika is associated with the milder cultivars of *C. annuum* adapted to cooler climates (Attokaran, 2017). There are many synonyms in English for the different *Capsicum* fruits that are grown as a spice. The most used other names are cayenne, chili, and red pepper (Kowalchik & Hylton, 1998; Peter, 2001). Other *Capsicum* species commercially grown in North America include *C. frutescens,* which includes the Tabasco cultivar, and *C. chinense,* which includes the habanero cultivar (Attokaran, 2017; USDA/ ARS / GRIN, 2022).

The chemical constituent most often attributed for the piquant flavor of various hot peppers is capsaicin (Attokaran, 2017; Burdock, 2016). Capsaicin's capacity to deliver heat is measured in Scoville heat units (SHUs) (Burdock, 2016; Sharangi, 2018). Capsaicin is a phenol that is not volatile with steam but it can be made into ethanol tinctures (Burdock, 2016). Dried powdered and flaked chili peppers are the prevailing way that the flavor is used in most applications (Attokaran, 2017; Sharangi, 2018), and India accounts for about half of all global chili exports (Sharangi, 2018). However, the oleoresins are sometimes used (Attokaran, 2017). *Capsicum* oleoresins are extracted using ethylene dichloride or a mixture of hexane and acetone, often after preparation with various other chemicals such as ethanol, methanol, and benzyl peroxide (Attokaran, 2017).

Paprika is also used as a coloring agent. The USDA added "Paprika color—dried powder and vegetable oil extract (CAS #68917-78-2)" to the National List [7 CFR 205.606] in 2007 [72 FR 35137]. Paprika was removed from the National List on March 30, 2022 [87 FR 10930].

Parsley

Parsley (*Petroselinum crispum*) is a hardy herb originating with use documented to Greek and Roman antiquity (Kowalchik & Hylton, 1998). Parsley leaves are the most familiar for use as an herb, both fresh and dried into flakes. Derivatives from parsley fruits and seeds may be used as flavor precursors and parsley roots are also sometimes used (Khan & Abourashed, 2010). Parsley fruits are 3-6% essential oil consisting of 60-80% myristicin in some varieties, and up to 70% apiol in other varieties (Burdock, 2016). Another reported chemical is allyl tetramethoxy benzene, which in some varieties may be up to 75% of the oil.

Pepper (black and white)

Black pepper (*Piper nigrum*) is a woody tropical perennial climbing vine crop native to the evergreen forest of the Western Ghat of India (Khan & Abourashed, 2010; Peter, 2001; Thankamani, 2008). Black pepper is the most commonly used spice in the world, with a history of over 3,000 years of use (Ravindran, 2003). India, Indonesia, and Vietnam account for about two-thirds of the world's production of black pepper. By volume, black pepper is the leading organic spice traded by India (Choudhuri et al., 2018). Kerala is the state of India that produces the most black pepper (V. Parthasarathy et al., 2008). The ripe whole fruits of the black pepper plant are harvested, dried, cleaned, graded and packaged as black pepper (Balasubramanian et al., 2016). White pepper is made by removing the fruit wall (pericarp) of fully ripe black pepper (Ravindran, 2003). Black pepper oleoresin may be extracted using ethanol, acetone, ethylene dichloride, or ethyl acetate (Balasubramanian et al., 2016). Indian black pepper yields higher oleoresins and has a different flavor profile than black pepper harvested elsewhere (Peter, 2001). The main active constituent of black pepper is piperine (Attokaran, 2017; Balasubramanian et al., 2016; Burdock, 2016; V. A. Parthasarathy et al., 2008; Peter, 2001). Piperine levels in whole black pepper will vary by variety, soil, climate, and other local conditions (V. A. Parthasarathy et al., 2008; Peter, 2001).

Rosemary

The hardy perennial evergreen, *Rosmarinus officinalis*, is the source of rosemary (Kowalchik & Hylton, 1998). It is commonly used in soups, meat dishes, and savory baked goods (Khan & Abourashed, 2010). Peak harvest for the rosemary plant is at the flowering top stage (Başer & Demirci, 2012). Rosemary oil is made by steam distillation of the fresh flowering tops (Khan & Abourashed, 2010). Extraction is

improved by the superheating of water under pressure (Basile et al., 1998). Other solvents used in extraction include acetone, hexane, and supercritical carbon dioxide (EFSA, 2008). The primary active ingredients found in rosemary are carnosol, rosmanol, rosmarin and rosmarinic acid, with yields and composition varying by cultivar, location, and seasonal conditions. Rosemary can be made into a fluid extract, tincture, or oleoresin (Burdock, 2016).

Saffron

The stigmata of crocus (*Crocus sativus*) are the source of saffron (Kowalchik & Hylton, 1998). A native of Asia Minor, it has a broad cultivation range. Spain, Iran, and India are the main producers of saffron (Attokaran, 2017; Peter, 2001). It is very labor intensive to produce, requiring the collection of stigmata from tens or even hundreds of thousands of plants to make commercial quantities, with yields of between 1.5 and 3.0 kg/ha (1.3-2.7 lb./A) (Peter, 2001). Saffron is mostly used whole in small quantities, and is not practical to make extractives (Attokaran, 2017). Specific applications may involve an alcohol tincture, steam distillation, or solvent extraction (Burdock, 2016). Saffron is also used as a coloring agent. "Saffron extract color (pigment CAS #1393-63-1)" was added to the National List [7 CFR 205.606] in 2007 [72 FR 35137]. In 2019, the annotation was amended to also say, "Derived from *Crocus sativus*" [83 FR 66559].

Sage

Sage (*Salvia spp.*) is a genus of evergreen perennial that is hardy in a wide range of climates. The primary culinary sage is *S. officinalis* also called common or Dalmatian sage, but Clary sage (*S. sclarea*), pineapple sage (*S. elegans*), and Mexican bush sage (*S. leucantha*) are also cultivated for specific culinary uses (Kowalchik & Hylton, 1998). Common sage is believed to have originated in the Mediterranean region. Sage essential oil is produced by steam distillation, with yields and composition highly variable depending on region, harvest season, and climatic conditions (Attokaran, 2017). Yields of 1-3% essential oils are common. Sage essential oils contain a rich and variable mix of aromatic compounds, including salvin, picrosalvin, carnosol, terpenes, tannins, phenolic acids, flavonoids, and ethers (Baser & Buchbauer, 2009; Burdock, 2016; Khan & Abourashed, 2010). Some phenolic flavoring substances are unique to sage (Burdock, 2016). The oleoresin is obtained by solvent extraction (Burdock, 2016). Sage derivatives and isolates are used as flavoring ingredients in a wide range of foods, including meats, candy, frozen dairy desserts, and alcoholic and non-alcoholic beverages (Khan & Abourashed, 2010).

Savory

Two species from the genus *Satureja* are cultivated as herbs. One is the annual summer savory (*S. hortensis*) and the other is the woody perennial winter savory (*S. montana*). They are both temperate herbs originating in Europe (Kowalchik & Hylton, 1998). Summer savory is the more widely cultivated and used herb (Attokaran, 2017). Greek savory (*S. spinosa*) is also used (Khan & Abourashed, 2010). Savory is used as ingredients in condiments, sauces, meats, processed vegetables, and gravy, with the highest levels reported in condiments (Khan & Abourashed, 2010). The main flavoring components of savory are carvacrol and various terpenes, specifically γ-terpinene (Attokaran, 2017; Khan & Abourashed, 2010). Most oleoresins and extracts are made from summer savory (Khan & Abourashed, 2010).

Tarragon

Tarragon (*Artemesia dracunculus*) is a hardy perennial grown in temperate climates (Kowalchik & Hylton, 1998). While believed to be Russian in origin, tarragon is most associated with French cuisine (Attokaran, 2017). Tarragon is used in condiments, sauces, cooking vinegar, meat, fish, and egg preparations (Attokaran, 2017; Khan & Abourashed, 2010; Kowalchik & Hylton, 1998). The primary flavoring component is estragole, also known as methyl chavicol (Attokaran, 2017; Burdock, 2016; Khan & Abourashed, 2010). The Russian varieties have a different flavor profile and chemical composition from the French varieties (Attokaran, 2017). Tarragon may be prepared as an extract, alcohol tincture, essential oil, or oleoresin (Burdock, 2016). Tarragon essential oil is made from steam distillation (Burdock, 2016). Tarragon oleoresin is extracted with hexane (Attokaran, 2017).

Thyme

Thyme is an herb derived from the leaves of the *Thymus* spp. plants (Kowalchik & Hylton, 1998). There are estimated to be 215 species of thyme (Morales, 2003). The most commercially important one is *T. vulgaris* (Attokaran, 2017; Kowalchik & Hylton, 1998). Other species may be used (Burdock, 2016; Khan & Abourashed, 2010; Morales, 2003). Thyme is associated with Creole, Cajun, and French cuisines. Spain, France, and Portugal are the leading producers of thyme (Lawrence et al., 2002). Most thyme essential oil is produced through steam distillation of the flowering tops (Khan & Abourashed, 2010). Steam distillation of partially dried thyme tops yields about 0.5-1.2% oil (Burdock, 2016). Aromatic petroleum solvents, such as butane; alcohols, including methanol; acetone, and supercritical carbon dioxide may also be used to extract various flavoring compounds (Venskutonis, 2003). The main flavoring compound is thymol (Attokaran, 2017; Burdock, 2016; Khan & Abourashed, 2010). Thyme and thyme derivatives are used in salad dressings, soups, gravies, meat and poultry products, candy, and alcoholic and non-alcoholic beverages (Attokaran, 2017; Khan & Abourashed, 2010; Kowalchik & Hylton, 1998).

Turmeric

Rhizomes of the turmeric (*Curcuma longa*) plant are native understory plants in tropical climates (Choudhuri et al., 2018). Turmeric is a major ingredient in Indian and Southeast Asian cuisines and India remains the main producer (Attokaran, 2017). One of the main uses is in prepared mustards (Khan & Abourashed, 2010). Turmeric is also used in other condiments. High-yielding turmeric cultivars performed well with organic trials in the northwestern Himalayas (Choudhary & Rahi, 2018). Turmeric is used mostly in dry powdered form (Attokaran, 2017). Turmeric essential oil is prepared by steam distillation (Burdock, 2016). The essential oil is about 60% turmerones (Khan & Abourashed, 2010). These are complex sesquiterpenes (Attokaran, 2017). Turmeric is also used for coloring, with its characteristic pigment mostly contributed by curcumin (Attokaran, 2017; Khan & Abourashed, 2010). Turmeric may also be prepared in an ethanol extract or tincture (Burdock, 2016). Ethylene dichloride is the preferred solvent for turmeric oleoresin extraction (Sharangi, 2018). Other solvents used include acetone, ethyl alcohol, hexane, isopropyl alcohol, methylene dichloride, and trichloroethylene (Burdock, 2016). Turmeric is also used as a coloring agent. In 2007, "Turmeric extract color (CAS #458-37-7)" was added to the National List [7 CFR 205.606, 72 FR 35137]. In 2019, the annotation was amended to add, "Derived from *Curcuma longa*" [83 FR 66559]. Turmeric was removed from the National List on March 30, 2022 [87 FR 10930].

<u>Essential Oils, Oleoresins, Extracts, and Isolates</u>

The volatile aromatic portions of plants can be extracted, isolated, and concentrated by various means. They are distinguished from herbal preparations by their concentration and purity, as well as the techniques used for extraction. These techniques often involve agriculturally produced herbs and spices. Analytical chemistry to identify the chemical constituents of plant organs harvested for fragrance and flavor was first recorded in the industrial production of essential oils beginning in 1833 (Baser & Buchbauer, 2009). As analytical techniques improved through the 19th century, various molecular structures and formulas associated with specific flavors became better known, and with them the ability to produce essential oils of a specific purity and standardized concentration of aromatic compounds.

Essential oils are a hydrophobic complex mixture of volatile hydrocarbons derived from plant material. Many of the chemical constituents are cyclic structures, such as terpenes, phenols, benzenoids, ring alcohols, and aromatic esters. Essential oils also contain non-aromatic hydrocarbons, and their functionality depends on the concentrations of specific constituents. Many of the essential oils are derived from herbs and spices, such as cinnamon, cloves, rosemary, thyme, and sage. As such, they may be considered agricultural products.

Essential oils can be extracted by many different methods. The oldest method is through steam, a process known as hydrodistillation. The volatile portions of the plant organs will evaporate at temperatures lower than the boiling point of water. The evaporated essence is captured and concentrated. Essential oils may also be extracted using aromatic petroleum solvents such as hexane. A relatively new technique for concentrating essential oils is to use supercritical carbon dioxide (CO_2).

A comprehensive review of all essential oils, oleoresins, extracts, and isolates from nonorganic sources that are currently used in certified organic processed product is beyond the scope of this technical report. However, a few essential oils discussed below, serve as examples of how extracts, essential oils, oleoresins, and isolates are produced from herbs and spices.

Anise oil

Anise oil is extracted from either anise or star anise (Khan & Abourashed, 2010). Anise oil may be extracted by steam distillation or supercritical carbon dioxide (Rodrigues et al., 2003), making organic sources feasible. The primary component of anise oil is anethole (Khan & Abourashed, 2010). Anise oil may be used as a source for the isolates 4-anisaldehyde, estragole and pseudoisoeugenyl-2-methylbutyrates. Sweet anise seeds are about 2.5% oil upon steam distillation, consisting of about 95% trans-anethole and 2% methyl chavicol (Burdock, 2016). Steam-distilled star anise has 3-3.5% volatile oil, with 85-90% anethole (Attokaran, 2017). Star anise can also be made into an alcohol tincture (Burdock, 2016).

Cinnamon oil

Cinnamon oil is derived from the bark, leaves, and twigs of trees in the genus *Cinnamomum* (Coppen, 1995). The bark is composed of approximately 4% volatile oils extractable by steam distillation (Dayananda et al., 2004; O'Neil, 2013). The principle active component is cinnamaldehyde or cinnamic aldehyde, with camphor, coumarin, eugenol, and linalool also part of the flavor profile. *C. osmophloeum* has higher levels of the *trans*- isomer of cinnamaldehyde (Hussain et al., 1986), which is significantly more reactive than the *cis*- isomer (Klibanov & Giannousis, 1982). Cinnamon oil can also be distilled from the leaves and twigs, but consists of between 80 and 88% eugenol, which is also the main constituent of clove oil. The root bark oil of *C. zeylanicum* has approximately 4-5% cinnamaldehyde and eugenol, and about 60% camphor (Wijesekera et al., 1974). Cinnamon oleoresins are mostly produced by extraction with a solvent, such as hexane (Dayananda et al., 2004). It is possible to produce cinnamon oil by use of supercritical fluid extraction, but that technique is rarely used because of the high cost and insignificant quality advantage. The literature reviewed and interviews conducted by the authors of this report did not clarify how nonorganic cinnamon isolates are extracted or produced, or why there are no organic sources of cinnamon oil.

Clove oil

Clove essential oil is produced from the plant buds, but other constituents of the clove plant may be used for various extracts and isolates. Clove buds are approximately 15-21% volatile oil (Merck, 2015), with extraction yields averaging 15-18% (Khan & Abourashed, 2010). Eugenol is the primary active constituent and main isolate. Other constituents present in clove buds include glucosides of sterols (sitosterol, stigmasterol, and campesterol), crategolic acid, methyl ester, oleanolic acid, quercetin, eugeniin, kaempferol, and rhamnetin (Khan & Abourashed, 2010). The chemical compositions of clove oils will vary due to the differences in plant growing conditions, genetic traits, plant parts used, and the extraction methods (Alma et al., 2007).

Clove bud and leaf oil are generally extracted by water distillation, while clove stem oil is extracted by steam distillation. The stems yield 4-6% and the leaves yield 2-3% volatile oils (Khan & Abourashed, 2010). Clove oil consists of 60-90% eugenol, 2-27% eugenyl acetate, 5-12% β-caryophyllene, and minor constituents such as methyl amyl ketone, methyl salicylate, and benzaldehyde (Bhuiyan, 2012; Bhuiyan et al., 2010; Khan & Abourashed, 2010; Merck, 2015). Clove stem oil usually contains 90–95% and clove leaf oil 82–88% eugenol. Stem and leaf oil may have traces of naphthalene (Burdock, 2016; Khan & Abourashed, 2010).

Mint oils

Various species of the plant genus *Mentha* can be used as sources of mint oil and other mint derivatives (Baser & Buchbauer, 2009). Most commercial sources of mint oil are from cornmint (*M. arvensis*), peppermint (*M. piperita*), spearmint (*M. spicata*), bergamot mint (*M. citrate*), and horse mint (*M. longifolia*) (Lawrence, 2007). Each of these species has a distinct flavor profile based on different chemical

compositions. Peppermint oil is one of the most produced essential oils in the world (Schmidt, 2009). Cornmint and peppermint are the main sources of menthol (Lawrence, 2007). Menthol can also be produced synthetically (Fischetti, 2010). Cornmint oil is sometimes blended with or even misrepresented as peppermint oil (Burdock, 2016). By comparison, the main aromatic component of spearmint oil is carvone (Lawrence, 2007). The mints all contain a rich, variable, and complex mixture of many other aromatic and flavoring compounds, including vindifloral, pulegone, piperitone, limonene, and various flavonoids, terpenoids, and carotenoids (Baser & Buchbauer, 2009; Burdock, 2016; Khan & Abourashed, 2010; Lawrence, 2007).

Most mint oils are produced by high pressure steam distillation (Lawrence, 2007). The original processing method involved packing fresh mint into a chamber and passing steam through it. The moisture would be removed by condensation and the oil would float on top. The mint essential oil would then be removed by distillation using the different boiling points of oil and water (Russell, 1926). Advances in temperature control, vacuum distillation, and crystallization have resulted in higher yields and a greater range of derivatives appropriate for various applications, but mint oil extraction remains mostly a physical and mechanical process (Denny & Lawrence, 2007). Mint oils and other derivatives are used in candy and frozen dairy desserts. Mint essential oils are used in many soaps, toothpastes, and other personal care products, as well as tobacco products (Burdock, 2016; Hayes et al., 2007; Khan & Abourashed, 2010; Lawrence, 2007).

Vanilla extract

The pods from various species of orchids of the genus *Vanilla* are used to make an extract that is one of the most widely used flavoring agents in the world. The primary commercial species *V. planifolia* is native to the upland tropical rain forests of pre-Columbian Meso-America (Lubinsky et al., 2008). Most references to vanilla are to this species, but where there is ambiguity, it may be called "Mexican" or "Bourbon" vanilla. Other species cultivated for use as flavoring agents include *V. tahitensis* or Tahitian vanilla and *V. pompona.* The vanilla orchid is a shade-loving crop and organic farming systems generally intercrop it with other perennial plantation crops, such as coconut, areca nut, and black pepper (Choudhuri et al., 2018). Vanillin, one of the flavoring constituents of natural vanilla, can be produced from synthetic sources (Haarmann, 1884; Hocking, 1997) as well as from genetically modified yeast (*Saccharomyces cerevisiae*) (Brochado et al., 2010; Ramaen et al., 2018). Over 85% of the vanillin sold in the world uses petrochemical-derived guaiacol (Bomgardner, 2016; Ciriminna et al., 2019). Less than 1% comes from natural sources and organic sources are a fraction of that. The FDA classifies vanillin as a synthetic additive [21 CFR 182.60].

Types and WONF

Flavor that is obtained "From The Named Fruit" or "From The Named Flavor" may be labeled as FTNF (FEMA, 2011). Flavors labeled as "types" may contain ingredients other than the juices, extracts, or other derivatives within the identified precursors. If a food contains "both a characterizing flavor from the product whose flavor is simulated and other natural flavor which simulates, resembles or reinforces the characterizing flavor, the food shall be labeled [according to regulatory requirements with] the words "with other natural flavors" [21 CFR 101.22(i)(1)(iii)]. "With Other Natural Flavor" is often abbreviated "WONF." Most products that are made WONF are simulating or resembling fruit and vegetable flavors, but the term may also appear on labels to describe other flavors. A flavor described as a "strawberry flavor WONF" will have flavor components derived from strawberries but will also contain flavoring ingredients that come from other precursors. By contrast, a "strawberry type" natural flavor will contain flavorings derived from other fruit that mimic the taste of strawberries.

<u>Fruit Concentrates and Extracts</u>

Fruit extracts and flavorings have a long history of being used as flavors in mineral waters and carbonated beverages (Berenstein, 2018; Walter, 1916). The 1920s in the U.S. saw numerous innovations in the use of fruit flavorings in beverages. The development of soft drinks to replace the market for alcoholic beverages made illegal by prohibition drove innovation in fruit flavors (Berenstein, 2018), as

did the invention of the cocktail and novel flavoring agents that could be used in illicit alcoholic beverages to make them more palatable (A. F. Smith, 2013).

Because high heat can damage fruit flavors, lower temperatures are used. Sugar solutions become solid at a lower temperature than water, and the water can be removed by freezing, so the concentrate can be poured off. Vacuum distillation has a long history of use in capturing and concentrating various fruit flavors (Cruess, 1924, 1948; Guadagni & Dimick, 1953; Walter, 1916). A third method is removal of water by osmosis through a semi-permeable membrane. These methods would be mechanical or physical processes and would not involve the use of processing aids that are prohibited for organic production. Ion exchange can be used to remove various polar substances.

As noted above, fruit flavoring ingredients that come exclusively from the named flavor may be labeled as "From The Natural Fruit" or "From The Natural Flavor" abbreviated FTNF (FEMA, 2011). These may be formulated with non-flavoring adjuvants. However, label claims may be more restrictive.

Fruit flavors can be categorized by plant taxonomy or origin (Jiang & Song, 2010). Within the classification of fruit concentrates and extracts, the category can be further divided into types of fruit. This report will look at berries, citrus, grape, pome fruit, stone fruit, and tropical fruit. Based on interviews of accredited certifying agents, WONF flavor ingredients comprise a large portion if not most of the certified organic fruit flavors in the Organic Integrity Database (OID) (NOP, 2022).

Berries

Berries are characterized as "soft fruits" because they are highly perishable and difficult to ship without special care in handling. Many have a narrow harvest window that limits sales as fresh fruit. Over 1,800 certified organic berry flavors were listed in the OID. The predominant certified organic berry flavors are strawberry, raspberry, blueberry, and cranberry (NOP, 2022). The database also includes unspecified berry flavor blends. Many of these are modified by the word "type" or "WONF." Extracting berry flavors is considered a value-added proposition.

Citrus

Citrus fruits (*Citrus spp.*) are grown in tropical and subtropical regions and have a distinct flavor profile that is considered desirable in many foods. Species produced for flavors are oranges (*C. sinensis*), lemons (*C. limon*), limes (*C. aurantifolia)*, grapefruit (*C. paradisi*), tangerines (*C. reticulata*), and bitter lemon; these all have different distinct flavor profiles (Burdock, 2016; Hui et al., 2010). Flavorings may be extracted from various parts of the fruit that are not usually consumed. For example, lemon flavor may originate from peels or seeds. The most basic form of a fruit flavoring is a juice concentrate. Concentrates have had the water removed from them by various methods. While citrus greening disease has set back organic production in the U.S. and elsewhere, most organic citrus fruits are still commercially available.

Grapes

Grapes (*Vitis vinifera*) are grown in a broad range of temperate, subtropical, and Mediterranean climates (Winkler, 1974). The fruit is versatile in that it can be consumed fresh as table grapes, dried as raisins, pressed into non-alcoholic juice, or fermented into wine. Grapes were one of the first crops to be produced organically on a large scale (NRC / NAS, 1989). Grape concentrate is one of the main flavor components of fruit flavors that are labeled as [specific fruit] "Type" or "WONF." Determination of the flavors contributed from various organic and nonorganic grape sources in such organic products would require further investigation.

Pome fruit

Apples (*Malus domestica*) and pears (*Malus persica*) are the predominant pome fruits, but other pome fruits are used to derive precursors that create other natural flavors and flavoring agents (Y. H. Hui et al., 2010). Organic apples and pears are extensively cultivated. Organic sources of apple derivatives appear to have the potential to be commercially available, particularly if fruit that does not meet table-grade standards can be used to derive precursors. Apples and pears—like grapes—also appear to be used as sources of flavor components identified in flavor products labeled as "WONF." It was not possible to

determine which flavors use organic apples as precursor sources or are made from nonorganic apples and pears given the data available on the OID (NOP, 2022).

Stone fruit

Various members of the genus *Prunus* are classified as stone fruits based on the presence of a pit found in the center that protects a single seed. The most widely cultivated stone fruits are peaches, plums, apricots, and cherries. Almonds are technically a stone fruit, with the fruit considered the hull and the pit containing the shell and nutmeat. Certified organic sources of all stone fruits considered are listed on the OID, possibly making their derivatives commercially available from organic sources (NOP, 2022).

Tropical fruit

Bananas (*Musa* spp.) are the primarily consumed tropical fruit and with that, the main tropical fruit flavoring used. Most bananas used for fresh fruit are *M. acuminata* var. "Cavendish." However, for flavoring, other varieties and species may be used. More often other fruits are used to make "banana type" flavors. The other tropical fruits that are used as precursors for natural flavors are pineapple (*Ananas comosus*), mango (*Manfifera* spp.), papaya (*Carica papaya*), starfruit (*Averrhoa caramboloa*), and passionfruit (*Passiflora edulis*) (Y. H. Hui et al., 2010). Replication of tropical fruit flavors became a focus of research during the shortages of World War II (Berenstein, 2018). Artificial pineapple flavor was one of the first flavors isolated using a distillation / fractionation process (Haagen-Smit, 1949).

Vegetable Extracts

Vegetable flavors are also used in certain foods. The main vegetable flavors used are garlic, onion, tomato, and peppers. These all appear on the OID, as does carrot extract, sweet potato flavoring, and mixed vegetable flavor or vegetable broth (NOP, 2022). Celery and peppers are covered in the section on herbs. Most of these concentrated forms would be agricultural in origin and minimally processed. Some of the isolated chemicals from hot pepper, e.g., capsaicin, or allicin from garlic, may require additional processing steps that may not be acceptable in organic handling.

Garlic

Garlic (*Allium sativum*) is a vegetable with a recognizable pungent flavor profile. It is well adapted for organic production throughout the temperate U.S. (Bachmann & Hinman, 2008). The characteristic flavor of garlic is largely from the sulfur-containing compounds, primarily diallyl disulfide and the related compounds allicin, allyl disulfide, and triallyl disulfide (Block, 2010). Diallyl disulfide comprises about 60% of garlic oil by weight (Khan & Abourashed, 2010). Diallyl disulfide readily decomposes into the other two allyl sulfide molecules (Block, 2010). Allicin is the main odor component (Khan & Abourashed, 2010). When garlic cloves are cut or crushed, the cysteine-related amino acid alliin is enzymatically converted to allicin, making it a secondary metabolite (Block, 1985).

While fresh and powdered garlic are used for domestic cooking, food processing applications use the oil form of garlic extensively as a flavor ingredient (Khan & Abourashed, 2010). Because it is heavier than most essential oils, garlic oil is produced by a special water and pressurized steam distillation process, with enzymes frequently used in preparations to increase yields (Attokaran, 2017). The oleoresin may be produced either through hexane extraction or the use of supercritical carbon dioxide (Attokaran, 2017). Over 20 different garlic oil volatiles are also isolated and produced by supercritical extraction (Attokaran, 2017). Various derivatives of the amino acid cysteine are extracted from garlic (Burdock, 2016). Garlic is a common flavor in many savory foods, and its derivatives are used as flavoring agents in condiments, relishes, snack foods, soups, dressings, meat, gravies, and many other processed foods (Attokaran, 2017; Khan & Abourashed, 2010).

Tomatoes

Tomatoes (*Lycopersicum esculentum*) are the second most consumed vegetable in the U.S. after potatoes (USDA / ERS, 2022). Lycopene provides tomatoes with a distinct flavor and color profile (Attokaran, 2017). Tomato lycopene extract can be made from the whole fruit, the ripe tomato pulp, or the skins removed in the canning process. Most processes will include some ß-carotene. Various techniques may

be used, including dehydration, solvents such as ethyl acetate, hexane, ethanol, or supercritical CO_2 (Attokaran, 2017).

Animal-derived flavors

Flavoring agents associated with various animal products are used to enhance or recreate flavors in certain products. Most are related to dairy products such as cheeses, frozen desserts, and yogurts. Meat flavor is also desired in certain products. Fish and shellfish flavors are used in some specialty products. Insects are also a source of flavors. Honeybees are the main insect source of flavors, but other insects are being explored for potential future use.

Dairy Flavors

Most milk and dairy flavors consumed in the U.S. are derived from milk and milk products of cattle (*Bos taurus*), such as milk, butter, cheese, whey, and other dairy products. Organic milk is commercially available. The final uses for these flavors are often in non-dairy products where butter or cheese flavor may be advantageous. The introduction of dairy flavor isolates to imitation dairy products has a long and sometimes controversial history. These may be marketed as lactose-free products to the lactose intolerant. Growing interest in the market for vegan dairy substitutes has increased interest in finding dairy flavor substitutes. Partial-dairy or hybrid products that are predominately plant-based but contain animal-derived flavoring components extracted from casein and whey from dairy animals offer a middle ground between animal-based products and those that are completely plant-derived. Such hybrids face ambiguous regulatory status (Kamath et al., 2022).

Meat, Seafood, and Umami Flavors

Meat flavoring is a relatively new development compared to herbs, spices, and essential oils. The science is rapidly changing. Most meat flavoring agents were historically extracted or concentrated from slaughtered and cooked livestock by freeze-drying and concentrating a ground meat slurry from cuts of meat that were edible but not otherwise marketable. Beef bouillon served as a flavoring agent to introduce savory flavors to preparations that were largely plant-based when meat was in short supply. One of the earliest patents for flavorings intended to resemble meat involved the processing of milk and dairy products (Eberhard, 1902). A later invention used whey treated with hydrochloric acid as a meat analog flavor for textured vegetable protein products (Baugher, 1975).

The introduction of the amino acid salt monosodium glutamate (MSG) changed the flavor industry, particularly for savory flavors (Marshall, 1948). MSG was first isolated in 1908 from the Japanese sea vegetable *Laminaria japonica* (Lindemann et al., 2002). MSG introduced the word "umami" as a fifth flavor to common English usage (Tracy, 2016). Other ingredients, mostly L-α-amino acid salts and 5′-ribonucleotides, were introduced to the market as meat and seafood flavorings. The original sources of MSG were considered to be nonsynthetic in the early literature (Marshall, 1948). Most commercial production of MSG is from bacterial fermentation of *Cornyebacterium glutamicum, Brevibacterium lactofermentum,* and *Brevibacterium flavum* (Sano, 2009).

It is unclear whether it would be possible to produce MSG in a way that would meet the criteria specified in the annotation for flavors in § 205.605(a). There are no certified organic sources of MSG. Amino acids in general, particularly MSG, have been the subject of debate within the organic community. Amino acids were included in the original set of NOSB recommendations. Prior to the Natural Flavors recommendation made in 1994, the NOSB tabled the petition. NOSB members voiced the opinion that amino acids should be petitioned separately on a case-by-case basis, although no formal vote appears to have been taken.

More recent inventions involve the genetic modification of microorganisms to recreate the flavor, aroma, texture and colors of meat in predominantly plant-based and fermentation-produced foods through the expression of proteins, amino acids, and fatty acids previously found either exclusively or in higher concentrations in animal tissue (Fraser et al., 2019; Vrljic et al., 2018). These patents disclose the organisms used and DNA sequences responsible. Such techniques could be considered excluded methods under § 205.105, and thus impossible to produce organically.

Bees and other insects

Honeybees (*Apis mellifera*) provide various flavors. Honey, propolis, and beeswax are recognized as flavoring agents or may be used as precursors (IOFI, 2022; U.S. FDA, 2022). Other invertebrates produce chemical substances that are potential precursors to natural flavors. Insect protein and chitin are being explored as potential sources for replicating meat and shellfish flavors in plant-based food (Melgar-Lalanne et al., 2019). Without specific invertebrate standards, the organic certification of insects and other invertebrate animals as agricultural flavor sources remains ambiguous.

Beverage Flavors

Flavors associated with specific non-alcoholic and alcoholic beverages are another category that requires special consideration. Some of these flavors are also used in candies and confectionaries. Alcoholic beverages fit into a separate category and are subject to a different set of regulations from food and non-alcoholic beverages. Flavorings used for beer, wine, and spirits are briefly reviewed here.

Chocolate

The seeds of the cacao plant (*Theobroma cacao*) are used to make the base for the beverage cocoa as well as the flavor component for chocolate. Cocoa extract is made by curing and fermentation of cacao beans, which are then dried and roasted (Burdock, 2016).

Coffee

Fruit of various *Coffea* species are roasted to make coffee. The two main species cultivated are *C. arabica* and *C. robusta*, sometimes called *C. canephora* (Khan & Abourashed, 2010). Roasted coffee is known to contain over 1,000 volatile flavor components (Burdock, 2016). Coffee flavor is mostly associated with the beverage but may also be used as a flavoring agent in some food applications. Powdered coffee is an extract that is sold as instant coffee, but may also be used as a flavoring ingredient (Attokaran, 2017). Coffee flavor may also be extracted using ethanol (Attokaran, 2017; Burdock, 2016).

Tea

Tea is usually associated with the beverage made from the leaves of *Camellia sinensis* (Attokaran, 2017; Khan & Abourashed, 2010). The unfermented leaves that are used to make green tea are treated by either steaming or dry heat processes (Khan & Abourashed, 2010). Black tea is fully fermented after heat treatment (Attokaran, 2017). Enzymes for fermentation are contained in the leaves (Burdock, 2016). White tea and oolong tea are also derived from *Camellia sinensis* through specific traditional treatments and processing. Certain teas are grown and harvested at specific times for specific flavor profiles, with teas grown at high altitudes in India, such as Darjeeling, particularly prized for their quality (Attokaran, 2017). Tea is known for its tannin, which comprises about 13% of the dried leaves (Burdock, 2016). It is also a natural source of flavonoids, anthocyanins, and aldehydes (Khan & Abourashed, 2010). A growing number of ready-to-drink teas are being marketed, many of which rely on various added tea flavorings. Many certified organic flavors are classified as tea, which may be *Camillia sinensis,* but flavors labeled as tea may also refer to uncaffeinated herbal tea blends. Examples include chamomile (mostly *Matricaria chamomilla* and *Chamaemeium nobile but* may be from other sources); rooibos (*Aspalathus* spp.); and hibiscus (*Hibiscsus* spp.). Chai tea—more properly called "masala chai" is made from *Camillia sinensis* and the blend of spices that comprise garam masala. Tea extracts are prepared by several different methods. The most common is steeping in hot water. Tea derivatives can also be made by solvent extraction of the cured leaves by alcohol or other solvents (Burdock, 2016). In addition to use in ready-to-consume shelf-stable tea beverages, tea extracts may be found in baked goods, candy, and frozen desserts, with some baked goods consisting of up to 3% tea extracts (Khan & Abourashed, 2010).

Hops

The main flavoring component of beer is hops (*Humulus lupulus*) (Attokaran, 2017). Hops come from a vigorous climbing perennial vine that has male and female flowers on separate plants. The female flowers, known as cones, are used for flavors. The active flavoring components are found in volatile oils that comprise 0.3-1.0% of the flowers, and 3-12% resinous bitter principles (Khan & Abourashed, 2010). Hops have a complex range of aromas and flavors that reflect a diversity of chemical constituents. Hops

have two types of acids that are responsible for imparting bitterness and aroma. The α-acids include humalone and its related compounds that contribute to bitterness. On the other hand, ß-acids include lupulone and allied chemicals responsible for aroma (Attokaran, 2017). Historically, U.S. brewers preferred milder varieties with lower levels of bitters and aroma (Attokaran, 2017). Craft brewing has changed the preferences for hops that are stronger and have a broader palate of flavors. Hops can be made into an infusion, fluid extracts, tinctures, concretes, and absolutes (Burdock, 2016). Hop oil can be made by steam extraction (Burdock, 2016; Khan & Abourashed, 2010).

Hops were added to 7 CFR 205.606 on June 21, 2007 [72 FR 35137]. In 2009, the USDA received a petition to remove hops from the National List because organic hops were commercially available from multiple sources (Quinn, 2009). Hops were subsequently removed from the National List on October 30, 2014 [79 FR 58655]. However, it is not clear from either the *Federal Register* notice [79 FR 58655] or Policy Memo 11-1 (NOP, 2011) whether the removal of hops from § 205.606 applies to the various hops extracts, or if nonorganic hops extracts are allowed under § 205.605(a).

Wine

The literature on wine flavors is vast, varied, and difficult to summarize. Wood chips may be used to impart an "oak" or other flavor consistent with being wooden barrel-fermented when fermentation takes place in steel tanks.

Maple Flavor

Maple syrup is produced from the sugar maple (*Acer saccharum*). Maple flavor, on the other hand, may be extracted from various spices, such as fenugreek (Burdock, 2016).

Mushrooms and Fungi

Various mushrooms and other members of the fungal kingdom are used to produce flavors. The NOSB recommended standards on October 17, 2001 for organic mushroom production, which are still pending action from the USDA (NOSB, 2001). Although the USDA has not established separate standards for mushrooms and other fungi, certified organic mushroom producers appear in the OID, as do mushroom-derived flavors such as mushroom distillates (NOP, 2022). Mushroom and yeast derivatives are used to produce umami or meat-like flavors (Holtz, 1998).

Smoke Flavor

Many foods are identified by a flavor that reminds the eater of food being prepared over an open wood fire. The invention of liquid smoke allowed for recreation of the flavor without preparing the food over a wood fire. Wood smoke is forced into a kettle or chamber filled with water, which is then steam distilled through a conduit. The smokey liquid is then condensed. An early patent used wood from sugar maple (Chase, 1893). Other sources of wood used may be agricultural or wild harvested in origin. Subsequent improvements were made in processes to removed undesirable flavors and odors, and to formulate products with various ancillary ingredients that improve the dispersion of the flavor through the food matrix (Goblik et al., 1974; Hollenbeck, 1963; Melcer & Sair, 1975; Underwood, 2000). Acetic acid, which may be produced from vinegar or synthesized, was the preferred stabilizer for earlier processes (Goblik et al., 1974; Hollenbeck, 1963). Phosphoric acid may also be added as a stabilizer (Underwood, 2000).

Most smoke flavor comes from combustion or pyrolysis of industrial timber into charcoal. It may be possible to use wood gathered from certified organic fruit trees, but there is no evidence that this is currently done.

Focus Areas Requested by the NOSB

The NOSB requested responses to three focus questions within this technical report:

1) What flavors are available in organic form?
2) What flavors could be certified organic based on their source and manufacturing, but are not?
3) What flavors cannot be certified organic based on their source and manufacturing?

These questions are answered below based on information gathered from documents published by USDA and by the Accredited Certifiers Association (ACA), the literature (with weight given to peer-reviewed journal articles), from data downloaded from the USDA's Organic Integrity Database (OID), and from interviews conducted with personnel working with USDA Accredited Certifying Agents (certifying agents) that have expertise in organic and nonorganic flavors.

USDA and ACA Documents

Official guidance and industry best practices formed the baseline to answer the focus questions. The most relevant official document is the NOP USDA's Policy Memo 11-1 on the *Use of Natural Flavors* (NOP, 2011). That memo superseded an earlier Guidance document titled *NOP Guidance for Certifiers on Flavors* (NOP, 2007). Prior to that, the USDA prepared an *Overview of Flavor Additives* (NOP, 2005). Other relevant NOP documents are the *Classification of Materials* (NOP, 2016a) along with the decision tree to classify substances as synthetic or nonsynthetic (NOP, 2016c). Also relevant is the Accredited Certifier Association's *ACA Best Practices for Review of Nonorganic Flavors* (ACA, 2021a) and *ACA Best Practices for Commercial Availability of Nonorganic Flavors* (ACA, 2020).

While these documents are not legally binding, they serve as guides for the certifiers to implement the regulation consistently.

Organic Integrity Database

To answer the focus questions, OMRI downloaded records of all products identified in the Organic Integrity Database (NOP, 2022) by keywords associated with flavors and status of Certified Organic that were current between November 3 and November 10, 2022. Keywords used included "flavor," "essence," "essential oil," "extract," "WONF," "oleoresin," "distillate," "fortifier," "masker," and "modifier." All certified organic products from processors and handlers that appeared to exclusively make or sell flavors were also downloaded. Many of the certifying agents, particularly those based outside the U.S., identified operations as certified organic only for "flavors" sometimes with modifiers such as "spices" or "extracts" but no specific product identification. These resulted in null fields for specific products. Other operations appeared to be distributors or re-packers that did not process flavors. After removing null records and apparent duplicates, there were approximately 14,877 certified organic flavor products produced by about 154 certified organic handling operations contained in the OID. These operations were certified by 25 of the USDA accredited certifying agents. These are estimates; the exact numbers could not be fully verified with the certifying agents by the deadline for this technical report. *Appendix B* - Suppliers of Organic Flavors includes a list of operations certified organic for products that could be considered "flavors" using the above search criteria, along with their certifying agents and the number of certified organic products identified as "flavors" that they carry.

Certifier Interviews

OMRI requested interviews with certifying agent personnel familiar with the review of organic flavors and evaluation of the use of nonorganic natural flavors in certified organic processed products. Personnel for seven ACAs were interviewed between November 21 and December 15, 2022, in chronological order: QAI, OTCO, CCOF, Pennsylvania Certified Organic, ACO Certification Ltd, and

Washington State Department of Agriculture. The individuals interviewed were either reviewers or supervisors. Most of the interviews were conducted by videoconference. In four of the seven interviews, a supervisor and a reviewer specializing in the review of processing operations were both present.

Experience with organic certification under the NOP ranged from less than one to over ten years. Several had worked for multiple certifiers. Collectively, the certifying agents that agreed to be interviewed account for the certification of 79% of the estimated number of operations that are certified to handle or process organic flavors and 96% of the estimated number of organic flavors certified. The interview questions are included in *Appendix D* - Flavors Technical Report - Certifier Interview Questions. The responses are anonymous and not attributed to any single certifying agent or individual. Aggregate responses are summarized in response to the questions. Exceptions are noted but are not further explained to maintain anonymity. The certifying agents and interviewees were told that the information that they provided would be made public, so no confidential business information was divulged.

Responses to NOSB Focus Questions

1. **What flavors are available in organic form?**

Between November 4 and 10, 2022, OMRI identified over 14,000 different products that are listed as certified organic flavor ingredients on the USDA's Organic Integrity Database (OID). The certifying agents for these products believe that an undetermined number of these products contain less than 5% nonorganic flavor ingredients. If carriers or delivery systems make up over 95% of the ingredients net of water and salt, and the nonorganic ingredients are on the National List, a flavor ingredient is considered eligible to be certified organic. Certifying agents interviewed stated that many products identified as certified organic flavors on the OID contain a nonorganic flavor component or components at less than 5%. The OID does not distinguish between 100% organic natural flavors and those that are a minimum of 95%. Only two products identified as organic flavors in the OID have "100% organic" in the product name, both of which are orange essences. Cold-pressed citrus extracts in general should be commercially available. The certifiers that account for the most certified organic flavors stated that few certified organic flavors—if any—would be 100%. The certifiers that certified only a few flavor manufacturers were more likely to certify 100% organic flavor ingredients, many of which were single ingredients that were mechanically extracted or concentrated.

Order of words on the label of the certified organic product matter. By comparison, 4,563 of the certified organic flavors in the OID are identified as "WONF" or "With Other Natural Flavors." Accredited Certifying Agent review staff familiar with these products indicated that these other natural flavors are more often nonorganic natural flavors meeting the annotation of § 205.605(a). They may be made from nonorganic sources, or the precursors may have been extracted using solvents or other processing aids that are acceptable under the annotation but that are not acceptable to produce a certified organic flavor. The "other natural flavors" may also be certified organic, so WONF is not, by itself, an indication of a nonorganic flavoring agent in an organic flavor.

All ACAs interviewed reported that they allowed nonorganic flavors that were available in organic form, but the word "form" has other meanings besides organic or nonorganic. Specifically, when referring to flavors, the word "form" often refers to the physical characteristics, such as liquid or solid. Within the physical state, there may be functional differences related to the way that they are extracted or delivered. Solids may be in powder, flake, or granular form. Some concentrated solids or semi-solids are called "concrete" forms. Liquids may be presented as extracts, essential oils, or oleoresins. Thus, a processor may not be able to find a certified organic flavor to be commercially available in the form required for a specific application in an organic processed product. Questions regarding functionality and quality may require greater documentation. By definition, a flavor is limited only to that functionality, but as discussed above, flavoring agents may be multifunctional. Quality is inherently subjective. Certifying agents may ask for the results from flavor panels or other supporting empirical evidence, but none was able to provide specific examples where they deemed such evidence unacceptable.

The nonorganic flavoring components in an organic flavor, or a nonorganic flavor that a processor uses in lieu of an organic flavor, may involve chemical processing steps that would not be obvious if the nonorganic flavoring agent is supported by an affidavit, rather than the certifier independently verifying its extraction or isolation process. Several of the certifiers acknowledged that they do not evaluate every nonorganic agent in a certified organic flavor that they certify using Guidance 5033-2 (NOP, 2016b) in order to confirm that the ingredient is nonagricultural and thus permitted under § 205.605(a), and that it has not undergone a chemical change and is thus nonsynthetic.

2. What flavors could be certified organic based on their source and manufacturing process, but are not?

Certifying agents reported in interviews that when added up between them all, they have reviewed thousands of nonorganic flavor ingredient declarations. None could give a precise number of how many they have reviewed over the years, although the smaller certifiers interviewed thought that the information could be retrieved without much effort. The larger ones would take more time, and they do not archive withdrawn product applications that they never certified.

The interviewees said that they consistently followed the ACA's *Best Practices for Commercial Availability of Natural Flavors* (ACA, 2020) and indicated that they mostly followed the ACA's *Best Practices for the Review of Organic Flavors* (ACA, 2021a), but with some variations in interpretation. The ACA Best Practices and the accompanying forms are included in *Appendix C - ACA Best Practices*.

The procedures in both best practices rely mostly on documentation provided by the entity seeking to use a nonorganic flavor. While the *Best Practices for the Review of Natural Flavors* document indicates that additional verification steps may be taken, the follow-up is done to varying degrees. Those interviewed acknowledged that in most cases they do not follow up with the vendors of the flavors to investigate whether specific nonorganic flavors used by their clients could potentially be produced and handled in a way that would make them eligible for organic certification. A complicating factor in some cases occurs when multiple operations and suppliers are involved, such as when a brand owner is purchasing the ingredients and setting the specifications, and a co-packer or toll processor is doing the actual processing for a private label product.

Certifying agents that agreed to be interviewed reported that answering the question, "What flavors could be certified organic based on their source and manufacturing process, but are not?" would require a manual search to identify what nonorganic flavors have been approved and a further investigation into the factors that rendered them nonorganic. Such a project requires investigation of each individual nonorganic flavor that is currently used, going back to the production of the agricultural source, each isolated flavor precursor, and each final flavor. The data that is required is supposed to be on file with the certifiers and can be requested through the accreditation process. Each nonorganic flavor used would need to be evaluated to determine whether the source is agricultural or nonagricultural, whether isolation or extraction of the flavor precursor maintains organic integrity under § 205.270, and whether transformation of the precursor into the final flavoring agent renders it synthetic or maintains it as nonsynthetic. This includes nonorganic flavors used as ingredients in certified organic flavors. For certifiers, this might take a few hours of personnel time. For others, such a review could take hundreds of hours of file review and in some cases may still lead to inconclusive results.

Given that the suppliers of nonorganic flavors are not required to disclose the production and handling techniques, it is not possible to determine whether the obstacles to organic certification are insurmountable. The obstacles may be related to production, handling, or both. Some of the certifiers interviewed indicated that supply chain disruptions and changing international conditions (e.g., the revocation of India's recognition agreement) have created shortages of previously available organic ingredients. These may be seen as temporary but could be long-term if facilities have closed or will have difficulties with the changed regulatory environment. Several certifiers interviewed indicated that they believed the new Strengthening Organic Enforcement [88 FR 3548] regulation will make the certification of organic flavors more difficult. Strengthening Organic Enforcement was published after the primary

drafting of this report on January 19, 2023.

Coming up with an exhaustive list of what flavors could be certified organic would require a case-by-case review of every source of every flavor identified by IOFI and the Flavor Extract Manufacturers Association (FEMA) using the definitions in OFPA and the NOP regulations for both agricultural/nonagricultural and synthetic/nonsynthetic. Under current guidance, that would mean applying Policy 5033 (NOP, 2016) to multiple sources of the same flavor ingredient (NOP, 2016a). Some flavors may be considered both natural and synthetic by FDA, and even a natural source according to the FDA definition could be considered synthetic under the NOP. An example given in the ACA *Best Practices for the Review of Organic Flavors* is the derivative ethyl acetate *(*ACA, 2021a*)*. Ethyl acetate is considered synthetic by the FDA in 21 CFR 182.60, though some certifying agents have reviewed it as nonsynthetic. Even if it were technically possible to produce a currently nonorganic flavor as certified organic, further research would be required in each case to determine the form needed to meet quality standards, and sufficient quantity would be needed for it to be considered commercially available.

When asked whether nonorganic flavors used in organic products could feasibly be certified organic, most certifying agents interviewed either had no opinion or thought it was not possible. However, at least two interviewees thought that it would be technologically possible to replicate any flavor currently used in an organic product in organic form. The certifying agents did not express a consensus about what it would be required for organic products to be made only with certified organic flavors if flavors were sunset from 7 CFR 205.605(a). The question of what nonorganic nonagricultural flavors that are currently permitted under § 205.605(a) would no longer be permitted if flavors were removed from the National List was also not possible to answer based on the available data in the published literature. The data would need to be collected from the processors and the certifying agents that certify them. Further investigation of the consequences of removing flavors from § 205.605(a) is needed. The feasibility of replacing specific individual nonorganic flavors used in organic processed products with organic ones that are commercially available is outside the scope of this technical report.

3. What flavors cannot be certified organic based on their source and manufacturing?

Flavors that are synthetic, made with excluded methods, or made with ingredients and processing aids that do not appear on the National List cannot be certified organic. These are represented in Case #s 2, 4, 6, and 7 on *Table 1* of this report. Such flavors are currently not allowed for use under 7 CFR 205.605(a) and the sunset of natural flavors would not change that. This includes most if not all artificial flavors as defined by the FDA in 21 CFR 101.22(a)(1) The FDA has also listed some flavors as "synthetic" at 21 CFR 101.60 (*Table 2*). These presumably cannot be certified organic or be used as a natural flavor in an organic product under 7 CFR 205.605(a) because they are synthetic and not included on § 205.605(b). The ACA *Best Practices for the Review of Non-Organic Flavors* refer to the FDA sections relevant for the review of natural flavors, but do not outline steps for the verification that flavors identified as synthetic by the FDA are *not* used. The Best Practices appear to allow some artificial flavors that may be derived from natural sources. Thus, a precautionary approach would be to assume that the flavors are synthetic in the absence of a thorough evaluation of the source and manufacturing process of each using NOP Guidance 5033 (NOP, 2016a).

Table 1: Flavors considered "synthetic" by the FDA.

Acetaldehyde (ethanal)
Acetoin (acetyl methylcarbinol)
Anethole (parapropenyl anisole)
Benzaldehyde (benzoic aldehyde)
N-Butyric acid (butanoic acid)
d- or l-Carvone (carvol)
Cinnamaldehyde (cinnamic aldehyde)
Citral (2,6-dimethyloctadien-2,6-al-8, gera-nial, neral)
Decanal (N-decylaldehyde, capraldehyde, capric aldehyde, caprinaldehyde, aldehyde C-10)
Ethyl acetate
Ethyl butyrate
3-Methyl-3-phenyl glycidic acid ethyl ester (ethyl-methyl-phenyl-glycidate, so-called strawberry aldehyde, C-16 aldehyde)
Ethyl vanillin
Geraniol (3,7-dimethyl-2,6 and 3,6-octadien-1-ol)
Geranyl acetate (geraniol acetate)
Limonene (d-, l-, and dl-)
Linalool (33lorenti, 3,7-dimethyl-1,6-octadien-3-ol)
Linalyl acetate (bergamol)
Methyl anthranilate (methyl-2-aminobenzoate)
Piperonal (3,4-methylenedioxy-benzaldehyde, heliotropin)
Vanillin

Source: 21 CFR 182.60

More artificial flavors are listed in the FDA regulations in 21 CFR 172.515(b). While most presumably are prohibited for use as ingredients in organic food products based on 7 CFR 205.105(c), there may be exceptions. It was not possible to determine from secondary sources or from interviews with certifying agents which, if any, of these substances are used as flavoring agents in certified organic flavors, or as nonorganic flavors permitted for use in organic processed products under § 205.605(a). To make that determination would require identification and declaration of each ingredient in a flavor, and a case-by-case review using NOP Guidance 5033 to determine whether they are agricultural or nonagricultural and, if nonagricultural, whether they are synthetic or nonsynthetic (NOP, 2016a). A safe assumption is that most, if not all of these substances are nonagricultural and synthetically produced unless sources and manufacturing processes are fully documented and verified to be nonagricultural and nonsynthetic, which is the conclusion of Case 6 in *Table 1* above. However, from the interviews, it does not appear that certification agents currently take that approach.

Every interviewee indicated that they did not have the information or expertise to determine what certified organic flavors are infeasible. None of the certifiers interviewed use NOP *Decision Tree for the Classification of Substances as Agricultural or Non-Agricultural* or the *Decision Tree for the Classification of Substances as Synthetic or Non-synthetic* when evaluating flavors (NOP, 2016b, 2016c). Although they acknowledged that doing so would be consistent with best practices, they indicated that it was not required under NOP *Policy Memo on the Use of Natural Flavors* (NOP, 2011). Doing so would add significantly to the time required to evaluate flavor components. Some certification personnel questioned whether such an approach was consistent with a sound and sensible approach to organic certification. The ACA *Best Practices for the Review of Non-Organic Flavors* document and NOP *Policy Memo on the Use of Natural Flavors* do not explain the conditions under which a flavor ingredient from an agricultural source would be transformed into a nonagricultural ingredient (ACA, 2021a; NOP, 2011*)*. Most, if not all, natural flavors are agricultural in origin. Most of the processing techniques that would render them to be nonagricultural would likely render them synthetic as well, and thus not allowed for use in an organic processed food product [7 CFR 205.105(c)].

Certification decisions to allow specific flavor ingredients as nonagricultural and nonsynthetic were not made available in the interviews. In many cases, these involve proprietary techniques or trade secrets. One approach to answering this focus question would be to conduct a manual search of organic handling plan statements and investigate the sources, manufacturing processes, processing aids, and ancillary ingredients used to make certified organic food products.

With respect to *Table 1* above, the certifiers presented differing interpretations of what was meant to be agricultural and nonagricultural, what made a specific isolate or derivative synthetic or nonsynthetic, what qualified under § 205.605(a), and what was prohibited based on § 205.105. While most said they followed the ACA *Best Practices for the Review of Non-Organic Flavors (ACA, 2021a)*, the degree that they followed up with additional questions beyond what is provided in the application varied. Certifying agents do not perform inspections of uncertified flavor manufacturers to verify sources, extraction methods, and formulation procedures, consistent with other non-organic processing ingredients. In general, flavor ingredients are not third party verified for compliance with the annotation.

Nonorganic flavoring agents produced in-house by certified organic flavor producers also posed a dilemma, and there was no consensus among the interviewees about the appropriate procedures to pursue verifying the validity of claims of compliance in such situations. The prevailing approach was to continue to request more information for a questionable ingredient rather than deny certification or issue a noncompliance. None could provide a specific publicly disclosed case of a noncompliance or suspension based on the use of a nonorganic flavor that did not comply with § 205.605(a). All certifiers interviewed acknowledged that the review of flavors was difficult, complicated, and time-consuming to verify under the current regulations.

A growing number of flavors are not possible to be certified organic based on their origin from genetically modified organisms. Given the exclusion set by § 205.105, these also do not meet the requirements to be used as nonorganic, nonagricultural ingredients allowed in organic processed products. Vegetable, bacterial, and fungal-based meat flavorings are a prominent recent example, as discussed above. Natural flavors from genetically modified fermentation organisms are also being introduced to replace vanilla and citrus fruits.

Flavors that are derived from certified organic sources and precursors but do not have specific organic standards—yeast, for example—offer a challenge. Yeast appears separately on § 205.605(a) with a similar annotation to flavors. Given that there are no specific standards for fungi or invertebrate animals, other possible ingredients that may be nonorganic include derivatives from honeybees and edible mushrooms, though certified organic distilled honey, propolis extract, yeast flavors, and distilled mushroom flavors are all found in the OID *(NOP, 2022)*. The NOP does not have aquaculture standards, making flavors derived from fin fish, shellfish, and aquatic plants a challenge. While aquatic animals are not certified organic, there are some aquatic plants certified under the current USDA organic standards.

Various flavors derived from forest and timber products may not be possible to certify as organic. Several natural flavor extracts come from pine or fir needles. One source flavoring that is outside the jurisdiction of the FDA is wood chips used for the aging of wine, whiskey, and other beverages that contain alcohol. Processors may use oak chips to flavor wines, for example. While it is hypothetically possible to certify organic oak trees, in practice it is not done. Other nonorganic, nonagricultural flavoring agents permitted for alcoholic beverages and tobacco products may not be possible to produce organically.

Five examples of non-certifiable flavors are:

1) Castoreum derived from beavers.
2) Tonquin musk oil from musk deer.
3) Wood chips from nonorganic forest products.
4) Distilled liquid smoke.
5) Fish flavors.

Salt (sodium chloride) is in a unique category as a flavoring agent in that it is excluded from the calculation of organic percentage, along with water. There have been attempts to develop standards for certified organic salt in other countries. Other minerals may have functionality as flavoring agents, but none are as recognizable or primary as salt. Other minerals already on the National List at § 205.605 have some influence over flavor, but they are used as additives with other primary functionalities. Examples include calcium chloride, potassium chloride, and magnesium sulfate.

Report Authorship

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Appendix A - Natural Flavor Additives

Name	CAS Number or Other ID	FEMA Number
Alfalfa, Extract (Medicago sativa L.)	84082-36-0	2013
Alfalfa, Herb And Seed (Medicago sativa L.)	977092-93-5	
Allspice (Pimenta officinalis Lindl.)	977051-72-1	2017
Allspice, Oil (Pimenta officinalis Lindl.)	8006-77-7	2018
Allspice, Oleoresin (Pimenta officinalis Lindl.)	977017-87-0	2019
Almond, Bitter, Oil (ffpa) (Prunus spp.)	8013-76-1	2046
Aloe, Extract (Aloe spp.)	84837-08-1	2047
Althea Flowers (Althea officinalis L.)	977052-71-3	
Althea Root (Althea officinalis L.)	977005-75-6	2048
Ambergris, tincture	977023-08-7	2049
Ambrette, Absolute, Oil (Hibiscus abelmoschus L.)	977017-79-0	2050
Ambrette Seed (Hibiscus abelmoschus L.)	977052-20-2	
Ambrette Seed, Oil (Hibiscus abelmoschus L.)	8015-62-1	2051
Ambrette, Tincture (Hibiscus abelmoschus L.)	977017-78-9	2052
Amyris (Amyris balsamifera L.)	977059-69-0	
Amyris, Oil (Amyris balsamifera L.)	8015-65-4	
Angelica (Angelica spp.)	977050-05-7	
Angelica Root (Angelica spp.)	977050-06-8	2087
Angelica Root, Extract (angelica Archangelica L.)	977032-49-7	2087
Angelica Root, Oil (angelica Archangelica L.)	8015-64-3	2088
Angelica Seed (Angelica spp.)	977050-07-9	
Angelica Seed, Extract (Angelica archangelica L.)	977032-50-0	2089
Angelica Seed, Oil (Angelica archangelica L.)	977050-08-0	2090
Angelica Stem, Oil (Angelica archangelica L.)	977032-48-6	2091
Angola Weed (Roccella fuciformis Ach.)	977038-44-0	
Angostura (Galipea offincinalis Hancock)	977000-22-8	
Angostura, Extract (Galipea officinalis Hancock)	68916-12-1	2092
Anise (Pimpinella anisum L.)	977007-65-0	2093
Anise, Oil (Pimpinella anisum L.)	8007-70-3	2094
Anise, Star (Illicium verum Hook, F.)	977052-16-6	2095
Apricot Kernel, Oil (Prunus armeniaca L.)	72869-69-3	2105
Arnica Flowers (Arnica spp.)	977000-27-3	
Artemisia (Artemisia spp.)	977052-73-5	3114
Artemisia Extract	977032-37-3	3115
Artemisia Oil	8008-93-3	3116
Artichoke Leaves (Cynara scolymus L.)	977038-45-1	
Asafetida, Fluid Extract (Ferula assafoetida L.)	977038-46-2	2106
Asafetida, Gum (Ferula assafoetida L.)	9000-04-8	2107
Asafetida, Oil (Ferula assafoetida L.)	72869-70-6	2108
Balm (Melissa officinalis L.)	977051-08-3	2111
Balm Leaves (Melissa officinalis L.)	977090-74-6	
Balm Leaves, Extract (Melissa officinalis L.)	84082-61-1	2112

Name	CAS Number or Other ID	FEMA Number
Balm, Oil (Melissa officinalis L.)	8014-71-9	2113
Balsam, fir needles and twigs (Abies balsamea (l.) Mill.)	977107-97-3	
Balsam, Peru, Oil (Myroxylon pereirae Klotzsch)	977136-92-7	2117
Basil (Ocimum basilicum L.)	977050-14-8	2118
Basil Bush (Ocimum minimum L.)	977051-55-0	
Basil, Extract (Ocimum basilicum L.)	84775-71-3	
Basil, Oil (Ocimum basilicum L.)	8015-73-4	2119
Basil, Oleoresin (Ocimum basilicum L.)	977017-82-5	2120
Bay (Laurus nobilis L.)	977050-15-9	2124
Bay Leaves, Sweet, Extract (Laurus nobilis L.)	84603-73-6	2613
Bay Leaves, Sweet, Oil (Laurus nobilis L.)	8007-48-5	2125
Bay Leaves, West Indian, Oil (Pimen46aponariosa (mill.) J.w. Moore)	8006-78-8	2122
Carrot, Oil (Daucus carota L.)	8015-88-1	2244
Dog Grass, Extract (Agropyron repens (l.) Beauv.)	977038-73-5	2403
Dra'on's Blood, Extract (Daemonorops spp. or other botanical sources)	9000-19-5	2404
Benzoin, Resin (Styrax spp.)	9000-05-9	2133
Bergamot, Oil (Citrus aurantium L. Subsp. Bergamia Wright Et Arn.)	8007-75-8	2153
Blackberry Bark, Extract (Rubus, spp. Of section Eubatus)	977047-53-2	2155
Bois De Rose, Oil (Aniba rosaeodora Ducke)	8015-77-8	2156
Boldus Leaves (Peumus boldus Mol.)	977052-75-7	
Boronia, Absolute (Boronia megastigma Nees)	8053-33-6	2167
Bryonia Root (Bryonia spp.)	977000-49-9	
Buchu Leaves (Barosma betulina46aponariaata)	977000-50-2	
Buchu Leaves Extract	977009-82-7	
Buchu Leaves, Oil (Barosma spp.)	68650-46-4	2169
Buckbean Leaves (Menyanthes trifoliata L.)	977038-51-9	
Buckbean Leaves, Extract (Menyanthes trifoliata L.)	977038-52-0	
Cajeput, Oil (Melaleu46aponaria46onron L.)	8008-98-8	2225
Calumba Root (Jatrorrhiza palmata (lam.) Miers)	977000-55-7	
Calumba Root, Extract (Jatrorrhiza palmata (lam.) Miers)	977000-74-0	
Camphor, Japanese, White, Oil (Cinnamomum camphora (l.) Nees Et Eberm.)	8008-51-3	2231
Cananga, Oil (Cananga odorata Hook. F. And Thoms.)	68606-83-7	2232
Capers (Capparis spinosa L.)	977050-25-1	
Capsicum (Capsicum spp.)	977007-72-9	
Capsicum Extract (Capsicum spp.)	977018-42-0	2233
Capsicum, Oleoresin (Capsicum spp.)	8023-77-6	2234
Caraway (Carum carvi L.)	977001-27-6	2236
Caraway, Black (Nigella sativa L.)	977017-84-7	2237
Caraway, Oil (Carum carvi L.)	8000-42-8	2238
Cardamom (Elletaria cardamomum (l.) Maton)	977005-95-0	2240
Cardamom oleoresin	977090-82-6	
Cardamom Seed, Oil (Elletaria cardamomum (l.) Maton)	8000-66-6	2241
Haw Bark, Black, Extract (Viburnum prunifolium L.)	84929-54-4	2538

Name	CAS Number or Other ID	FEMA Number
Hemlock (Tsuga spp.)	977074-62-6	
Hemlock Needles And Twigs, Oil (Tsuga spp.)	8008-10-4	
Carob Bean, Extract (Ceratonia siliqua L.)	84961-45-5	2243
Cascara, Bitterless, Extract (Rhamnus purshiana Dc.)	977090-83-7	2253
Cascarilla Bark, Extract (Croton spp.)	977083-53-6	2254
Cascarilla Bark, Oil (Croton spp.)	8007-06-5	2255
Cassia Buds (Cinnamomum cassia Blume)	977091-24-9	2259
Cassie, Absolute (Acacia farnesiana (l.) Willd.)	977017-58-5	2260
Castoreum, Extract (Castor spp.)	8023-83-4	2261
Castoreum, Liquid (Castor spp.)	977016-89-9	2262
Castor Oil (Ricinus communis L.)	8001-79-4	2263
Catechu, Black, Extract (Acacia catechu Willd.)	8001-76-1	2264
Catechu, Black, Powder (Acacia catechu Willd.)	977090-84-8	2265
Cedar Leaf, Oil (Thuja occidentalis L.)	8007-20-3	2267
Celery Seed (Apium graveolens L.)	977007-75-2	2268
Celery Seed, Extract (Apium graveolens L.)	89997-35-3	2269
Celery Seed, Extract Solid (Apium graveolens L.)	977038-53-1	2270
Celery Seed, Oil (Apium graveolens L.)	8015-90-5	2271
Celery Seed, Oleoresin	977090-86-0	
Centaury (Centaurium umbellatum Gilib.)	977052-77-9	
Chamomile Flower (Anthemis nobilis L.)	977007-26-3	
Chamomile Flower, Hungarian, Oil (Matricaria chamomilla L.)	8002-66-2	2273
Chamomile Flower (Matricaria chamomilla L.)	977001-96-9	
Chamomile Flower, Oil (Anthemis nobilis L.)	8015-92-7	2272
Chamomile Flower, Roman, Extract (Anthemis nobilis L.)	84649-86-5	2274
Cherry Bark, Wild, Extract (Prunus serotina Ehrh.)	84604-07-9	2276
Cherry-laurel Leaves (Prunus laurocerasus L.)	977052-78-0	
Cherry Laurel, Oil (Prunus laurocerasus L.) (ffpa)	8000-44-0	2277
Cherry-laurel Water (Prunus laurocerasus L.)	977038-56-4	
Cherry Pits, Extract (Prunus spp.)	977038-54-2	2278
Chervil (Anthriscus cerefolium (l.) Hoffm.)	1338-80-3	2279
Chervil, Extract (Anthriscus cerefolium L.)	85085-20-7	
Chestnut Leaves (Castanea dentata (marsh.) Borkh.)	977052-79-1	
Chestnut Leaves, Extract (Castanea dentata (marsh.) Borkh.)	977023-21-4	
Chestnut Leaves, Extract Solid (Castanea dentata (marsh.) Borkh.)	977038-58-6	
Chicory, Extract (Cichorium intybus L.)	68650-43-1	2280
Chirata (Swertia chirata Buch.-ham.)	977052-80-4	
Chirata, Extract (Swertia chirata Buch.-ham.)	90604-50-5	
Chives (Allium schoenoprasum L.)	977050-37-5	
Cinchona Bark, Red (Cinchona succirubra Pav. Or Its Hybrids)	977052-81-5	2281
Cinchona Bark, Red, Extract (Cinchona succirubra Pav. Or Its Hybrids)	977038-61-1	2282
Cinchona Bark, Yellow (Cinchona spp.)	977052-82-6	2283
Cinchona Bark, Yellow, Extract (Cinchona spp.)	977083-24-1	2284

Name	CAS Number or Other ID	FEMA Number
Cinchona, Extract (Cinchona spp.)	68990-12-5	2285
Cinnamon (Cinnamomum spp.)	977000-66-0	2289
Cinnamon Bark, Extract (Cinnamomum spp.)	977038-60-0	2290
Cinnamon Bark, Oil (Cinnamomum spp.)	8007-80-5	2291
Cinnamon Bark Oleoresin, Ceylon, Chinese, Or Saigon (Cinnamomum spp.)	977091-23-8	
Cinnamon Leaf, Oil (Cinnamomum spp.)	8015-96-1	2292
Cinnamon Leaf Oil, Rectified	977184-45-4	
Citronella, Oil (Cymbopogon nardus Rendle)	8000-29-1	2308
Citrus Peels, Extract (Citrus spp.)	977038-62-2	2318
Civet, Absolute (Viverra civetta Schreber & Viverra zibetha Schreber)	68916-26-7	2319
Clary (Salvia sclarea L.)	977051-94-7	2320
Clary, Oil (Salvia sclarea L.)	8016-63-5	2321
Clary Sage, Absolute	8022-75-1	
Clary Sage, Concrete	977183-97-3	
Clover (Trifolium spp.)	977002-83-7	
Clover, Extract (Trifolium spp.)	977070-51-1	
Clover, Oil (Trifolium spp.)	977042-18-4	
Clover Tops, Red, Extract Solid (Trifolium pratense L.)	977038-65-5	2326
Coca Leaf, Extract (decocainized) (Erythroxylon coca Lam.)	977073-62-3	2329
Coffee Concentrate, Pure	977091-25-0	
Coffee Extract, Solid	977091-26-1	
Cognac, Green, Oil	8016-21-5	2331
Cognac, White, Oil	977050-49-9	2332
Copaiba (South American spp. Of Copaifera L.)	8001-61-4	
Copaiba, Oil (South American spp. Of Copaifera L.)	8013-97-6	
Coriander (Coriandrum sativum L.)	977007-81-0	2333
Coriander Leaf Oil (Coriandrum sativum L.)	977183-62-2	
Coriander, Oil (Coriandrum sativum L.)	8008-52-4	2334
Cork, Oak (Quercus spp.)	977038-68-8	
Costmary (Chrysanthemum balsamita L.)	977017-86-9	
Costus Root, Oil (Saussurea lappa Clarke)	8023-88-9	2336
Cubeb (Piper cubeba L. F.)	977000-82-0	2338
Cubeb, Oil (Piper cubeba L. F.)	8007-87-2	2339
Cumin (Cuminum cyminum L.)	977050-55-7	2340
Cumin, Oil (Cuminum cyminum L.)	8014-13-9	2343
Currant Buds, Black, Absolute (Ribes nigrum L.)	68606-81-5	2346
Currant Juice, Black	977038-70-2	
Currant Leaves, Black (Ribes nigrum L.)	977032-41-9	
Damiana Leaves (Turnera diffusa Willd.)	977000-85-3	
Dandelion, Fluid Extract (Taraxacum spp.)	977038-71-3	2357
Dandelion Root, Extract Solid (Taraxacum spp.)	977038-72-4	2358
Davana Oil (Artemesia Pallens Wall.)	8016-03-3	2359
Dill Seed, Indian (Anethum spp.)	977082-99-7	2384

Name	CAS Number or Other ID	FEMA Number
Dill Seed Oil (Anethum sowa Roxb.)	8016-05-5	
Dittany Of Crete (Origan49aponarianus L.)	977017-92-7	2399
Dittany (fraxinella) Roots (Dictamnus albus L.)	977047-65-6	
Elder Flowers (Sambucus canadensis L. Or Sambucus nigra L.)	977002-47-3	2406
Elder Flowers, Extract (Sambucus canadensis L. Or Sambucus nigra L.)	977010-39-1	
Elder Tree Leaves (Sambucus nigra L.)	977038-74-6	
Elecampane Root, Extract (Inula helenium L.)	84012-20-4	
Elecampane Root, Oil (Inula helenium L.)	1397-83-7	
Elemi, Gum	9000-75-3	2407
Elemi, Oil (Canarium spp.)	8023-89-0	2408
Erigeron, Oil (Erigeron canadensis L.)	8007-27-0	2409
Eucalyptus, Oil (Eucalyptus globulus Labille)	8000-48-4	2466
Fennel, Common (Foeniculum vulgare Mill.)	977001-13-0	2481
Fennel, Sweet (Foeniculum vulgare Mill. Var. Dulce (d.c.) Alef.)	977007-85-4	2482
Fennel, Sweet, Oil (Foeniculum vulgare Mill. Var. Dulce (d.c.) Alef.)	8006-84-6	2483
Fenugreek (Trigonella foenum-graecum L.)	977155-29-5	2484
Fenugreek, Extract (Trigonella foenum-graecum L.)	84625-40-1	2485
Fenugreek, Oleoresin (Trigonella foenum-graecum L.)	977018-53-3	2486
Fir (pine) Needles And Twigs (Abies sibirica Ledeb.)	8021-29-2	2905
Fir Needles And Twigs, Oil (Abies spp.)	8021-28-1	2905
Galanga, Greater (Alpinia Galanga Willd)	977050-77-3	
Galangal Root (Alpinia spp.)	977038-75-7	2498
Galangal Root, Extract (Alpinia spp.)	977038-76-8	2499
Galangal Root, Oil (Alpinia spp.)	8024-40-6	2500
Galbanum, Oil (Ferula spp.)	8023-91-4	2501
Galbanum, Resin (Ferula spp.)	9000-24-2	2502
Gambir (Uncaria gambir Roxb.)	8001-48-7	
Genet, Absolute (Spartium junceum L.)	977161-78-6	2504
Genet, Extract (Spartium junceum L.)	90131-21-8	2505
Gentian Root, Extract (Gentiana lutea L.)	72968-42-4	2506
Gentian, Stemless (Gentiana acaulis L.)	977088-41-7	
Geranium (Pelargonium spp.)	977001-35-6	
Geranium, East Indian, Extract (Cymbopogon martini Stapf.)	977091-47-6	
Geranium, East Indian, Oil (Cymbopogon martini Stapf.)	8014-19-5	2831
Geranium Extract (Pelargonium spp.)	977091-46-5	
Geranium, Oil (Pelargonium spp.)	8000-46-2	
Geranium, Rose, Oil (Pelargoni49lorentinalen' L'her.)	977143-78-4	2508
Germander, Chamaedrys (Teucrium chamaedrys L.)	977081-08-5	
Germander, Chamaedrys, Extract (Teucrium chamaedrys L.)	977091-51-2	
Germander, Chamaedrys, Extract Solid (Teucrium chamaedrys L.)	977091-52-3	
Germander, Golden (Teucrium polium L.)	977088-44-0	
Ginger (Zingiber officinale Rosc.)	977001-38-9	2520
Ginger, Extract (Zingiber officinale Rosc.)	84696-15-1	2521

Name	CAS Number or Other ID	FEMA Number
Ginger, Oil (Zingiber officinale Rosc.)	8007-08-7	2522
Ginger, Oleoresin (Zingiber officinale Rosc.)	8002-60-6	2523
Grains Of Paradise (Aframomum melegueta (rosc.) K. Schum.)	977050-87-5	2529
Grapefruit Essence, Natural	977091-55-6	
Grapefruit, Extract	90045-43-5	
Grapefruit, Juice	977038-26-8	
Grapefruit, Oil (Citrus paradisi Macf.)	8016-20-4	2530
Grapefruit Oil, Conc.	977083-05-8	
Grapefruit, Oil, Terpeneless (Citrus paradisi)	68916-46-1	
Guaiac Gum (Guaiacum spp.)	9000-29-7	
Guaiac Gum, Extract (Guaiacum spp.)	84650-13-5	2531
Guaiac Wood, Extract (Guaiacum spp.)	977083-52-5	2533
Guaiac Wood, Oil (Guaiacum spp.)	8016-23-7	2534
Guarana, Gum (Paullinia cupana Hbk)	84929-28-2	2536
Guarana Seed, Extract	977145-75-7	
Guava Extract	90045-46-8	
Hickory Bark, Extract (Carya spp.)	977023-22-5	2577
Hops, Extract Solid (Humulus lupulus L.)	977083-25-2	2579
Hops, Oil (Humulus lupulus L.)	8007-04-3	2580
Horehound Extract (Marrubium vulgare L.)	84696-20-8	2581
Horehound (Marrubium vulgare L.)	977001-59-4	
Horehound Solid, Extract	977089-41-0	
Horsemint Leaves, Extract (Monarda spp.)	8006-85-7	2582
Horseradish (Armoracia lapathifolia Gilib.)	977050-94-4	
Hyacinth, Absolute (Hyacinthus orientalis L.)	977086-46-6	
Hyacinth Flowers (Hyacinthus orientalis L.)	977047-90-7	
Hyssop, Extract (Hyssopus officinalis L.)	84603-66-7	2590
Hyssop (Hyssopus officinalis L.)	977001-63-0	2589
Hyssop, Oil (Hyssopus officinalis L.)	8006-83-5	2591
Iceland Moss (Cetraria islandica Ach.)	977017-63-2	
Immortelle, Absolute (Helichrysum angustifolium Dc)	977060-66-4	
Immortelle, Extract (Helichrysum angustifolium Dc.)	90045-56-0	2592
Imperatoria (Peucedanum ostruthium (l.) Koch (Imperatoria ostruthium L.))	977002-32-6	
Iva (Achillea moschata Jacq.)	977091-61-4	
Iva, Extract (Achillea moschata Jacq.)	977091-62-5	
Jasmine, Absolute (Jasminum spp.)	977146-68-1	2598
Jasmine, Concrete (Jasminum spp.)	977125-38-4	2599
Jasmine, Oil (Jasminum grandiflorum L.)	8022-96-6	2600
Jasmine, Spiritus (Jasminum grandiflorum L.)	977038-79-1	2601
Juniper, Extract (Juniperus communis L.)	84603-69-0	2603
Juniper Oil (Juniperus communis L.)	8002-68-4	2604
Kola Nut, Extract (Cola acuminata Schott Et Endl.)	68916-19-8	2607
Labdanum, Absolute (Cistus spp.)	977046-98-2	2608

Name	CAS Number or Other ID	FEMA Number
Labdanum, Oil (Cistus spp.)	8016-26-0	2609
Labdanum, Oleoresin (Cistus spp.)	977092-72-0	2610
Lavandin Absolute	977183-98-4	
Lavandin, Concrete	977183-99-5	
Lavandin, Oil	8022-15-9	2618
Lavender, Absolute (Lavandula officinalis Chaix)	977126-26-3	2620
Lavender, Concrete (Lavandula officinalis Chaix)	977089-32-9	2621
Lavender (Lavandula officinalis Chaix)	977001-82-3	2619
Lavender, Oil (Lavandula officinalis Chaix)	8000-28-0	2622
Lavender, Spike (Lavandula latifolia Bill.)	977051-05-0	
Lavender, Spike, Oi51aponariaula spp.)	8016-78-2	3033
Lemon Essence	977091-76-1	
Lemon, Extract (Citrus limon (l.) Burm. F.)	84929-31-7	2623
Lemon Grass, Oil (Cymbopogon citratus Dc. & Cymbopogon flexuosusstapf)	8007-02-1	2624
Lemon, Oil, Terpeneless (Citrus limon (l.) Burm. F.)	68648-39-5	2626
Lemon, Juice	68916-88-1	
Lemon Peel Extract	977091-77-2	
Lemon-verbena (Lippia citriodora Hbk.)	977047-96-3	
Lemon Verbena, Oil (Lippia citriodora)	8024-12-2	
Lime, Essence	977164-71-8	
Lime, Juice	977026-98-4	
Lime Juice, Dehydrated	977091-78-3	
Lime Oil, Expressed	977059-80-5	
Lime, Oil, Terpeneless (Citrus aurantifolia (Christman) Swingle)	68916-84-7	2632
Linaloe Wood, Oil (Bursera delpechiana Poiss. & other Bursera spp.)	977051-12-9	2634
Linden Flowers, Extract (Tilia spp.)	84929-52-2	
Linden Flowers (Tilia glabra Vent.)	977009-77-0	2647
Linden Leaves (Tillia spp.)	977073-42-9	
Lovage, Extract (Levisticum officinale Koch)	977091-63-6	2650
Lovage (Levisticum officinale Koch)	977048-47-7	2649
Lovage, Oil (Levisticum officinale Koch)	8016-31-7	2651
Lungmoss (Sticta pulmonacea Ach.)	977022-85-7	
Mace (Myristica fragrans Houtt.)	977051-14-1	2652
Mace, Oil (Myrstica fragrans Houtt.)	977051-15-2	2653
Mace, Oleoresin (Myrstica fragrans Houtt.)	977010-60-8	2654
Maidenhair Fern (Adiantum capillus-veneris L.)	977070-30-6	
Mandarin, Oil (Citrus reticulata Blanco)	8008-31-9	2657
Marigold, Pot (Calendula officinalis L.)	977001-93-6	2658
Marjoram, Oleoresin (Marjorana hortensis Moench (Origanum majorana L.))	977038-85-9	2659
Marjoram, Pot (Majorana onites (l.) Benth. (Origanum vulgare L.))	977051-22-1	2660
Marjoram Seed (Majorana hortensis Moench (Origanum majorana L.))	977038-86-0	2661
Marjoram, Sweet (Majorana hortensis Moench (Origanum majorana L.))	977051-23-2	2662
Marjoram, Sweet, Oil (Majorana hortensis Moench (Origanum majorana L.))	8015-01-8	2663

Name	CAS Number or Other ID	FEMA Number
Mate, Absolute (Ilex paraguariensis St. Hil.)	977146-67-0	
Mimosa, Absolute (Acacia decurrens Willd. Var. Dealbata)	977092-60-6	2755
Mimosa Concrete (Acacia decurrens Willd. Var. Dealbata)	977184-00-1	
Molasses, Concentrate	977083-12-7	
Molasses, Extract (Saccharum officinarum L.)	977091-60-3	
Mountain Maple (Acer spicatum Lam.)	977048-48-8	
Mountain Maple Bark (Acer spicatum Lam.)	977089-64-7	
Mountain Maple, Extract Solid (Acer spicatum Lam.)	977089-65-8	2757
Mullein Flowers (Verbascum spp.)	977048-46-6	
Musk Tonquin (Moschus moschiferus L.)	8001-04-5	2759
Mustard, Brown (Brassica spp.)	977051-38-9	2760
Mustard, Brown, Extract (Brassica spp.)	977091-79-4	
Mustard, Yellow (Brassica spp.)	977051-39-0	2761
Mustard, Yellow, Extract (Brassica spp.)	977091-80-7	
Myrrh, Extract	100084-96-6	
Myrrh, Gum (Commiphora spp.)	9000-45-7	2765
Myrrh, Oil (Commiphora spp.)	8016-37-3	2766
Myrtle Leaves (Myrtus communis L.)	977070-85-1	
Myrtle, Oil (Myrtus communis L.)	8008-46-6	
Naringin, Extract (Citrus Paradisi Macf.)	977038-87-1	2769
Neroli, Bigarade Oil (Citrus aurantium L.)	8016-38-4	2771
Nutmeg (Myrstica fragrans Houtt.)	977051-44-7	2792
Nutmeg, Oil (Myrstica fragrans Houtt.)	8008-45-5	2793
Nutmeg Oleoresin	8007-12-3	
Oak Chips, White, Extract (Quercus Alba L.)	977083-13-8	2794
Oak Moss, Absolute (Evernia spp.)	977059-15-6	2795
Oak Moss, Concrete (Evernia prunasti spp.)	977183-63-3	
Oak Wood, English (Quercus robur L.)	977089-90-9	
Olibanum, Absolute (Boswellia spp.)	977184-03-4	
Olibanum, Gum, Resin (Boswellia spp.)	8050-07-5	
Olibanum, Oil (Boswellia spp.)	8016-36-2	2816
Olibanum, Resinoid (Boswellia spp.)	977184-02-3	
Onion, Oil (Allium cepa L.)	8002-72-0	2817
Opopanax, Gum	9000-78-6	
Opopanax, Non-specific	977136-06-3	
Opopanax, Oil	8021-36-1	
Opopanax Tincture	977091-81-8	
Orange Essence, Natural	977091-85-2	
Orange Essence Oil, Natural	68514-75-0	
Orange, Extract	977130-92-9	
Orange Flowers, Absolute (Citrus aurantium L.)	977049-65-2	2818
Orange, Juice	977059-38-3	
Orange Leaf, Absolute (Citrus aurantium L.)	977091-84-1	2820

Name	CAS Number or Other ID	FEMA Number
Orange, Oil, Distilled (Citrus sinensis (l.) Osbeck)	977091-83-0	2821
Orange, Oil, Terpeneless (Citrus sinensis (l.) Osbeck)	68606-94-0	2822
Orange Peel, Bitter, Extract (Citrus aurantium L.)	977081-87-0	2344
Orange Peel, Bitter, Oil (Citrus aurantium L.)	68916-04-1	2823
Orange Peel, Sweet, Extract (Citrus sinensis (l.) Osbeck)	977091-82-9	2824
Orange Peel, Sweet, Oil, Terpeneless (Citrus sinensis (l.) Osbeck)	977154-09-8	2826
Oregano (Lippia spp., Usually L. graveolens Hbk)	977138-70-7	2827
Origanum Oil, Extract (Thymus Capitatus Hoff. Et Link)	8007-11-2	2828
Orris, Concrete, Liquid, Oil (Ir53lorentinaina L.)	977086-43-3	2829
Orris Root, Extract (Ir53lorentinaina L.)	977096-43-7	2830
Pansy (Viola tricolor L.)	977068-82-8	
Paprika Oleoresin (Capsicum annuum L.)	68917-78-2	2834
Parsley, Oil (Petroselinum spp.)	8000-68-8	2836
Parsley, Oleoresin (Petroselinum spp.)	8025-95-4	2837
Parsley (Petroselinum spp.)	977051-58-3	2835
Passion Flower Extract	8057-62-3	
Passion Flower (Passiflora incarnata L.)	977001-53-8	
Patchouly, Oil (Pogostemon spp.)	8014-09-3	2838
Peach Kernel, Extract (Prunus persica Sieb Et Zucc.)	8023-98-1	
Peach Leaves, Extract (Prunus persica (l.) Batsch)	977183-61-1	
Peach Leaves (Prunus persica (l.) Batsch)	977009-83-8	
Peanut Stearine (Arachis hypogaea L.)	977051-59-4	
Pennyroyal, Oil, American (Hedeoma pulegiodes (l.))	8007-44-1	2839
Pennyroyal, Oil, European (Mentha pulegium L.)	8013-99-8	
Pepper, Black, Oil (Piper nigrum L.)	8006-82-4	2845
Pepper, Black, Oleoresin (Piper nigrum L.)	8002-56-0	2846
Pepper, Cayenne	977071-33-2	2266
Peppermint Leaves (Mentha Piperita L.)	977018-19-1	2847
Peppermint Plant	977001-36-7	
Pepper, Red	977184-01-2	2849
Pepper, White, Oil (Piper nigrum L.)	977018-20-4	2851
Pepper, White, Oleoresin (Piper nigrum L.)	977018-21-5	2852
Pepper, White (Piper nigrum L.)	977051-63-0	2850
Petitgrain, Lemon, Oil (Citrus limon (l.) Burm. F.)	8048-51-9	2853
Petitgrain, Mandarin, Oil (Citrus reticulata Blanco Var. Mandarin)	977051-67-4	2854
Petitgrain, Oil (Citrus aurantium L.)	8014-17-3	2855
Silver Fir, needles & twigs, Oil (abies Alba Mill.)	8021-27-0	
Simaruba Bark (Simaruba amara Aubl.)	977029-60-9	
Sloe Berries, Extract (Prunus spinosa L.)	90105-94-5	3021
Sloe Berries, Extract Solid (Prunus spinosa L.)	977029-61-0	3022
Snakeroot, Canadian, Oil (Asarum canadense L.)	8016-69-1	3023
Locust (carob) Bean Gum	9000-40-2	2648
Pimenta Leaf, Oil (Pimenta officinalis Lindl.)	977157-17-7	2901

Name	CAS Number or Other ID	FEMA Number
Pine Bark, White, Extract Solid (Pinus strobus L.)	977089-63-6	
Pine Bark, White, Oil (Pinus strobus L.)	977089-62-5	
Pine Bark, White (Pinus strobus L.)	977002-91-7	
Pine Needle, Dwarf, Oil (Pinus mugo turra Var. Pumilio (haenke) Zenari)	8000-26-8	2904
Pine, Scotch, Oil (Pinus sylvestris L.)	8023-99-2	2906
Pine, White, Oil (Pinus spp.)	977019-44-5	
Pipsissewa Leaves, Extract (Chimaphi54aponariaata Nutt.)	89997-56-8	2914
Pomegranate Bark, Extract (Punica granatum L.)	977018-22-6	2918
Poplar Buds (Populus spp.)	977002-20-2	
Poppy Seed (Papaver somniferum L.)	977051-77-6	2919
Prickly Ash Bark Extract (Xanthoxylum spp.)	977018-23-7	2110
Prickly Ash Bark, Oil	977018-24-8	
Quassia, Extract (Picrasma excelsa (sw.) Planch Or Quassia amara L.)	68915-32-2	2971
Quebracho Bark Extract	977092-71-9	2972
Quillaia Extract (Quilla saponariaria Molina)	68990-67-0	2973
Quillaia (Quilla saponariaria Molina)	977002-27-9	2973
Quince Seed, Extract (Cydonia spp.)	977018-25-9	2974
Rhatany, Extract (Krameria spp.)	84775-95-1	2979
Rhubarb, Garden Root (Rheum rhaponticum L.)	977035-94-1	
Rhubarb Root (Rheum spp.)	977039-94-3	
Rose, Absolute (Rosa spp.)	977091-93-2	2988
Rose Hips, Extract (Rosa spp.)	977021-37-6	2990
Roselle (Hibiscus sabdariffa L.)	977017-88-1	
Rosemary, Extract (Rosmarinus officinalis L.)	84604-14-8	
Rosemary, Oil (Rosemarinus officinalis L.)	8000-25-7	2992
Rosemary, Oleoresin	977029-68-7	4705
Rosemary (Rosemarinus officinalis L.)	977002-36-0	2991
Rose, Oil (Rosa spp.)	8007-01-0	2989
Rose Water, Stronger (Rosa Centifolia L.)	8030-26-0	2993
Rosin (Pinus spp.) And Rosin Derivatives	8050-09-7	
Saffron (Crocus sativus L.)	977051-90-3	2998
Saffron, Extract (Crocus sativus L.)	84604-17-1	2999
Sage, Greek (Salvia Triloba L.)	977051-95-8	
Sage, Oil (Salvia officinalis L.)	8022-56-8	3001
Sage, Oleoresin (Salvia officinalis L.)	977029-66-5	3002
Sage (Salvia officinalis L.)	977002-44-0	3000
Sage, Spanish, Oil (Salvia lavandulaefolia Vahl.)	977125-77-1	3003
Sandalwood, Red (Pterocarpus santalinus L.f.)	98225-55-9	
Sandalwood, White (Santalum album L.)	977020-85-1	
Sandalwood, Yellow, Oil (Santalum album L.)	8006-87-9	3005
Sandarac (Tetraclinis articulata (Vahl.) Mast.)	9000-57-1	
Sarsaparilla, Extract (Smilax spp.)	977022-67-5	3009
Sassafras Leaves (safrole-free) (Sassafras albidum (nutt.) Nees)	977088-38-2	3011

Name	CAS Number or Other ID	FEMA Number
Savory, Summer, Oil (Satureja hortensis L.)	8016-68-0	3013
Savory, Summer, Oleoresin (Satureja hortensis L.)	977029-75-6	3014
Savory, Summer (Satureja hortensis L.)	977051-98-1	3012
Savory, Winter, Oil (Satureja montana L.)	977029-74-5	3016
Savory, Winter, Oleoresin (Satureja montana L.)	977029-76-7	3017
Savory, Winter (Satureja montana L.)	977051-99-2	3015
Schinus Molle, Oil (Schinus molle L.)	68917-52-2	3018
Senna, Alexandria (Cassia acutifolia Delile)	977083-19-4	
Serpentaria (Aristolochia serpentaria L.)	977002-55-3	
Sesame (Sesamum indicum L.)	977052-01-9	
Spearmint, Extract (Mentha spicata L.)	84696-51-5	3031
Spearmint (Mentha spicata L.)	977002-61-1	3030
Spruce Needles And Twigs, Extract (Picea spp.)	977062-73-9	
Spruce Needles And Twigs, Oil (Picea spp.)	8008-80-8	3034
St. Johnswort Leaves, Flowers And Caulis (Hypericum perforatuml.)	977092-96-8	
Storax Extract (Liquidambar spp.)	977029-80-3	3037
Storax (Liquidambar spp.)	8046-19-3	3036
Storax Oil	8024-01-9	
Tagetes, Oil (Tagetes spp.)	8016-84-0	3040
Tamarind Extract (Tamarindus indica L.)	84961-62-6	
Tangerine, Essence	977029-78-9	
Tangerine, Extract (Citrus reticulata Blanco)	90063-83-5	
Tangerine, Oil (Citrus reticulata Blanco)	8016-85-1	3041
Tansy, Oil (Tanacetum vulgara L.)	8016-87-3	
Tansy (Tanacetum Vulgara L.)	977032-44-2	
Tarragon (Artemisia dracunculus L.)	977052-32-6	3043
Tarragon Extract (Artemisia dracunculus L.)	977029-81-4	
Tarragon Oil (Artemisia dracunculus L.)	8016-88-4	2412
Tea Extract (Thea sinensis L.)	84650-60-2	
Thistle, Blessed (Cnicus benedictus L.)	977023-13-4	
Thistle, Blessed, Extract (Cnicus benedictus L.)	977048-22-8	
Thistle, Blessed, Extract Solid (Cnicus benedictus L.)	977048-24-0	
Thistle, Blessed, Oil (Cnicus benedictus L.)	977048-23-9	
Thyme, Extract	84929-51-1	
Thyme Oil (Thymus vulgaris L. And T. zygis Var. Gracilis Boiss.)	8007-46-3	3064
Thyme Oleoresin	977029-72-3	
Thyme (Thymus serpyllum L.)	977052-37-1	
Thyme (Thymus vulgaris L.)	977052-36-0	3063
Thyme, Wild Or Creeping, Extract (Thymus aerpyllum L.)	84776-98-7	
Tolu, Balsam, Extract (Myroxylon spp.)	977075-28-7	3069
Tolu, Balsam, Gum (Myroxylon spp.)	9000-64-0	3070
Tuberose, Oil (Polianthes tuberosa L.)	8024-05-3	3084
Turmeric (Curcuma longa L.)	977052-44-0	3085

Name	CAS Number or Other ID	FEMA Number
Turmeric, Extract (Curcuma longa L.)	84775-52-0	3086
Turmeric, Oleoresin (Curcuma longa L.)	129828-29-1	3087
Turpentine	8052-14-0	
Turpentine, Gum (Pinus spp.)	9005-90-7	3088
Turpentine, Rectified	977022-00-6	
Turpentine, Steam Distilled (Pinus spp.)	8006-64-2	3089
Valerian Root, Extract (Valeriana officinalis L.)	8057-49-6	3099
Valerian Root, Oil (Valeriana officinalis L.)	8008-88-6	3100
Vanilla, Absolute (Vanilla spp.)	977189-04-5	
Vanilla, Extract (Vanilla spp.)	8024-06-4	3105
Vanilla, Oleoresin (Vanilla spp.)	8023-78-7	3106
Vanilla (Vanilla spp.)	977004-06-0	3104
Veronica (Veronica officinalis L.)	977000-83-1	
Vervain, European (Verbena officinalis L.)	977000-41-1	
Vetiver, Oil (Vetiveria zizanioides Stapf)	8016-96-4	
Vetiver (Vetiveria zizaniodes Stapf)	977059-70-3	
Violet Leaves Absolute (Viola odorata L.)	8024-08-6	3110
Violet, Swiss (Viola calcarata L.)	977089-10-3	
Walnut Hull, Extract (Juglans spp.)	977014-38-2	3111
Walnut Leaves, Extract (Juglans spp.)	977091-98-7	
Woodruff, Sweet (Asperula odorata L.)	977070-09-9	
Yarrow, Herb (Achillea millefolium L.)	977000-16-0	3117
Yarrow, Oil (Achillea millefolium L.)	8022-07-9	
Yerba Santa, Fluid Extract (Eriodictyon californicum (hook And Arn) Torr)	977092-73-1	3118
Ylang-ylang, Oil (Cananga odorata Hook. F. And Thomas)	8006-81-3	3119
Yucca, Joshua-tree (Yucca brevifolia Engelm.)	977083-21-8	3120
Yucca, Mohave, Extract (Yucca spp.)	977083-20-7	3121
Zedoary Bark, Extract (Curcuma zedoaria (berg.) Rosc.)	84961-49-9	3123
Zedoary (Curcuma zedoaria (berg.) Rosc.)	977052-57-5	3122

2238 *Sources: FDA Food Substances Database, 2022; FEMA, 2022.*
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Appendix B - Suppliers of Organic Flavors

Certifier Name	Operation Name	Number of Certified Flavors
QAI	Flavor Producers, LLC	1891
QAI	Gold Coast Ingredients, Inc.	925
QAI	FONA International, LLC	669
QCS	Earth Supplied Products, LLC	628
QAI	Allen Flavors, Inc.	591
OTCO & QAI	Kerry Ingredients & Flavours	469
CCOF	Primal Essence, Inc.	431
QAI	WILD Flavors, Inc.	406
QAI	OSF Flavors, Inc.	398
OTCO	Custom Ingredients, Inc	377
QAI	Citromax Group Inc.	341
QAI	International Flavors & Fragrances, Inc.	296
OTCO	FlavorFocus, LLC	290
CCOF	Synergy Flavors, Inc.	286
CCOF	Sovereign Flavors Inc.	280
OTCO	Abelei, Inc.	266
QAI	Sensient Flavors, LLC	262
OTCO	Sentrex Ingredients	255
OTCO	Mother Mur'hy's Laboratories	254
QAI	Blue Pacific Flavors, Inc.	249
CUC	Bell Flavors and Fragrances	234
QAI	Givaudan Flavors Corporation	221
QAI	Scisorek & Son Flavors, Inc.	214
QAI	Tastepoint Inc. dba Tastepoint by IFF	197
OTCO	Robertet Flavors, Inc.	191
OTCO	Brand Aromatics, Inc.	163
OTCO	Ungerer and Company	149
QAI	Symrise Inc	140
QAI	Virginia Dare Extract Co. Inc.	131
QCS	CAS Organics, LLC	130
QAI	T. Hasegawa USA, Inc.	130
QAI	Flavorchem Corporation	128
QAI	Flavor Manufacturing Center	126
QCS	Green Line Botanicals	122
QAI	Jogue Inc.	122
QAI	Sh'nk's Extracts LLC	119
OTCO	Medicine Flower LLC	110
OTCO	Target Flavors, Inc.	110
OTCO	Sapphire Flavors and Fragrances	109
QAI	Comax Manufacturing Corp.	108
QAI	Frutarom USA Inc.	108
OTCO	Metarom USA, LLC	104

Certifier Name	Operation Name	Number of Certified Flavors
MOSA	Edgar A Weber & Company, dba Weber Flavors	94
QAI	Flavor & Fragrance Specialties	91
QAI	Aromatech Flavorings Inc.	86
OTCO	DairiConcepts L.P.	86
QAI	Alfrebro LLC	76
OTCO	H.B. Taylor Co.	72
WFCFO	Trilogy Essential Ingredients, Inc	72
OTCO	Savoury Systems International, LLC, Brookside Flavors & Ingredients	70
OTCO	Flavor Dynamics, Inc	68
QAI	California Custom Fruits & Flavors, Inc.	65
QAI	Jogue, Incorporated	65
OTCO	AMT Group, LLC (DBA Imbibe)	60
OTCO	Revela Foo–s - New Berlin, LLC	54
OTCO	Vigon International, LLC	53
QAI	Lassonde Pappas and Company Inc.	43
QCS	Vidya Herbs, Inc	43
OTCO	Callisons, Inc.	40
OTCO	Kalsec, Inc.	40
OTCO	Centrome, Inc./DBA Advanced Biotech	39
QAI	Flavors of Origin dba Flavor Materials International	38
OTCO	Butter Buds Inc.	35
QAI	Flavor Insights, LLC	35
CCOF	Silesia Flavors, Inc.	35
MOSA	Fontana Flavors	34
OTCO	Prinova Flavors LLC	34
OTCO	Spray-Tek LLC	33
OTCO	Phoenix Flavors, LLC	32
OTCO	eSense, LLC.	31
QAI	OC Flavors, Inc.	29
OTCO	Bluegrass Ingredients, Inc.	25
CCOF	Cook Flavoring Co./RR Lochhead Mfg. Co.	25
OTCO	Green Mountain Flavors, Inc.	25
TDA	Lineage Logistics LLC	25
QAI	Sensapure, Inc.	25
CCOF	Guayaki SRP	24
WFCFO	Lemur International	22
QAI	The Edlong Corporation	20
QCS	Treatt USA	19
QCS	Garden of Life, LLC	16
OTCO	Marsh'll's Flavor House, Inc.	16
QAI	Mission Flavors & Fragrances, Inc.	16
QAI	Jean Niel Inc	15
MOSA	Beck Flavors	14

Certifier Name	Operation Name	Number of Certified Flavors
QAI	Nielsen-Massey Vanillas, Inc.	14
QAI	All American Foods, Inc.	13
OTCO	Continental Flavors, LLC	13
OTCO	Mane, Inc.	13
QAI	ZoomEssence, Inc	13
OTCO	Elan, Inc.	11
PJRFSI	Arylessence, Inc.	10
OTCO	Dutch American Foods, Inc.	10
WSDA	Fruitsmart, Inc.	10
QAI	Quality Ingredients Corporation	10
CCOF	Essential Flavors & Fragrances, Inc.	9
CDA	Rodelle Inc.	8
OTCO	The Lebermuth Company, Inc.	8
QCS	Citrus Extracts, LLC	7
QAI	Jedwards International, Inc.	7
OTCO	Pharmachem Laboratories LLC	7
QCS	Phyto-Plus, Inc.	7
QAI	S&D Coffee, Inc.	7
Transitioning to a new certifier	Templar Food Products	7
OTCO	Agropur MSI, LLC	6
ACO	Dr. Oetker Queen Australia Pty Ltd	6
BCS	Konfrut Gida Sanayi ve Ticaret A.Ş.	6
MOSA	Northwestern Extract Co	6
CCOF	Campbell Soup Supply Co.	5
MOSA	First Choice Ingredients	5
OTCO	IFC Solutions Inc.	5
OTCO	Kalsec Southwest	5
MOSA	Lan' O' Lakes	5
MOSA	QualiTech, Inc	5
ONE	SensoryEffects Inc.	5
QAI	Takasago International Corp. (US–) - Flavor Division	5
QAI	American Fruits and Flavors, LLC	4
OTCO	Cloud Top Organics, Inc.	4
PCO	Homesweet Homegrown, LLC	4
QCS	Nutranomy, LLC	4
QAI	Premier Specialties, Inc.	4
QAI	Agropur, Inc. – Le Sueur Food Ingredients Facility	3
QAI	Eatem Foods Company	3
UDAF	Aspen Copak	2
GOA	Dr. Vanilla LLC	2
QAI	Fruitcrown Products Corporation	2
CMEX	Industria Mexicana de Sabores S.A. de C.V.	2
ACO	Intec Vanilla Niugini Ltd	2

Certifier Name	Operation Name	Number of Certified Flavors
PJRFSI	Lorann Oils, Inc	2
QAI	MetaBev, Inc.	2
QAI	Refresco Beverages USA	2
BAC	4Care Co., Ltd.	1
MOSA	Brolite Products Inc.	1
OC	Carmi Flavors & Fragrances Company	1
OC	Cvista, LLC	1
CUC	E-Silk Route Ventures (Pvt) Ltd	1
BCS	Gaya Vanilla y Especies, SA.	1
CU	Holly Oak Chemical, Inc.	1
OCIA	Jeneil Biotech, Inc.	1
ONE	L.O.D.C. Group, Ltd. DBA Lily of the Desert	1
GOA	Meridian Flavors, Inc	1
SCS	Native Vanilla, Inc.	1
OC	Newport Flavours & Fragrances, Ltd, Nat’re's Flavors, Select, Inc.	1
WSDA	Northwest Naturals LLC	1
ACO	Organic Lemon Myrtle Plantations Sdn. Bhd	1
OTCO	OS Holdings	1
QAI	SciTech International dba SciTech Ingredients	1

Source: Organic Integrity Database, November 2022. See the database for certifier name abbreviations.

Appendix C - ACA Best Practices

Commercial Availability of Natural Flavors

According to 7 CFR 205.2, commercial availability is the ability to obtain a production input in an appropriate form, quality, or quantity to fulfill an essential function in a system of organic production or handling, as determined by the certifying agent in the course of reviewing the organic plan. The working group agreed to the following when determining commercial availability of organic natural flavors and flavoring substances:

- Operators must contact at least three valid suppliers, with exceptions considered on a case-by-case basis.
    - An operator sourcing natural flavors products or flavoring substances to be used in an organic flavor must contact flavor houses that may have an organic version of the flavor/ flavoring substance or the ability to create an organic version.
    - Operators should check with different suppliers of flavors year-to-year.
    - Having a contract in place with a flavor manufacturer is not sufficient justification to contact fewer than three valid suppliers. Additional documentation must be submitted and may be considered on a case-by-case basis.
- A contract in place with a non-organic flavor manufacturer working towards certification or with a certified organic flavor manufacturer working to develop an organic version may be sufficient justification for contacting fewer than three valid suppliers, provided that documentation is submitted to verify the anticipated date of certification and/or organic system plan.
    - Claiming that a flavoring substance cannot be certified organic is not sufficient justification for contacting fewer than three valid suppliers. Additional documentation must be submitted justifying the lack of ability to certify the ingredient, which may be considered on a case-by-case basis, or three valid suppliers must be contacted.
- Operators must verify and document commercial availability annually for each non-organic flavor or flavoring substance used, with exceptions considered on a case-by-case basis.
    - An ordering or manufacturing schedule can be considered if part of the company's Standard Operating Procedure (SOP).
- The use of otherwise compliant non-organic flavors in made-with-organic products does not invoke a commercial availability search (as long as it meets the requirements of made with organic products).
- The use of made-with-organic flavors as an ingredient in an organic product does invoke a commercial availability search since not "organic."
- Using the flavor name alone may not be sufficient evidence to verify lack of commercial availability of an organic flavor.
- Price cannot be a consideration for determination of the commercial availability.

Source: ACA, 2020.

Criteria for Verification of Allowed Flavors

Non-organic flavors, in accordance with 7 CFR 205.605(a), must:

- Be derived from organic or nonsynthetic sources only
- Be produced without synthetic solvents and carrier systems or any artificial preservative
- Be in compliance with § 205.105 Allowed and prohibited substances, methods, and ingredients in organic production and handling, including being produced and handled without genetic modification.
- Function as a flavor within the product labeled as "organic" or "made with organic (specified ingredients or food group(s))"
- Only be used if organic versions are not commercially available - see separate ACA best practices document on assessing commercial availability of flavors

Additional verification steps may include:

- Verification that all other ingredients (ingredients besides flavors, solvents, carrier systems, and preservatives) are allowed
- Verification that all flavor component ingredients are allowed
- Verification that the flavor is non-agricultural
- Verification that the flavor is non-synthetic according to NOP 5033-1

Source: (ACA, 2021a, 2021b)

Natural Flavor Declaration Form

See following page.

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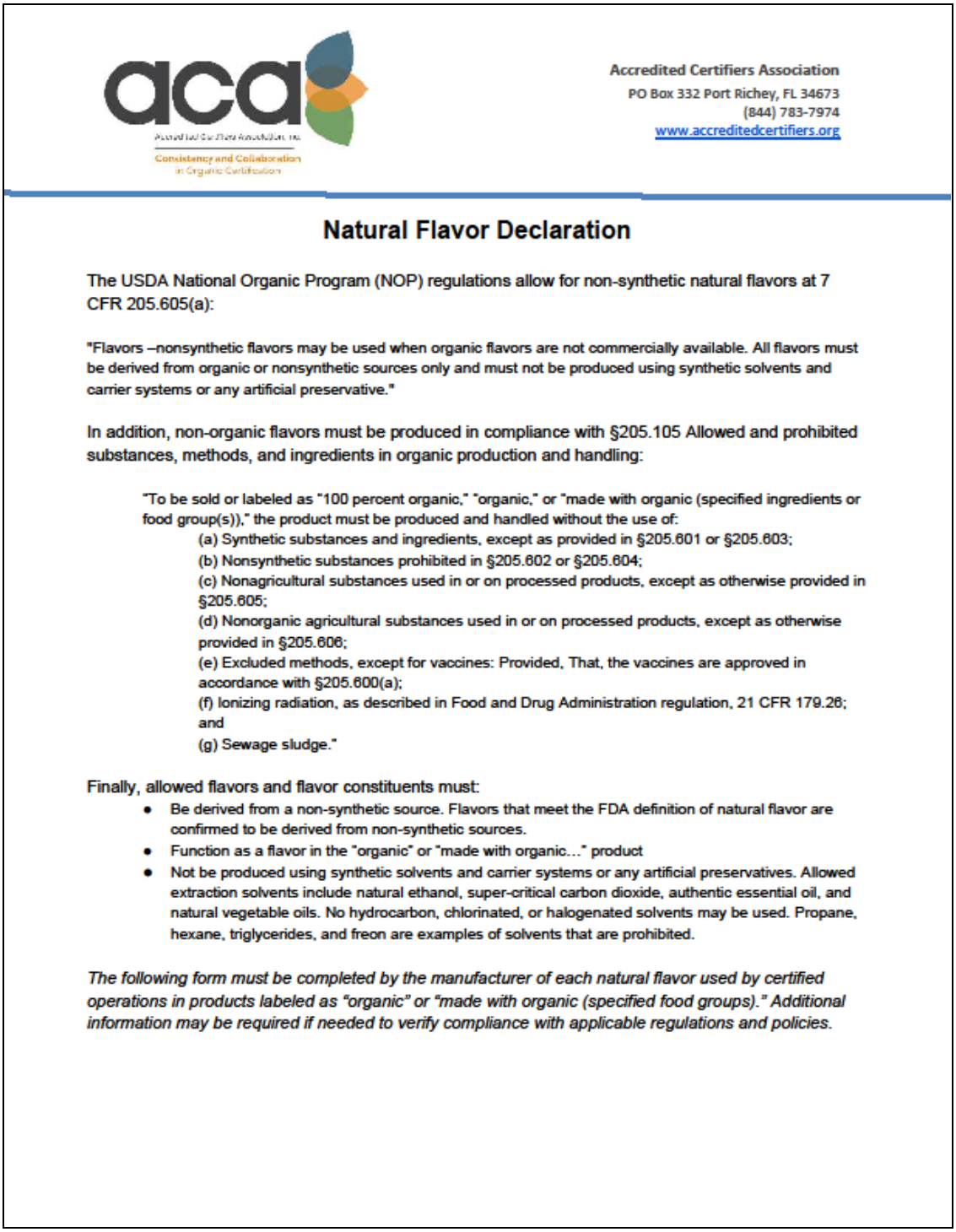

Accredited Certifiers Association
PO Box 332 Port Richey, FL 34673
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www.accreditedcertifiers.org

Natural Flavor Declaration

The USDA National Organic Program (NOP) regulations allow for non-synthetic natural flavors at 7 CFR 205.605(a):

"Flavors –nonsynthetic flavors may be used when organic flavors are not commercially available. All flavors must be derived from organic or nonsynthetic sources only and must not be produced using synthetic solvents and carrier systems or any artificial preservative."

In addition, non-organic flavors must be produced in compliance with §205.105 Allowed and prohibited substances, methods, and ingredients in organic production and handling:

> "To be sold or labeled as "100 percent organic," "organic," or "made with organic (specified ingredients or food group(s))," the product must be produced and handled without the use of:
> (a) Synthetic substances and ingredients, except as provided in §205.601 or §205.603;
> (b) Nonsynthetic substances prohibited in §205.602 or §205.604;
> (c) Nonagricultural substances used in or on processed products, except as otherwise provided in §205.605;
> (d) Nonorganic agricultural substances used in or on processed products, except as otherwise provided in §205.606;
> (e) Excluded methods, except for vaccines: Provided, That, the vaccines are approved in accordance with §205.600(a);
> (f) Ionizing radiation, as described in Food and Drug Administration regulation, 21 CFR 179.26; and
> (g) Sewage sludge."

Finally, allowed flavors and flavor constituents must:

- Be derived from a non-synthetic source. Flavors that meet the FDA definition of natural flavor are confirmed to be derived from non-synthetic sources.
- Function as a flavor in the "organic" or "made with organic…" product
- Not be produced using synthetic solvents and carrier systems or any artificial preservatives. Allowed extraction solvents include natural ethanol, super-critical carbon dioxide, authentic essential oil, and natural vegetable oils. No hydrocarbon, chlorinated, or halogenated solvents may be used. Propane, hexane, triglycerides, and freon are examples of solvents that are prohibited.

The following form must be completed by the manufacturer of each natural flavor used by certified operations in products labeled as "organic" or "made with organic (specified food groups)." Additional information may be required if needed to verify compliance with applicable regulations and policies.

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ACA Natural Flavors Declaration
May 2021

Manufacturer Name: _____

Flavor name and code on technical data sheet: _____

1. Do this natural flavor and all of its flavor constituents meet the following FDA definition of a natural flavor?
   ☐ **Yes** ☐ **No**
   A natural flavor or natural flavoring is the essential oil, oleoresin, essence or extractive, protein hydrolysate, distillate, or any product of roasting, heating or enzymolysis, which contains the flavoring constituents derived from a spice, fruit or fruit juice, vegetable or vegetable juice, edible yeast, herb, bark, bud, root, leaf or similar plant material, meat, seafood, poultry, eggs, dairy products, or fermentation products thereof, whose significant function in food is flavoring rather than nutritional. Natural flavors include the natural essence or extractives obtained from plants listed in §§ 182.10, 182.20, 182.40, and 182.50 and part 184 of this chapter, and the substances listed in 172.510 of this chapter. (21 CFR 101.22(a)(3))

2. List all specific sources of the flavor constituents (e.g., spice, plant part, essential oil, etc).
   _____

3. Describe the function(s) of this product _____

4. Does the flavoring agent(s) in this material only consist of substances that do not impart a specific characteristic flavor, such as flavorings with modifying properties? *For example, if the only flavoring agent in the material is Luo Han Guo (Monk Fruit) derived products, Thaumatin, Glycosylated Steviol Glycosides, or similar the response should be Yes.* ☐ **Yes** ☐ **No** ☐ **NA**
   a. If Yes, attach documentation detailing the maximum usage rate for the overall flavor material to qualify as a natural flavor: ☐ **Attached** ☐ **NA**

5. Can the material legally be labeled as a "natural flavor" on the finished product labels per the applicable regulatory body? ☐ **Yes** ☐ **No**
   FDA labeling regulations, https://www.accessdata.fda.gov/scripts/cdrh/cfdocs/cfcfr/CFRSearch.cfm?fr=101.22 sections 101.22(h)(1) states that a natural flavor must be identified in the ingredient statement as a natural flavor, and sections 101.22(i)(1)(i) includes that on the principal display panel the name of the flavor may be immediately preceded by the word "natural" and shall be immediately followed by the word "flavored".
   a. If the flavor consists of a natural flavoring that must be declared by its common or usual name on the label, list the name here: _____ ☐ **NA**

6. Do you sell an organic version of this flavor? ☐**Yes** ☐ **No**

7. List any non-flavor constituents, including but not limited to solvents, carrier systems, and preservatives, used in this product, including the function of each constituent. Attach any relevant documentation for these ingredients, such as a specification sheet. Additional information may be requested to verify the compliance of these non-flavor ingredients.

Non-Flavor Ingredient/ Adjuvant	Function in the Flavor	Documentation Attached?

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8. If alcohol/ethanol is used, please attach documentation describing the manufacturing process ☐ **Attached** ☐ **NA**
9. If maltodextrin is used, please attach documentation describing the manufacturing process and GMO status ☐ **Attached** ☐ **NA**

10. If glycerin is used, please provide its organic certificate and/or a attach a full manufacturing description ☐ **Attached** ☐ **NA**

11. If citric acid is used, please attach documentation describing the manufacturing process ☐ **Attached** ☐ **NA**

12. Excluded methods, including genetic modification/GMOs, are prohibited for use at any stage in the process of making natural flavor products for use in products certified under the NOP. *Please see the following pages for the definition and examples of excluded methods.*
    a. This natural flavor, including any solvents, carriers, preservatives or other processing aids used or contained therein, was produced and handled without the use of excluded methods (NOP), as defined at 7 CFR 205.2. ☐ **Yes** ☐ **No**

13. Ionizing radiation is prohibited for the treatment of organic products and inputs used to produce organic products. Other forms of radiation, including those used for food inspection, are permitted providing the uses meet applicable regulations that establish limitations pertaining to all (organic and non-organic) food products.
    a. This natural flavor has been handled without the use of ionizing radiation as described in 21 CFR 179.26. ☐ **Yes** ☐ **No**

14. Materials produced or processed using nanotechnology or technologies intentionally manipulating matter at atomic, molecular, or macromolecular dimensions typically between 1 and 100 nm to create materials, devices and systems with fundamentally new properties and functions, are prohibited for all uses and as materials used in organic products. Naturally occurring nano-sized particles or those produced incidentally are permitted.
    a. This natural flavor has been handled without the use of nanotechnology as described in NOP Policy Memo 15-2 as applicable. ☐ **Yes** ☐ **No**

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To be signed by a qualified, technical representative of the manufacturer. Any operation that makes a false statement under The Organic Foods Production Act of 1990 to an accredited certifying agent shall be subject to the provisions of section 1001 of title 18, United States Code (205.100(c)(2)).

Pursuant to applicable regulations, I, on behalf of the manufacturer, hereby attest that the information provided in this form is accurate and truthful to the best of my knowledge.

Signature:		Date:
Printed Name:	Title:	
Address:		
City:	State:	Zip:
Phone:	Email:	

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Other relevant definitions:

- A **nonsynthetic** (natural) substance is derived from mineral, plant, or animal matter and does not undergo a synthetic process as defined in section 6502(21) of the Act (7 U.S.C. 6502(21)). (7 CFR 205.2)
- A **synthetic** substance is formulated or manufactured by a chemical process or by a process that chemically changes a substance extracted from naturally occurring plant, animal or mineral sources, except that such term shall not apply to substances created by naturally occurring biological processes. (7 CFR 205.2)
- **Excluded methods** are defined as a variety of methods used to genetically modify organisms or influence their growth and development by means that are not possible under natural conditions or processes and are not considered compatible with organic production. Such methods include cell fusion, microencapsulation and macroencapsulation, and recombinant DNA technology (including gene deletion, gene doubling, introducing a foreign gene, and changing the positions of genes when achieved by recombinant DNA technology). Such methods do not include the use of traditional breeding, conjugation, fermentation, hybridization, in vitro fertilization, or tissue culture.(7 CFR 205.2) Prohibited excluded methods include, but are not limited to:

Method and synonyms	***Types***
Targeted genetic modification (TagMo) syn. Synthetic gene technologies syn. Genome engineering syn. Gene editing syn. Gene targeting	Sequence-specific nucleases (SSNs) Meganucleases Zinc finger nuclease (ZFN) Mutagenesis via Oligonucleotides CRISPR-Cas system (Clustered regularly interspaced short palindromic repeats) and associated protein genes TALENs (Transcription activator-like effector nucleases) Oligonucleotide directed mutagenesis (ODM) Rapid Trait Development System
Gene Silencing	RNA-dependent DNA methylation (RdDM) Silencing via RNAI pathway RNAI pesticides
Accelerated plant breeding techniques	Reverse Breeding Genome Elimination FasTrack Fast flowering
Synthetic biology	Creating new DNA sequences Synthetic chromosomes Engineered biological functions and systems
Cloned animals and offspring	Somatic nuclear transfer
Plastic transformation	
Cisgenesis	The gene modification of a recipient plant with a natural gene from a crossable-sexually compatible-plant. The introduced gene includes its introns and is flanked by its native promoter and terminator in the normal-sense orientation.
Intragenesis	The full or partial coding of DNA sequences of genes originating from the sexually compatible gene pool of the recipient plant and arranged in sense or antisense orientation. In addition, the promoter, spacer, and terminator may originate from a sexually compatible gene pool of the recipient plant.
Agro-infiltration	
Transposons – Developed via use of in vitro nucleic acid techniques	
Induced mutagenesis	Developed through in vitro nucleic acid techniques

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Appendix D - Flavors Technical Report - Certifier Interview Questions

1. **<u>What flavors are available in organic form?</u>**
    a. What flavors does your ACA certify?
    b. Are these all on the OID?
    c. How many are labeled 100% organic and contain only organic ingredients, other than water and salt?
    d. How many of these certified organic flavors contain non-organic ingredients?
    e. Are any of those non-organic ingredients themselves considered flavor components, including flavor enhancers or potentiators?
    f. If so, would all certified organic flavors still comply if "natural flavors" was sunset from the National List?
    g. If not, which currently certified flavors would be non-compliant?
    h. What components would be non-compliant?

2. **<u>What flavors could be certified organic based on their source and manufacturing process, but are not?</u>**
    a. What is the procedure to determine whether a flavor is commercially available?
    b. Has your agency reviewed and approved any non-organic flavors for use in organic products that *do not appear* in certified organic form at all on the OID?
    c. If so, which ones?
    d. What, were the reasons given for the unavailability of organic flavors?
    e. Has your agency reviewed and approved non-organic flavors for use in organic products that *do appear* in certified organic form at all on the OID?
    f. If so, what factors were considered valid reasons to determine that organic flavors were not required?

3. **<u>What flavors cannot be certified organic based on their source and manufacturing?</u>**
    a. Have any flavors applied for certification and have been denied certification?
    b. What does your agency require to determine whether all the ingredients in a non-organic flavor or flavoring agent are non-synthetic or produced with excluded methods?
    c. Are there any flavors that have either applied for certification or for use as a non-organic flavor in an organic processed product your agency has determined to be non-agricultural?
    d. If so, which ones?
    e. Has your agency reviewed any natural (non-synthetic) flavors with agricultural precursors that are not possible to produce or handle organically?
    f. If so, which ones?
    g. What is it about their source or processing that disqualifies them from certification?