METHODS FOR REDUCING THE SENSORY EFFECTS OF ODOROUS COMPOUNDS

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Filed: Jun. 26, 2009

Related U.S. Application Data
Provisional application No. 61/075,993, filed on Jun. 26, 2008.

Publication Classification
Int. Cl. B65D 85/72 (2006.01) B65B 55/00 (2006.01)
U.S. Cl. 426/124; 426/271

ABSTRACT
The present invention is directed to compositions containing a food product capable of developing a volatile, malodorous sulfur-containing and/or nitrogen-containing compound after packaging, and a pristine metal in an amount sufficient to minimize the sensory effects of the volatile, malodorous compounds at a time of use.
METHODS FOR REDUCING THE SENSORY EFFECTS OF ODOROUS COMPOUNDS

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims the benefit of the filing date of U.S. Patent Appl. No. 61/075,993, filed Jun. 26, 2008, which is incorporated by reference herein in its entirety.

BACKGROUND OF THE INVENTION

[0002] 1. Field of the Invention

[0003] The present invention is directed to food product compositions that exhibit reduced sensory effects arising from volatile, malodorous compounds and methods of making the same.

[0004] 2. Background

[0005] Methods of protecting food products and beverages from processes of aging and degradation are well known. For example, refrigeration and packaging materials have provided means to decrease the rate of food spoilage. However, even using these methods of preservation, many food products and beverages are susceptible to developing undesirable odors prior to use, for example, during shipment or storage.

[0006] In the case of hopped malt beverages, such as beer, ale, malt liquor, porter, and the like, a variety of volatile, malodorous compounds can be formed during storage (see, e.g., Food Chemistry 95:357 (2006)). Manufacturers and retailers are particularly concerned with the production of sulfur-containing compounds such as thiols (e.g., 3-methyl-2-butenyl thiol, methyl mercaptan, hydrogen sulfide, and the like) that have a “skunky” odor and are readily detectable by the human nose even at sub-micromolar concentration. Sulfur-containing compounds typically result from photochemical reactions, and the resulting tainted beverages are commonly referred to as “fight stuck” or “sunstuck.” In order to avoid this problem, many manufacturers package their products in tinted glass capable of absorbing ultraviolet and visible light having a wavelength of about 560 nm or less, with amber and green tinted glass being most common. However, such packaging prevents a consumer from viewing a product at the point of sale.

[0007] Alternative methods of protecting beverage products include the addition of photostabilizing materials (e.g., compounds containing 1.8-epoxy and/or 1.4-epoxy groups, such as described in U.S. Pat. No. 4,389,421) to a product, exposing a product to actinide radiation of a specific wavelength in order to decompose, e.g., riboflavin (a compound that can lead to thiol production, as described in U.S. Pat. No. 7,115,290), as well as co-fermenting a product with enzymes capable of removing and/or inactivating specific compounds capable of promoting thiol formation (see, e.g., U.S. Pat. No. 6,514,542).

[0008] Solid and semi-solid food products, in particular those that contain high levels of proteins and/or free amino acids are also susceptible to developing volatile, malodorous nitrogen-containing compounds and/or sulfur-containing compounds prior to use.

[0009] Packaging materials can incorporate, for example, polyalkylene imines, alumina and/or silica-containing zeolites, and the like, that are capable of sequestering specific compounds arising from the partial degradation of food products (see, e.g., U.S. Pat. Nos. 4,795,482, 5,284,892 and 5,413, 827). However, many materials are not safe for human consumption or have other problems associated with their disposal and/or production.

BRIEF SUMMARY OF THE INVENTION

[0010] What is needed is a facile, low-cost method for reducing the presence of volatile, malodorous sulfur- and/or nitrogen-containing compounds in a food product such as a beverage and/or solid and semi-solid food product. Thus, the present invention is directed to compositions and processes for reducing an unpleasant odor and/or flavor arising from a nitrogen- and/or sulfur-containing compound in a food product, such as a liquid food product, a semi-solid food product or a solid food product. The present invention permits all manner of food products to be packaged in transparent packaging without concern for the formation of volatile, malodorous compounds within a sealed package prior to use.

[0011] The present invention is directed to a composition comprising a liquid, semi-solid or solid food product in a sealed package, and a pristine metal in an amount sufficient to sequester a volatile, malodorous nitrogen- and/or sulfur-containing compound.

[0012] The present invention is directed to a composition comprising: a sealed package containing: a food product capable of forming a volatile, malodorous nitrogen-containing compound, a volatile, malodorous sulfur-containing compound, or a combination thereof; and a pristine metal present in an amount sufficient to sequester a volatile, malodorous nitrogen-containing compound, a volatile, malodorous sulfur-containing compound, or a combination thereof, such that a total concentration of volatile, malodorous nitrogen-containing and sulfur-containing compounds is below a human detection level at a time of use.

[0013] The present invention is also directed to a process for sequestering a nitrogen-containing compound, a sulfur-containing compound, or a combination thereof, from a food product prior to use, the process comprising: providing to a sealed food product a pristine metal suitable for sequestering a nitrogen-containing compound, a sulfur-containing compound, or a combination thereof, wherein the pristine metal is present in or on a sealed package containing the food product; in at least a portion of the sealed food product, or a combination thereof; and the pristine metal is present in an amount sufficient to sequester a nitrogen-containing compound, a sulfur-containing compound, or a combination thereof that is formed in situ prior to use of the food product.

[0014] Pristine metals suitable for use with the present invention include, but are not limited to, gold, platinum, silver, copper, palladium, and combinations thereof. A pristine metal can be present as: a film, a component of a film, a colloid, a sol, a nanoparticle, a nanocage, a microparticle, a mesoparticle, a metal-coated particle, a leaf, a wire, a glitter, a foil, a coin, a disk, a stirring rod, a sieve, a filter, or a combination thereof.

[0015] A pristine metal can added to a food product prior to processing, during processing and/or after processing of the food product. In some embodiments, at least a portion of a sealed package containing a food product is transparent or opaque.

[0016] In some embodiments, a sealed package contains a liquid food product, and a pristine metal is present: on an inner surface of the sealed package; in at least a portion of the liquid food product; or a combination thereof; and the pristine metal is present in an amount sufficient to provide a pristine
metal surface area of about 1 cm² per liter of the liquid food product. In some embodiments, a pristine metal is present in an amount sufficient to provide a pristine metal surface area of about 10 cm² per liter of the liquid food product. In some embodiments, a sealed package contains a solid or semi-solid food product, and a pristine metal is present on an inner surface of the sealed package in an amount sufficient to provide a pristine metal surface area of about 0.1 cm² per milligram of the solid or semi-solid food product. In some embodiments, a pristine metal is present in an amount sufficient to provide a pristine metal surface area of about 0.5 cm² per milligram of a solid or semi-solid food product.

[0017] Sulfur-containing compounds can include a functional group selected from: a thiol, a dithiol, a sulfide, a disulfide, a trisulfide, a sulfone, a sulfoxide, a sulfur-containing heterocycle, and combinations thereof. In some embodiments, a sulfur-containing compound includes 3-methyl-2-buten-1-thiol.

[0018] Nitrogen-containing compounds can include a functional group selected from: an amine, an amide, a nitro, a nitrogen-containing heterocycle, and combinations thereof. In some embodiments, a nitrogen-containing compound includes a compound selected from: spermine, spermidine, putrescine, and combinations thereof.

[0019] Additional embodiments, include the use of a pristine metal as a point of use device for removing a volatile, malodorous nitrogen- and/or sulfur-containing compound from a food product, as well as the addition of a haloamide and/or a maleimide to a food product or a package thereof.

[0020] In some embodiments, the present invention is directed to a method-for reducing an odor arising from a volatile, malodorous compound by the addition of a pristine metal to a commercial product and/or a package therefor, such as, but not limited to, tissue, air fresheners, perfume, deodorizer, soap, shampoo, toothpaste, mouthwash, and the like.

[0021] In some embodiments, the present invention is directed to a composition comprising: a sealed package containing a food product and a metal, wherein the sealed package contains a compound having an unpleasant flavor and/or odor in a concentration of about 100 ppm or less. In some embodiments, the sealed package is a bottle that contains a fermented malt beverage.

DETAILED DESCRIPTION OF THE INVENTION

[0022] This specification discloses one or more embodiments that incorporate the features of this invention. The disclosed embodiment(s) merely exemplify the invention. The scope of the invention is not limited to the disclosed embodiment(s). The invention is defined by the claims appended hereto. The embodiment(s) described, and references in the specification to “one embodiment,” “an embodiment,” “an example embodiment,” etc., indicate that the embodiment(s) described can include a particular feature, structure, or characteristic, but every embodiment may not necessarily include the particular feature, structure, or characteristic. Moreover, such phrases are not necessarily referring to the same embodiment. Further, when a particular feature, structure, or characteristic is described in connection with an embodiment, it is understood that it is within the knowledge of one skilled in the art to effect such feature, structure, or characteristic in connection with other embodiments whether or not explicitly described.

[0023] References to spatial descriptions (e.g., “above,” “below,” “up,” “down,” “top,” “bottom,” etc.) made herein are for purposes of description and illustration only, and should be interpreted as non-limiting upon the compositions, methods, and products of any method of the present invention, which can be spatially arranged in any orientation or manner.

Compositions

[0024] The present invention is directed to a composition comprising: a sealed package containing: a food product capable of forming a volatile, malodorous nitrogen-containing compound, a volatile, malodorous sulfur-containing compound, or a combination thereof; and a pristine metal present in an amount sufficient to sequester a volatile, malodorous nitrogen-containing compound, a volatile, malodorous sulfur-containing compound, or a combination thereof; such that a total concentration of volatile, malodorous nitrogen-containing sulfur-containing compounds is below a human detection level at a time of use.

[0025] Generally, the present invention provides methods for removing, reducing or otherwise sequestering volatile, malodorous compounds from a food product that can give rise to unpleasant odors and/or flavors. The present invention permits all varieties of food products to have enhanced shelf life and reduced odor. Food products suitable for use with the present invention are not particularly limited by form or composition, and include liquid, semi-solid, and/or solid food products, or any combination thereof.

[0026] As used herein, “at a time of use” refers to a time at which: a sealed package containing a food product is opened, a food product is removed from a sealed package and/or a food product is ingested or otherwise consumed. In some embodiments, the listed activities can occur substantially simultaneously.

[0027] A food product for use with the present invention can be fresh, raw, cooked, baked, grilled, irradiated, pickled, fermented, steamed, processed, preserved, and the like, and combinations thereof.

[0028] Food products suitable for use with the present invention include, but are not limited to, meats, poultry, fish and other seafood, dairy (e.g., cheese, milk, yogurt, and the like), ovalbumin, soy, whey, grains, cereals, breads, vegetables, fruits, fermented malt beverages, carbonated beverages, juices, sports drinks, vitamin-supplemented drinks, protein drinks, health shakes, herbs, spices, candy, pastries, desserts, sweets, mushrooms, soups, creams, cheeses, butters, dressings, condiments, gravies, and combinations thereof.

[0029] In some embodiments, a food product of the present invention comprises a fermented malt beverage such as, but not limited to, beer, ale, malt liquor, porter, and the like, and combinations thereof.

[0030] In some embodiments, a food product of the present invention comprises a fermented juice beverage, liquor and/or liqueur such as, but not limited to, fermented and/or distilled beverages prepared from grapes, agave, apples, pears, oranges, pineapples, grapefruits, lemons, limes, cherries, raspberries, blackberries, juniper berries, apricots, peaches, currants, plums or prunes, anise, licorice, potatoes, wheat, rice, rye, corn, sugar cane, and the like, and combinations thereof. In some embodiments, a food product of the present invention comprises a liquor or liqueur such as, but not limited to, vodka, tequila, gin, whisky, absinthe, brandy, cognac, rye, rum, and the like.
In some embodiments, a composition of the present invention comprises a commercial product having a distinct flavor and/or odor that can be adversely affected by a second, unwanted odor and/or flavor. The present invention is suitable for use with an aerosol, a liquid, a semi-solid, and/or a solid product, or any combination thereof. Commercial products suitable for use with the present invention include, but are not limited to, bathroom tissue, air fresheners, perfumes, deodorizers, soaps, shampoos, toothpaste, mouthwash, and combinations thereof.

The present invention is suitable for removing, reducing, or otherwise sequestering volatile, malodorous compounds that contain nitrogen and/or sulfur. Such compounds can arise from reactions (e.g., combination, substitution, oxidation and/or reduction reactions), between ingredients present in a food product, or between a food product and an environmental reagent. Such reactions can lead to degradation and/or spoilage of a food product at an accelerated rate. In some embodiments, compounds that can participate in a reaction that leads to an unpleasant odor and/or flavor can be introduced by cooking, baking, grilling, preserving, pickling, fermenting, vaporizing and/or evaporating a food product prior to packaging.

As used herein, “volatile” compounds refer to molecules, species, moieties, and the like that are detectable by a human nose at ambient conditions (i.e., a pressure of about 1 bar and a temperature of about 25°C). In some embodiments, a volatile compound has a molecular weight of about 1000 Daltons (“Da”) or less, about 750 Da or less, about 500 Da or less, about 400 Da or less, about 300 Da or less, about 250 Da or less, about 200 Da or less, about 150 Da or less, or about 100 Da or less.

Volatile malodorous sulfur-containing compounds include, but are not limited to, thiols, dithiols, sulfides, disulfides, sulfones, sulfoxides, sulfur-containing heterocyclic compounds, and combinations thereof. Exemplary sulfur-containing compounds include, but are not limited to, 3-methyl-2-buten-1-thiol, hydrogen sulfide, dimethyl trisulfide, 3-methylthio)propionaldehyde, 3-methyl-3-mercaptoprobutylformate, and combinations thereof.

Volatile malodorous nitrogen-containing compounds include, but are not limited to, in some embodiments, an unpleasant odor or flavor of the present invention comprises nitrogen-containing compounds such as, but not limited to: amines, amides, nitro and nitrogen-containing heterocyclic compounds. Exemplary nitrogen-containing compounds include, but are not limited to, ammonia, methyamine, 2-acytelypyrazine, 2-methoxypyrazine, spermine, spermidine, putrescine, ethyl nicotinate, and combinations thereof.

Odors and/or flavors are generally considered unpleasant if an odor or flavor is detectable by a human. The detection levels for many compounds can vary between subjects and therefore it is necessary to maintain a level of a volatile, malodorous compound at or below a minimum level. The present invention does this by sequestering a volatile, malodorous nitrogen- and/or sulfur-containing compound using a pristine metal. Thus, the present invention enables a consumer to ingest a food product that may otherwise contain a detectable amount of a volatile, malodorous compound and still be safe to consume. In some embodiments, the compositions of the present invention provide a food product having a total concentration of volatile, malodorous nitrogen-containing and sulfur-containing compounds of about 100 nmol or less, about 75 nmol or less, about 50 nmol or less, about 25 nmol or less, about 10 nmol or less, about 5 nmol or less, about 1 nmol or less, about 0.5 nmol or less, about 0.25 nmol or less, about 0.1 nmol or less, about 10 nmol or less, about 5 nmol or less, about 1 nmol or less, about 0.5 nmol or less, about 0.25 nmol or less, about 0.1 nmol or less, about 1 nmol or less, about 0.5 nmol or less, about 0.25 nmol or less, about 0.1 nmol or less.

In some embodiments, a total concentration of volatile, malodorous nitrogen-containing and sulfur-containing compounds is about 1 nmol to about 100 nmol, about 1 nmol to about 75 nmol, about 1 nmol to about 50 nmol, about 1 nmol to about 25 nmol, about 1 nmol to about 10 nmol, about 5 nmol to about 100 nmol, about 5 nmol to about 50 nmol, about 10 nmol to about 100 nmol, about 50 nmol to about 100 nmol, or about 50 nmol to about 100 nmol per milligram of the food product.

In some embodiments, a total concentration of volatile, malodorous nitrogen-containing and sulfur-containing compounds is about 1 pmol to about 10 nmol, about 1 pmol to about 10 nmol, about 100 pmol to about 10 nmol, about 500 pmol to about 10 nmol, about 1500 pmol to about 10 nmol, about 5000 pmol to about 10 nmol, about 10,000 pmol to about 10 nmol, about 100 pmol to about 1 nmol, about 50 pmol to about 1 nmol, about 10 pmol to about 1 nmol, about 5 pmol to about 1 nmol, about 1 pmol to about 1 nmol, about 0.5 pmol to about 1 nmol, about 0.25 pmol to about 1 nmol, about 0.1 pmol to about 1 nmol, or about 0.1 pmol to about 1 nmol per milligram of a food product.

The compositions of the present invention comprise a pristine metal in an amount sufficient to sequester a volatile, malodorous nitrogen-containing and/or sulfur-containing compound. As used herein, “sequester” refers to the formation of a chemical bonding interaction between a pristine metal and a volatile, malodorous nitrogen-containing and/or sulfur-containing compound. Bonding interactions within the term “sequestering” include, but are not limited to, a covalent bond (such as a metal-sigma bond, a metal-pi bond, a partial bond between a metal and a volatile compound, a metal-carbon bond, metal-sulfur bond, a metal-nitrogen bond, a metal-oxygen bond, a nitrogen-oxygen bond, a sulfur-sulfur bond, and the like), an ionic bond, and combinations thereof.

As used herein, “pristine metal” refers to a transition metal, a group IIIIB metal, a group IVB metal, an alloy thereof, a nitride thereof, an oxide thereof, a sulfide thereof, or a combination thereof capable of forming a bond with a sulfur-containing and/or a nitrogen-containing compound. In some embodiments, a pristine metal comprises a metal oxide, a metal nitride, a metal sulfide, or a combination thereof. In some embodiments, a surface of a pristine metal is substantially free from oxidation. In some embodiments, a pristine metal has an oxidation state of zero.

Pristine metals suitable for use with the present invention include, but are not limited to, gold, platinum, silver, copper, palladium, and combinations thereof.

A pristine metal can comprise any shape or form that permits a volatile, malodorous nitrogen-containing and/or sulfur-containing compound to become bonded thereto. In some embodiments, a pristine metal is present as: a film, a component of a film, a colloid, a sol, a nanoparticle, a nanocage, a microparticle, a mesoparticle, a metal-coated particle, a leaf, a wire, a glitter, a foil, a coin, a disk, a stirring rod, a filter, a sieve, or a combination thereof.

As used herein, a “film” refers to a layer or coating that is applied to a substrate. Films of the present invention can be applied to a portion of a food product, a portion of an interior surface of a package containing a food product, and/or to a substrate that is then applied to a food product and/or an interior surface of a package. In some embodiments, a film of the present invention consists essentially of a pristine
metal. In some embodiments, a film contains a material in addition to a pristine metal layer and/or coating. For example, substrates suitable for use with films of the present invention include plastics and polymers having an adhesive backing layer.

[0044] As used herein, a “colloid” refers to a substance containing particles dispersed or suspended throughout another substance, such as a liquid, a polymer, a gel, and the like. In some embodiments, a colloid comprises particles having a microscopic or smaller size. A “solv” refers to a fluid colloidal system. Most often one in which the medium is a liquid.

[0045] Nanoparticles of the present invention comprise particles in the solid state having at least one physical dimension of about 1 nm to about 100 nm.

[0046] Microparticles of the present invention comprise particles in the solid state having at least one physical dimension of greater than about 100 nm to about 10 μm.

[0047] Mesoparticles of the present invention comprise particles in the solid state having at least one physical dimension of greater than about 10 μm to about 10 mm.

[0048] Metal leaf of the present invention comprises a sheet or film comprising a pristine metal having a thickness of about 30 nm to about 1 μm. Foil of the present invention comprises a sheet or film comprising a pristine metal having a thickness of greater than about 1 μm to about 1 mm.

[0049] Wire of the present invention comprises pristine metal as an elongated cylinder, tube, thread or rod having a circular, ellipsoidal, triangular, square, pentagonal, hexagonal, octagonal or star shape. Generally, a wire has a length at least 10 times greater than a lateral dimension (e.g., a diameter).

[0050] Glitter of the present invention can comprise platelets, particles, beads, and the like having at least one lateral dimension of about 1 mm or greater. Glitter can optionally include a light reflective and/or light refractive surface.

[0051] In some embodiments, a pristine metal can be regenerated, for example, by thermal, chemical, biochemical, electrochemical, photochemical and/or mechanical treatment. For example, a pristine metal composition of the present invention can be treated to remove a volatile nitrogen-containing and/or sulfur-containing compound and reused in a second sealed package. Thus, the present invention includes recycling the pristine metal such that the pristine metal can be used multiple times.

[0052] In some embodiments, a pristine metal is present on the surface of a magnetic particle. Magnetic particles suitable for use with the present invention include, but are not limited to, particles containing iron, nickel, cobalt, gadolinium, chromium oxide, MgO, FeO, MnO, CoO, NiO, CuO, MnO, FeO, MnBi, Y2FeO12, doped variants thereof, and combinations thereof.

[0053] In some embodiments, a pristine metal is present on a non-metal support such as, but not limited to, a plastic (e.g., polyethylene, polypropylene, polyethylene terephthalate, polyvinylchloride, polystyrene, polycarbonate, an acrylic polymer, acrylonitrile butadiene styrene, a nylon, polylactic acid, and the like), a glass, diamond, graphite, quartz, alumina, and combinations thereof.

[0054] Packaging of the present invention comprises any type of package or container that can be sealed. Packaging materials suitable for use with the present invention include, but are not limited to, plastic (e.g., blown, foamed, extruded, injected and/or metal-coated plastics, and the like), paper (e.g., folded, coated and/or corrugated paper, and the like), wax, wood, glass, metal (foil, vapor deposited and/or extruded metal, and the like), laminates thereof, composites thereof, and combinations thereof.

[0055] In some embodiments, the present invention comprises a sealed package selected from: a bag, a box, a tray, a bowl, a can, a tube, and a bottle.

[0056] In some embodiments, a pristine metal is present on at least a portion of a package selected from: a stopper, a cap, a lid, an adhesive sheet, and the like suitable for enclosing or otherwise sealing a package. In some embodiments, a stopper, cap and/or lid includes a material selected from: cork, a plastic, an elastomer, a metal, and the like, and combinations thereof.

[0057] In some embodiments, at least a portion of a package is transparent to a visible and/or ultraviolet light. Thus, the present invention is particularly suited for sequestering a nitrogen-containing and/or sulfur-containing compound that can form when a food product is exposed to ultraviolet and/or visible light.

[0058] As used herein, “transparent” refers to a transmission of about 50% or more. In some embodiments, at least a portion of a package is transparent to at least one wavelength of about 350 nm to about 1800 nm, about 400 nm to about 1800 nm, about 400 nm to about 500 nm, about 450 nm to about 500 nm, about 450 nm to about 600 nm, about 480 nm to about 600 nm, about 500 nm to about 500 nm, or about 530 nm to about 500 nm. In some embodiments, at least a portion of a package appears substantially transparent to a human eye. Thus, in some embodiments the present invention is directed to a UV- and/or visible-light degradable food product contained in an optically transparent sealed package comprising a pristine metal in an amount sufficient to sequester a nitrogen-containing and/or sulfur-containing compound generated within the package prior to use.

[0059] In some embodiments, a pristine metal composition of the present invention is present on an interior surface of a package that contains a food product.

[0060] In some embodiments, a sealed package contains a liquid food product, and a pristine metal is present on an inner surface of the sealed package; in at least a portion of the liquid food product; or a combination thereof, and the pristine metal is present in an amount sufficient to provide a pristine metal surface area of about 1 cm2, about 10 cm2, about 20 cm2, about 30 cm2, about 50 cm2, about 75 cm2, or about 100 cm2 per liter of the liquid food product.

[0061] In some embodiments, a sealed package contains a solid or semi-solid food product, and a pristine metal is present on an inner surface of the sealed package in an amount sufficient to provide a pristine metal surface area of about 0.1 cm2, about 0.5 cm2, about 1 cm2, about 2 cm2, about 3 cm2, about 5 cm2, or about 10 cm2 per milligram of the solid or semi-solid food product.

[0062] In some embodiments, the present invention is directed to a composition comprising a sealed package transparent to at least one wavelength of about 350 nm to about 500 nm, containing: a liquid food product capable of forming a volatile, malodorous sulfur-containing compound; and a pristine metal present in a concentration of about 1 cm2 or more per liter of the liquid food product, wherein a total concentration of volatile, malodorous sulfur-containing compounds is about 100 nanol or less per milligram of the food product at a time of use.
In some embodiments, the present invention is directed to a composition comprising a sealed package transparent to at least one wavelength of about 350 nm to about 560 nm, containing: a semi-solid and/or solid food product capable of forming a volatile, malodorous nitrogen-containing and/or sulfur-containing compound; and a pristine metal present in a concentration of about 0.1 cm² or more per milligram of the semi-solid and/or solid food product, wherein a total concentration of volatile, malodorous sulfur-containing compounds is about 100 nmol or less per milligram of the food product at a time of use.

Processes

The present invention is directed to a process for sequestering a nitrogen-containing compound, a sulfur-containing compound, or a combination thereof, from a food product prior to use, the process comprising: providing to a sealed food product a pristine metal suitable for sequestering a nitrogen-containing compound, a sulfur-containing compound, or a combination thereof, wherein the pristine metal is present in or on a sealed package containing the food product; and in at least a portion of the sealed food product, or a combination thereof, wherein the pristine metal is present in an amount sufficient to sequester a nitrogen-containing compound, a sulfur-containing compound, or a combination thereof that is formed in situ prior to use of the food product.

A pristine metal can be added to a food product prior to processing, during processing and/or after processing of the food product.

In some embodiments, the providing comprises adding a pristine metal to a liquid food product in an amount sufficient to provide a pristine metal surface area of about 1 cm², about 10 cm², about 20 cm², about 30 cm², about 50 cm², about 75 cm², or about 100 cm² per liter of the liquid food product.

In some embodiments, the providing comprises adding a pristine metal to a package containing a solid or semi-solid food product in an amount sufficient to provide a pristine metal surface area of about 0.1 cm², about 0.5 cm², about 1 cm², about 2 cm², about 3 cm², about 5 cm², or about 10 cm² per milligram of the solid or semi-solid food product.

In some embodiments, a pristine metal is added to a food or commercial product by a consumer who purchases the product along with a pristine metal composition. Thus, as used herein, “providing” a pristine metal includes incorporating a pristine metal into a food product and/or the packaging thereof, as well as separately providing a food product and a pristine metal, and including instructions for a consumer to mix the food product with the pristine metal prior to use. For example, pouring a liquid food product through a sieve or filter comprising a pristine metal is within the scope of the present invention.

In some embodiments, a pristine metal is regenerated or recycled. Regeneration of a pristine metal includes any method that returns a metal for use with the present invention to a pristine state such that a metal is capable of sequestering a volatile, malodorous nitrogen-containing and/or sulfur-containing compound. Regeneration includes, but is not limited to, thermal, chemical, biochemical, electrochemical, photochemical, mechanical processes, and combinations thereof. For example, in some embodiments an electric potential is applied to a pristine metal in order to oxidize nitrogen-containing and/or sulfur-containing compounds sequestered thereon. In some embodiments, a chemical reagent (e.g., an acid) is applied to a pristine metal surface (e.g., copper) to remove any nitrogen-containing and/or sulfur-containing compounds sequestered thereon. In some embodiments, a pristine metal is heated thermaally in an oxidizing atmosphere to remove any nitrogen-containing and/or sulfur-containing compounds sequestered thereon. In some embodiments, a pristine metal is exposed to a plasma (e.g., an oxygen plasma) to remove any nitrogen-containing and/or sulfur-containing compounds sequestered thereon.

The following examples illustrate compositions and processes for reducing or eliminating the odor or flavors of nitrogen-containing and/or sulfur-containing compounds in food products are given for the purpose of illustrating the present invention and shall not be construed as being limitations on the scope or spirit of the invention.

EXAMPLES

Prophetic Example 1

At least a portion of an interior surface of a bottle will be coated with a film comprising a pristine metal (e.g., Au) by sputtering, vapor deposition, electrodeposition, or screen printing. The thickness of the pristine metal film will be varied from about 10 nm to about 100 nm. After the film is deposited, the resulting bottle will be cleaned and filled with a liquid food product, e.g., a hopped malt beverage, sealed, labeled and distributed for sale. The pristine metal film will sequester any volatile, malodorous sulfur-containing and/or nitrogen-containing compounds that are formed within the sealed package prior to use.

Prophetic Example 2

A metal colloids (e.g., Au colloid) comprising metal particles and a dispersion system will be mixed with a plastic melt and cooled to provide a plastic tray comprising a plurality of pristine metal particles. A liquid, semi-solid and/or solid food product will be provided to one or more areas of the tray, and the tray and the food product will be sealed to provide a sealed package. The tray comprising a plurality of pristine metal particles will sequester any volatile, malodorous sulfur-containing and/or nitrogen-containing compounds that are formed within the sealed package prior to use.

Prophetic Example 3

A textured plastic strip will be coated with a thin film comprising a pristine metal by sputtering, vapor deposition, electroplating, electroless deposition, or screen printing. The coated strip will be affixed to the inside surface of a cap, stopper, or lid and placed on a package comprising a food product to provide a sealed package. The strip will extend away from an interior surface of a cap, stopper, or lid and can optionally be partially immersed in a liquid, semi-solid, or solid food product contained within the sealed package. The coated strip comprising a pristine metal layer will sequester any volatile, malodorous sulfur-containing and/or nitrogen-containing compounds that are formed within the sealed package prior to use.

Prophetic Example 4

A transparent package will be filled with a fermented malt beverage and a pristine metal leaf (e.g., gold leaf), glitter and/or flake. The fermented beverage will be added to the container before or after a pristine metal. In some
embodiments, a pristine metal will be added directly to the fermented malt beverage prior to packaging. The pristine metal will sequester any volatile, malodorous sulfur-containing and/or nitrogen-containing compounds that are formed within the sealed package prior to use. The pristine metal can also improve the attractiveness of the packaging by improving the aesthetic appeal and perceived value of the fermented malt beverage.

Prophetic Example 5

A disposable tray will be coated with a thin layer of gold (via, e.g., vapor deposition, sputtering, and the like). A liquid, semi-solid and/or solid food product will be provided to one or more areas of the coated tray, and the coated tray and the food product will be sealed to provide a sealed package. The coated tray will sequester any volatile, malodorous sulfur-containing and/or nitrogen-containing compounds that are formed within the sealed package prior to use.

The coated tray can be recycled by returning the coated tray to the manufacturer for regeneration of the pristine metal, removal of the pristine metal from the surface of the coated tray, and the like.

Prophetic Example 6

A funnel will be coated with a pristine metal, and sold to a consumer either as a stand alone item, or as part of an integrated food product packaging system comprising a fermented beverage in a sealed package. A package comprising the funnel will include instructions directing a consumer to pour the fermented beverage through the funnel prior to ingestion of the fermented beverage product. In some embodiments, a funnel can have a traditional conical shape or a columnar shape. In some embodiments, a funnel can be at least partially filled with a porous matrix comprising a pristine metal.

Prophetic Example 7

A wire mesh comprising a pristine metal (e.g., copper and/or gold) will be placed across an opening of a bottle containing a liquid food product. The liquid food product will be dispensed from the bottle, and a volatile, malodorous sulfur-containing and/or nitrogen-containing compound will be removed from the liquid food product during the dispensing.

In a related embodiment, a wire mesh comprising a pristine metal (e.g., copper and/or gold) will be positioned transversely within the headspace region of a bottle, and the bottle will be filled with a liquid food product. The wire mesh will sequester a volatile, malodorous sulfur-containing and/or nitrogen-containing compound that forms inside the bottle prior to use.

Conclusion

These examples illustrate possible embodiments of the present invention. While various embodiments of the present invention have been described above, it should be understood that they have been presented by way of example only, and not limitation. It will be apparent to persons skilled in the relevant art that various changes in form and detail can be made therein without departing from the spirit and scope of the invention. Thus, the breadth and scope of the present invention should not be limited by any of the above-described exemplary embodiments, but should be defined only in accordance with the following claims and their equivalents.

It is to be appreciated that the Detailed Description section, and not the Summary and Abstract sections, is intended to be used to interpret the claims. The Summary and Abstract sections can set forth one or more, but not all exemplary embodiments of the present invention as contemplated by the inventor(s), and thus, are not intended to limit the present invention and the appended claims in any way.

All documents cited herein, including journal articles or abstracts, published or corresponding U.S. or foreign patent applications, issued or foreign patents, or any other documents, are each entirely incorporated by reference herein, including all data, tables, figures, and text presented in the cited documents.

What is claimed is:

1. A composition comprising: a sealed package containing: a food product capable of forming a volatile, malodorous nitrogen-containing compound, a volatile, malodorous sulfur-containing compound, or a combination thereof; and

a pristine metal present in an amount sufficient to sequester a volatile, malodorous nitrogen-containing compound, a volatile, malodorous sulfur-containing compound, or a combination thereof, such that a total concentration of volatile, malodorous nitrogen-containing and sulfur-containing compounds is below a human detection level at a time of use.

2. The composition of claim 1, wherein the pristine metal is selected from: gold, platinum, silver, copper, palladium, and combinations thereof.

3. The composition of claim 1, wherein the pristine metal is present as at least one of: a film, a component of a film, a colloid, a sol, a nanoparticle, a microparticle, a mesoparticle, a metal-coated particle, a leaf, a wire, a glitter, a foil, a coin, a disk, a stirring rod, a sieve, a filter, or a combination thereof.

4. The composition of claim 1, wherein at least a portion of the sealed package is transparent or opaque.

5. The composition of claim 1, wherein the sealed package contains a liquid food product, and the pristine metal is present:

on an inner surface of the sealed package; in at least a portion of the liquid food product; or a combination thereof, and

wherein the pristine metal is present in an amount sufficient to provide a pristine metal surface area of about 1 cm² per liter of the liquid food product.

6. The composition of claim 5, wherein the pristine metal is present in an amount sufficient to provide a pristine metal surface area of about 10 cm² per liter of the liquid food product.

7. The composition of claim 1, wherein the sealed package contains a solid or semi-solid food product, and the pristine metal is present on an inner surface of the sealed package, and wherein the pristine metal is present in an amount sufficient to provide a pristine metal surface area of about 0.1 cm² per milligram of the solid or semi-solid food product.

8. The composition of claim 7, wherein the pristine metal is present in an amount sufficient to provide a pristine metal surface area of about 0.5 cm² per milligram of the solid or semi-solid food product.

9. A process for sequestering a nitrogen-containing compound, a sulfur-containing compound, or a combination
thereof, from a food product prior to use, the process comprising: providing to a sealed food product a pristine metal suitable for sequestering a nitrogen-containing compound, a sulfur-containing compound, or a combination thereof, wherein the pristine metal is present:

in or on a sealed package containing the food product;

in at least a portion of the sealed food product; or

a combination thereof, and

wherein the pristine metal is present in an amount sufficient to sequester a nitrogen-containing compound, a sulfur-containing compound, or a combination thereof that is formed in situ prior to use of the food product such that malodorous nitrogen-containing and sulfur-containing compounds is below a human detection level at a time of use.

10. The process of claim 9, wherein the food product is a protein-containing food product that contains food selected from: a meat, poultry, a seafood, soy, whey, an egg, a dairy product, ovalbumin, and combinations thereof.

11. The process of claim 9, wherein a sulfur-containing compound includes a functional group selected from: a thiol, a dithiol, a sulfide, a disulfide, a trisulfide, a sulfone, a sulfoxide, a sulfur-containing heterocycle, and combinations thereof.

12. The process of claim 9, wherein the sulfur-containing compound includes 3-methyl-2-butene-1-thiol.

13. The process of claim 9, wherein a nitrogen-containing compound includes a functional group selected from: an amine, an amide, a nitro, a nitrogen-containing heterocycle, and combinations thereof.

14. The process of claim 9, wherein a nitrogen-containing compound includes a compound selected from: spermine, spermidine, putrescine, and combinations thereof.

15. The process of claim 9, wherein the pristine metal is selected from: gold, platinum, silver, copper, palladium, and combinations thereof.

16. The process of claim 9, wherein the pristine metal is present as at least one of: a film, a component of a film, a colloid, a sol, a nanoparticle, a nanocage, a microparticle, a mesoparticle, a metal-coated particle, a leaf, a wire, a glitter, a foil, a stopper, a coin, a disk, a stirring rod, a sieve, a filter, or a combination thereof.

17. The process of claim 9, wherein the providing comprises adding a pristine metal to a liquid food product in an amount sufficient to provide a pristine metal surface area of about 1 cm² per liter of the liquid food product.

18. The process of claim 9, wherein the providing comprises adding a pristine metal to a liquid food product in an amount sufficient to provide a pristine metal surface area of about 10 cm² per liter of the liquid food product.

19. The process of claim 9, wherein the providing comprises adding a pristine metal to a package containing a solid or semi-solid food product in an amount sufficient to provide a pristine metal surface area of about 0.1 cm² per milligram of the solid or semi-solid food product.

20. The process of claim 9, wherein the providing comprises adding a pristine metal to a package containing a solid or semi-solid food product in an amount sufficient to provide a pristine metal surface area of about 0.5 cm² per milligram of the solid or semi-solid food product.

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