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(71) Applicant (for all designated States except US): **PIMI AGRO CLEANTECH LTD.** [IL/IL]; P.O. Box 117, 30049 Hutzot Alonim (IL).

(72) Inventor; and

(75) Inventor/Applicant (for US only): **BEN YEHUDA, Nimrod** [IL/IL]; 17 Ma'alai Avshalom Street, 36011 Kiryat Tivon (IL).

(74) Agents: **WEBB & CO.** et al.; P.O. Box 2189, 76121 Rehovot (IL).

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(54) Title: METHODS FOR IMPROVING THE APPEARANCE OF EDIBLE PLANT MATTER

(57) Abstract: The present invention relates to environmentally friendly processes and compositions for improving the appearance of edible plant matter and foodstuff, for example for enhancing their brightness during all stages of storage and handling, including pre and post harvest, pre and post planting, pre and during storage, distribution, packing lines and marketing. The methods of the present invention involve contacting the edible plant matter with a composition comprising phosphonic acid and/or a salt thereof, according to a schedule as described herein. The edible plant matter can come in contact with the phosphonic composition by various methods such as dipping or immersing the edible plant matter in the composition, spraying the composition onto the edible plant matter, exposing the edible plant matter to a fog or gas of the composition, or any combination thereof.



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METHODS FOR IMPROVING THE APPEARANCE OF EDIBLE PLANT MATTER

The present invention relates to environmentally friendly processes and compositions for improving the appearance of edible plant matter and foodstuff, for example for enhancing their brightness during one or more stages of storage and handling, including pre and post harvest, pre and post planting, distribution, packing lines and marketing.

BACKGROUND OF THE INVENTION

Deteriorative losses of foodstuffs and plant matter during growing, storage and handling is a high priority global problem of considerable social, economic and political importance. Quantitative and qualitative losses during all stages of foodstuff and plant matter growing, storage and handling, impacts first and foremost the ability to sustain a reasonable nutritional level and quality for the consumers. Consequently, processes and compositions that can contribute significantly to quantitative and qualitative loss reduction/prevention are of paramount importance.

The current total global yield of potatoes is estimated to be in the vicinity of 300 million tons per annum. It is both a basic food staple because of its inherent nutritional value, being rich in carbohydrates and other nutrients, and at the same time is frequently prepared for quick snacks such as French fries or chips. It is also used in gourmet dishes, wherein product quality, taste and texture are more critical. Since the conditions under which potatoes grow prevail only in certain seasons of the year in the various regions of the globe in which they are grown, the issue of preventing qualitative and quantitative losses during storage or during inter regional trade, is vital to those involved in the field of potato growing, storage, trade and consumption.

U.S. Patent No. 6,946,155 and 7,147,872 disclose a process for treating plant matter and foodstuffs during storage, distribution and marketing, preplanting, growing, and pre and/or post harvest, to increase yields, eliminate health hazards, impart storage stability, extend shelf life and inhibit premature sprouting, rooting, germination, blossoming, decay, "black-heart" formation, pathogenic losses and other processes causing losses in quality and/or quantity of said plant matter and foodstuffs, by treating the plant matter or foodstuffs with an aqueous dosage comprising an effective concentration of hydrogen peroxide and

optionally comprising, an effective dosage of one or more additional components selected from (i) effective trace concentrations of dispersed metals or metal ions; (ii) effective concentrations of other and/or additional hydrogen peroxide activators, synergists and promoters; (iii) effective concentrations of hydrogen peroxide stabilizers and modifiers; (iv) 5 effective concentrations of pH regulators; and (v) effective concentrations of organic and/or inorganic additives. Stabilizers and modifiers include citric acid, tartaric acid, boric acid, hydrobromic acid, stannates, phosphonic acids and the like.

US Patent Application No. 2010/00119669 discloses and claims a method of treating edible plant matter to inhibit deterioration thereof by undesirable microbiological or biochemical processes during storage and handling of the edible plant matter, comprising 10 contacting the edible plant matter with an aqueous composition by at least one of dipping the edible plant matter in the aqueous composition, spraying the aqueous composition onto the edible plant matter and exposing the edible matter to a fog of the aqueous composition, wherein the aqueous composition has a pH no greater than 4 and comprises (1) phosphonic 15 acid, (2) metals or metallic ions of at least one of silver, copper and zinc, present in the aqueous composition in an amount of 1 ppb to 1,000 ppm, and (3) at least one of citric acid, phosphoric acid and sulfuric acid.

PCT International Patent Application No. WO 2012/037294 discloses methods of treating edible matter comprising applying a composition comprising performic acid, 20 optionally with additional excipients including phosphonic acid, phosphoric acid, citric acids and surfactants.

Deteriorative loss of foodstuffs and plant matter such as fruit and vegetables is often associated with loss of color, pigmentation, brightness, and the like. The foodstuffs and plant matter appear pale and thus unappealing to the consumer, who prefers to consume fruit and 25 vegetables with bright colors, because vibrant coloring is a sign that the food contains healthy nutrients. Growers sometimes enhance the color of fruit and vegetables with artificial or natural dyes.

There remains an unmet need in the art for methods for improving the appearance of edible plant matter and foodstuff, especially fruit and vegetables, for example by enhancing 30 their brightness during all stages of storage, handling and marketing.

SUMMARY OF THE INVENTION

The present invention relates to environmentally friendly processes and compositions for improving the appearance of edible plant matter and foodstuff, for example for enhancing their brightness during one or more stages of storage, handling and marketing, including pre and post harvest, pre and post planting, pre and during storage, distribution, packing lines and marketing. The methods of the present invention involve contacting the edible plant matter with a composition comprising phosphonic acid and/or a salt thereof according to a schedule as described herein. The edible plant matter can come in contact with the phosphonic composition by various methods such as dipping or immersing the edible plant matter in the composition, spraying the composition onto the edible plant matter, exposing the edible plant matter to a fog or gas of the composition, or any combination thereof. The contacting step comprises at least one exposure to the phosphonic acid composition at a temperature below about 30°C during handling; and/or at least one exposure to the phosphonic acid composition below about 20°C during long-term storage. The methods can further comprise a curing step comprising exposure of the edible plant matter to a composition comprising phosphonic acid and/or a salt thereof at a temperature of about 30°C or above daily during the handling and short term storage states. In certain embodiments the curing step may further comprise a heating step.

The process and compositions of the invention improves the appearance of the edible plant matter or other foodstuff, for example by enhancing the brightness, color intensity, pigmentation, vividness, brilliance, clarity, glow or texture, or any combination thereof. Unexpectedly it has now been found that the exposure of edible plant matter to phosphonic acid and/or and salt thereof at low temperatures, results in enhanced brightness of the treated materials. Notably, multiple exposures of the plant matter to the compositions of the invention notably below 30°C or even during cold storage dramatically improve the appearance of the fruits or vegetables so treated.

As contemplated herein, the applicants have unexpectedly found that phosphonic acid and/or a salt thereof at a range of about 0.01% up to 70%, preferably about 0.01%-50%, more preferably from about 0.1% to about 1% and even more preferably about 0.2%-0.44% in an aqueous vehicle, has beneficial effects in enhancing the brightness of sweet potatoes and other fruit and vegetables at the curing stage and storage period and especially on the washing stage at the pre packing stage. The sweet potatoes are submerged in a bath

containing the phosphonic acid composition, or the composition is sprayed on the sweet potatoes or other fruit/vegetable. In one preferred embodiment, the composition is an aqueous composition.

5 In one embodiment, the process of the invention comprises exposing the plant matter to the composition during short-term handling for about 1 second to about 30 minutes, preferably for about 15 to about 30 minutes at a temperature below about 30°C, preferably at a temperature of about 18°C to 24°C.

10 In another embodiment, the process of the invention further comprises a curing step wherein the edible plant matter is exposed to the composition during handling and short-term storage, daily for about 1 to 7 days for at least a portion of each day, and at ambient temperature or above, preferably at a temperature of about 30°C to about 70°C, more preferably a temperature of about 35-50 °C.

15 In another embodiment, the process of the invention further comprises exposing the edible plant matter to said composition during long-term storage, at least once every two to four weeks at a temperature of below about 20°C, preferably at a temperature of about 0.5°C to 14°C.

The edible plant matter can be contacted with the phosphonic acid and/or phosphonic acid composition according to any one of the aforementioned schedules, i.e., (a) short-term handling; (b) handling and short-term storage; and (c) long term storage, or any combination
20 thereof. Preferably the edible plant matter is contacted with the phosphonic acid and/or phosphonic acid composition according to the following schedule:

- (a) during short-term handling for about 1 second to about 30 minutes, preferably for about 15 to 30 about minutes at a temperature below about 30°C, preferably at a temperature of about 18°C to 24°C;
- 25 (b) during handling and short-term storage, daily for about 1 to 7 days for at least a portion of each day, and at ambient temperature or above, preferably at a temperature of about 30°C to about 70°C, more preferably a temperature of about 35-50°C; and
- (c) during long-term storage, at least once every two to four weeks at a temperature of below about 20°C, preferably at a temperature of about 0.5 °C to 14 °C.

As demonstrated herein, application of a phosphonic acid/phosphonic acid salt composition according to the aforementioned schedule produces desirable results in enhancing the brightness of the fruit/vegetable under treatment, as compared with conventional treatments.

5 In one currently preferred embodiment, the edible plant matter is exposed to the phosphonic acid and/or phosphonic acid salt composition for about 6 to 12 hours a day for about 4 to 7 days during handling/short-term storage, followed by treatment every 2 to 4 weeks during long-term storage.

10 In some embodiment, in addition to phosphonic acid and/or or salt thereof, the composition preferably comprises a surfactant. A currently preferred surfactant is an alkyl poly glycoside.

15 In other embodiments, in addition to phosphonic acid and/or salt thereof, the composition preferably comprises hydrogen peroxide (H_2O_2), preferably wherein the concentration of hydrogen peroxide is between about 0.01% and 20% by weight of the composition.

In some embodiments, the composition comprises (a) phosphonic acid and/or a salt thereof, (b) hydrogen peroxide (H_2O_2); and (c) a surfactant, wherein the surfactant is preferably an alkyl polyglycoside.

20 Trace elements activators, synergists and promoters such as but not limited dispersions of metal, non-metals or ion, such as copper, zinc, nickel, iron, potassium manganese, silver, titanium, chromium, molybdenum, magnesium boron, phosphorous, iodine, sulfur, citrate, etc. may also be added to the compositions. In one embodiment the composition further comprises metals or metallic ions of at least one of silver, copper, titanium and zinc, which are preferably present in the aqueous composition in an amount of
25 about 1 ppb to about 1,000 ppm.

Optionally, the compositions can further comprise one or more of a stabilizer, additive, modifier or a pH regulator. Stabilizers, additives and modifiers include, but are not limited to, citric acid, tartaric acid, boric acid, hydrobromic acid, stannic acids (including stannates), HEDP (1-hydroxyethane 1,1-diphosphonic acid, DEQUEST®, such as

DEQUEST 2010®), EDTA ethyl acetate, and the like. Examples of pH regulators include mineral and organic acids, such as, but not limited to phosphoric acid, peracetic acid, performic acid or a precursor thereof, formic acid, hydrochloric acid, sulfuric acid, etc. Additional acids may include salicylic acid and nitric acid. Each possibility represents a separate embodiment of the present invention. In one embodiment, the composition comprises at least one of citric acid, phosphoric acid, sulfuric acid, acetic acid, formic acid or any other type of carboxylic acid. In one particular embodiment, the composition further comprises an effective amount of performic acid or a precursor thereof. Each possibility represents a separate embodiment of the present invention.

10 In one particular embodiment, the composition of the present invention comprises (a) phosphonic acid and/or a salt thereof, (b) hydrogen peroxide (H_2O_2); (c) a surfactant, wherein the surfactant is preferably an alkyl polyglycoside; and (d) at least one metal or metallic ion selected from silver, copper, titanium and zinc, present in an amount of about 1 ppb to about 1,000 ppm.

15 In another particular embodiment, the composition of the present invention consists of (a) phosphonic acid and/or a salt thereof, (b) hydrogen peroxide (H_2O_2); (c) a surfactant, wherein the surfactant is preferably an alkyl polyglycoside; and (d) at least one of citric acid, phosphoric acid, sulfuric acid, acetic acid or formic acid.

In another particular embodiment, the composition of the present invention consists of
20 (a) phosphonic acid and/or a salt thereof; and (b) an aqueous vehicle.

In another particular embodiment, the composition of the present invention consists of (a) phosphonic acid and/or a salt thereof, (b) hydrogen peroxide (H_2O_2); (c) a surfactant, wherein the surfactant is preferably an alkyl polyglycoside; and (d) an aqueous vehicle.

In another particular embodiment, the composition of the present invention consists of
25 (a) phosphonic acid and/or a salt thereof, (b) hydrogen peroxide (H_2O_2); (c) a surfactant, wherein the surfactant is preferably an alkyl polyglycoside; (d) at least one metal or metallic ion selected from silver, copper, titanium and zinc, present in an amount of about 1 ppb to about 1,000 ppm; and (e) an aqueous vehicle.

In another particular embodiment, the composition of the present invention consists of (a) phosphonic acid and/or a salt thereof, (b) hydrogen peroxide (H_2O_2); (c) a surfactant, wherein the surfactant is preferably an alkyl polyglycoside; (d) at least one of citric acid, phosphoric acid, sulfuric acid, acetic acid or formic acid; and (e) an aqueous vehicle.

- 5 In another embodiment, the composition of the present invention consists of (a) phosphonic acid and/or a salt thereof, (b) hydrogen peroxide (H_2O_2); (c) a surfactant, wherein the surfactant is preferably an alkyl polyglycoside; (d) at least one metal or metallic ion selected from silver, copper, titanium and zinc, present in an amount of about 1 ppb to about 1,000 ppm; (e) EDTA and/or HEDP; and (f) an aqueous vehicle.

- 10 The edible plant matter can be any fruit or vegetables, and is preferably selected from the group consisting of potatoes, sweet potatoes, yams, all variety of citrus fruit (e.g., oranges, grapefruit, lemon, lime, clementine, mandarin, tangerine, pomelo and the like), tomato, carrot, onions, garlic, cucumber, radish, avocado, mango, persimmon, grapes, cherries, figs, plums, apricot, peach, banana, celery, turnip, lettuce and other green leafy
15 vegetables, leek, cabbage, cauliflower, apple, pear, plum, kiwi, and other tropical fruit, kohlrabi, pepper, a variety of berries (e.g., strawberry, blackberry, raspberry, blueberry, bilberry, boysenberry, cranberry, white and red currants, gooseberry, huckleberry and the like), melon, watermelon, seeds and grains as well as any other fruit or vegetables whose appearance (e.g., brightness) can be enhanced or improved by applying the compositions of
20 the present invention.

Another group of pH regulators that can be added to the compositions of the present invention are bases such as but not limited to ammonium hydroxide, potassium hydroxide, potash, sodium hydroxide, magnesium hydroxide calcium carbonate, magnesium carbonate, ammonium carbonate, sodium carbonate, and the like.

- 25 For optimum effectiveness on, e.g., sweet potatoes, the pH should be lower than about 6, and preferably between about 1 and 4. In other embodiments, the pH of compositions may be raised by any of the pH modulators mentioned above, especially ammonia or potash, to neutral pH and higher. Preferred pH ranges, e.g., for citrus fruit, are about 6 to about 12, more preferably from about 7 to about 11.

The compositions of the present invention can be applied at ambient temperatures, however, in order to obtain faster results, the compositions are typically applied at elevated temperatures, for example between 30°C to about 70°C, preferably at a temperature of about 35°C-50°C during the curing stage. The temperature can be selected by a person of skill in the art, based on the type of fruit or vegetable being treated. The compositions can be prepared in an aqueous solution which is heated to the desired temperature, or alternatively the composition can be prepared by diluting the appropriate amount of phosphonic acid and/or salt thereof in hot or cold water at the desired temperature. For example, treatment of sweet potatoes at the entrance phase of the treatment and during short-term storage, can be achieved with fogging for about 6 to 12 hours, for about 4 to 7 sequential days, as well as treatment approximately every 2 to 3 weeks during the long-term storage period.

The edible plant matter or foodstuff can be contacted with the phosphonic acid and/or phosphonic acid salt composition for any length of time, typically between about 1 second and about 10 minutes, for example for a few seconds (e.g., 5-60 seconds) or a few minutes (e.g., 1-5 min).

Further embodiments and the full scope of applicability of the present invention will become apparent from the detailed description given hereinafter. However, it should be understood that the detailed description and specific examples, while indicating preferred embodiments of the invention, are given by way of illustration only, since various changes and modifications within the spirit and scope of the invention will become apparent to those skilled in the art from this detailed description.

BRIEF DESCRIPTION OF THE DRAWINGS

FIGURE 1. depicts a batch of sweet potatoes before (top) and after (bottom) treatment with the compositions of the present invention.

FIGURE 2. depicts a batch of sweet potatoes before (right side) and after (left side) treatment with the compositions of the present invention.

FIGURE 3. depicts a batch of sweet potatoes after treatment with the compositions of the present invention.

FIGURE 4. depicts a batch of sweet potatoes after conventional phosphonic acid treatment (right hand side) and after treatment with the compositions and methods of the present invention (left hand side).

FIGURE 5. depicts a batch of potatoes before (5A) and after (5B) treatment with the compositions of the present invention.

FIGURE 6. depicts a batch of oranges before (6A) and after (6B) treatment with the compositions of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

The present invention relates to environmentally friendly processes and compositions for improving the appearance of edible plant matter and foodstuff, for example for enhancing their brightness during one or more stages of storage and handling, including pre and post harvest, pre and post planting, pre and during storage, distribution, packing lines and marketing. The methods of the present invention involve contacting the edible plant matter with a composition comprising phosphonic acid and/or a salt thereof. The edible plant matter can come in contact with the phosphonic acid/phosphonic acid salt composition by various methods such as dipping or immersing the edible plant matter in the composition, spraying the composition onto the edible plant matter, exposing the edible plant matter to a fog or gas of the composition, or any combination thereof.

In one embodiment, the present invention relates to a method of improving the appearance of edible plant matter, the method comprising the step of contacting the edible plant matter with a composition comprising phosphonic acid and/or a salt thereof, during one or more stages of storage, handling and marketing, wherein the contacting step is carried out by at least one of dipping or immersing the edible plant matter in the composition, spraying the composition onto the edible plant matter, or exposing the edible plant matter to a fog or a gas comprising the composition, wherein the contacting step comprises at least one exposure to the composition at a temperature below about 30°C during handling; and/or at least one exposure to the composition below about 20°C during long-term storage.

The term "phosphonic acid" (or "phosphorous acid") refers to the compound H_3PO_3 or any salt thereof, for example the potassium, sodium, ammonium or magnesium salts. It is understood that reference to phosphonic acid throughout this application encompasses the parent acid as well as phosphonic acid salts.

5 The term "ambient temperature" as used herein refers to room temperature (about 25°C or above), for example ambient temperature may reach about 30°C or above.

While the present compositions and methods of the present invention are preferably used on vegetables such as potatoes, sweet potatoes and yams, it is evident that the same or similar methods and composition can be used to enhance and improve the appearance of plant material and foodstuffs in general. This applies not only to similar vegetable food crops, but also to any fruit or any other edible plant matter or foodstuff, including, but not limited to all variety of citrus fruit (e.g., oranges, grapefruit, lemon, lime, clementine, mandarin, tangerine, pomelo and the like), tomato, carrot, onions, garlic, cucumber, radish, avocado, mango, persimmon, grapes, cherries, figs, plums, apricot, peach, banana, celery, turnip, lettuce and other green leafy vegetables, leek, cabbage, cauliflower, apple, pear, plum, kiwi and other tropical fruit, kohlrabi, pepper, a variety of berries (e.g., strawberry, blackberry, raspberry, blueberry, bilberry, boysenberry, cranberry, white and red currants, gooseberry, huckleberry and the like), melon, watermelon, seeds and grains, as well as any other fruit or vegetables whose appearance (e.g., brightness) can be enhanced or improved by applying the compositions of the present invention.

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Unless indicated otherwise, percentages throughout the specification indicate weight-by-weight percentages.

In one embodiment, the compositions of the invention consists of phosphonic acid and/or a salt thereof in a vehicle, which is preferably an aqueous vehicle, wherein the phosphonic acid and/or salt thereof is present in an amount of about 0.1% up to 10%, more preferably about 0.1%-1% and even more preferably 0.2%-0.4%, based on the weight of the composition.

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The compositions of the present invention may optionally comprise, in addition to phosphonic acid and/or a salt thereof, the following additives and/or additional compounds:

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- (i) an effective concentration of hydrogen peroxide;

- (ii) effective-trace concentrations of dispersed metals or metal ions;
- (iii) effective concentrations of other and/or additional activators, synergists and promoters;
- (iv) effective concentrations of surfactants, stabilizers and/or modifiers;
- 5 (v) effective concentrations of pH regulators; and/or
- (vi) effective concentrations of organic and/or inorganic additives.

In some embodiment, the compositions comprise:

- (a) about 0.01% to about 70% of phosphonic acid and/or a salt thereof;
- 10 (b) optionally, about 0.0001% (1 ppb) to about 5% of metal ion selected from the group consisting of copper, zinc, nickel, iron, manganese, molybdenum, potassium or combinations thereof;
- (c) optionally, an effective concentration of hydrogen peroxide;
- (d) optionally, effective-trace concentrations of dispersed metals or metal ions;
- 15 (e) optionally, effective concentrations of other and/or additional activators, synergists and promoters;
- (f) optionally, effective concentrations of surfactants, stabilizers and/or modifiers; and/or
- (g) optionally, effective concentrations of pH regulators.

20 In other embodiment, the compositions comprise:

- (a) about 0.01% to about 70% of phosphonic acid and/or a salt thereof;
- (b) about 0.001% to about 50% of hydrogen peroxide, preferably about 0.01% and 20%;
- (c) about 0.0001% (1 ppb) to about 2.5% of silver ion;
- (d) about 0.0001% (1 ppb) to about 2.5% of metal ion selected from the group consisting
- 25 of copper, titanium, zinc, nickel, iron, manganese, molybdenum, potassium or combinations thereof.
- (d) an effective concentration of hydrogen peroxide;
- (e) an effective concentration of a surfactant;
- (f) optionally, effective-trace concentrations of dispersed metals or metal ions;
- 30 (f) optionally, effective concentrations of other and/or additional activators, synergists and promoters;
- (g) optionally, effective concentrations of stabilizers and/or modifiers; and/or
- (h) optionally, effective concentrations of pH regulators.

Preservatives such as potassium metabisulfite or potassium permanganate may also be added in combination with the other formulation ingredients.

Surfactants, for example, may lower the surface tension of the composition. Accordingly, the selection of surfactant may depend on the properties and components of the composition, the desired viscosity, the manner of application, toxicity, cost, and other properties of the surfactant. For example, the surfactant may provide other characteristics, functions, or properties to a composition, such as disinfectant properties. Suitable surfactants may be found among the cationic, anionic, non-ionic and amphoteric surfactants. Surfactants such as alkylpolyglycosides are currently preferred.

The term "performic acid precursor" is understood to mean any material that can be oxidized to produce performic acid. Examples of performic acid sources include formic acid, formic acid esters, and formic acid salts, such as water soluble salts of formic acid, for instance, alkali metal formates, such as sodium formate and calcium formate, formaldehyde, and formamide.

It has been indicated above that dispersed metals or metal ions useful in the present invention include copper, zinc, nickel, iron, potassium, magnate, chromium, molybdenum, manganese and boron, as well as silver and compounds or ions of phosphorous, iodine, sulfur and citrate. In addition to those, ions and/or fine particles of titanium and lithium may also be included. Also, in addition to the acids mentioned above, nitric acid may also be included.

The range of concentrations of dispersed metal and/or metal ion for use in accordance with this invention is from about 1 parts per billion (ppb) to about 5%, preferably from about 10 ppb to about 10,000 parts per million (ppm), more specifically from about 20 ppb to about 2000 ppm and even more specifically from about 20 ppb to about 1000 ppm.

The treatment or contacting step in accordance with this invention can be implemented satisfactorily in various ways. These include, in certain cases dipping or immersing the treated foodstuff or plant matter in the above-mentioned solution(s) on the packing line or spraying the solution(s) onto the treated foodstuff or plant matter on the packing line.

In addition, the application of the solution in the form of ultra small drops by solution atomizing systems that produce "dry" fogs with particle sizes of less than and up to 1000

microns in diameter, has been found to provide particularly beneficial results. These include compensation for or prevention of water loss, inhibition of sprouting, rot inhibition, less overall losses and higher yields for treated seeds for treated fruit, vegetables, plant propagation, seeds, meat, milk and milk products, eggs and other food commodities. The beneficial results include epical dominance breakdown. The advantages of small particle size "dry" fog is attributed to the fact that very small particles behave to a large extent like a gas. They facilitate the achievement of very high relative humidity, i.e., even as high as 99%, without any condensation on the stored matter. Furthermore, the small particles show a very high penetrability into small cracks and spaces. As a consequence, even when plant matter are stored in ordinary stacks or storage sacks, the "dry" fog storage has a high degree of penetrability and accessibility to all points in the stack or sack. This means that even in the simplest and most space compact facilities stored plant matter, such as potatoes and similar items, can be effectively treated to enhance the appearance thereof.

In certain aspects and applications, the beneficial effects of the process of the present invention are enhanced by the addition of certain additives to the treatment solution, these additives may include:

(a) Stabilizers and modifiers, such as but not limited to citric acid, tartaric acid, boric acid, hydrobromic acid, stannates, etc.

(b) pH regulators, primarily mineral and organic acids, such as but not limited to phosphoric acid, peracetic acid, performic acid, formic acid, hydrochloric acid, sulfuric acid, etc. For optimum effectiveness, the pH should be lower than about 6 and preferably between about 1 and about 4. In other embodiments, however, pH regulators such as ammonia and potash can be used to raise the pH to about 6-12, more preferably from about 7 to about 11.

(c) Trace element activators, synergists and promoters, such as but not limited to dispersions of metal, non-metals or ions (of various valences when appropriate) such as, copper, zinc, nickel, iron, potassium, manganese, silver, chromium, titanium, molybdenum, magnesium, boron, phosphorus, iodine, sulfur, citrate, etc.; and

(d) Organic or inorganic additives, such as but not limited to peracetic acid, performic acid, formic acid, phenol, gelatin, glycerin, sodium azide, polymoxin B, sodium bicarbonate, pectin, salicylic acid, etc.

The compositions of the invention may be pre-prepared at the manufacturing site and shipped to the end customer, to be diluted to a working solution with tap water at dilution

ratios (vol:vol) such as about 1:1 1:2 1:5 1:10 1:20 1:30 1:50 1:70 1:100 1:120 1:150 1:200 1:250 1:300 1:350 1:400 1:450 1:500 of phosphonic acid and/or a salt thereof to tap water. Alternatively, the compositions may be shipped already in diluted form, for use by the end user, where no additional dilution is required. Each possibility represents a separate embodiment of the present invention. In one embodiment, the composition is supplied as a concentrated solution comprising about 70% phosphonic acid in tap water, which may be diluted to the final concentration (preferably about 0.2% to about 0.4%) by addition of an appropriate amount of tap water.

As used herein and in the appended claims the singular forms “a”, “an,” and “the” include plural references unless the content clearly dictates otherwise.

The following examples are presented in order to more fully illustrate some embodiments of the invention. They should, in no way be construed, however, as limiting the broad scope of the invention. One skilled in the art can readily devise many variations and modifications of the principles disclosed herein without departing from the scope of the invention.

EXAMPLES

Example 1

In several experiments conducted in a storage room containing hundreds of metric tons of potatoes, sweet potatoes or citrus fruit, a phosphonic acid and/or salt thereof solution was introduced by spraying on the packing line, or by using a fogger. The phosphonic acid solution was prepared by diluting a 70%-100% phosphonic acid solution with tap water to get a solution comprising 1-5% phosphonic acid and/or a salt thereof. Alternatively, the phosphonic acid solution was prepared by diluting a 70%-100% phosphonic acid solution with tap water to get a solution comprising 0.2-0.6% phosphonic acid and/or a salt thereof.

The sweet potatoes are treated according to the following schedule:

(a) during short-term handling for about 1 second to about 30 minutes, preferably for about 15 to 30 about minutes at a temperature below about 30°C, preferably at a temperature of about 18°C to 24°C;

(b) curing step: during handling and short-term storage, daily for about 1 to 7 days for at least a portion of each day, and at ambient temperature or above, preferably at a

temperature of about 30°C to about 70°C, more preferably a temperature of about 30 °C -50 °C; in a particular embodiment the temperature of exposure is 35°C; and

(c) during long-term storage, at least once every two to four weeks at a temperature of below about 20°C, preferably at a temperature of about 4°C to 15°C.

5

As shown in Figures 1-6, the color, vividness, brightness and general appearance of potatoes, sweet potatoes or oranges is significantly improved and/or enhanced by application of the compositions of the present invention, as compared to no treatment (Figures 1-3 and 5-6), or by treatment with conventional compositions and administration schedules.

10

Example 2

The effect of treatment with various solutions of aqueous phosphonic acid plus additives at the following concentrations: 0% (control) and 0.01%-30%, by dipping or submerging the oranges, potatoes or sweet potatoes on the packing line for various lengths of time. Similar results to Figures 1-6 were obtained.

15

Example 3

Same as Example 2, except that instead of dipping or submerging, the solutions were sprayed onto the foodstuff substrate until dripping (high volume).

20

Example 4

Same as Example 2, except that the spraying onto the foodstuff substrate was low volume.

Example 5

Same as Example 2, except that the spraying onto the foodstuff substrate was by fogging. The gas liquid volume ratio was from 1200 air unit to 0.5 liquid unit up to air liquid 400:1.

25

Example 6

Same as example 2, but using an ultrasonic fogger that operates on electric current, where no air pressure is required. The fog produced by the ultrasonic fogger is a “dry fog” where the size of the micro-droplets can be adjust to the range of 0.01 - 1,000 microns.

30

Example 7

Same as example 2, but involving treatment of potatoes on the packing line as a final finish treatment for skin brightness.

5 Example 8

Same as example 2, but involving treatment of citrus fruit on the packing line as a final finish treatment for skin brightness.

Example 9

10 A composition for enhancing the brightness of sweet potatoes and other fruit and vegetables was prepared as set forth below:

1. Hydrogen Peroxide 0.1% - 70%, preferably 0.1%- 50%, more preferably 0.25 -35%, more preferably 0.3-20%.
2. Phosphonic acid neutralized with KOH to a pH of 1-10, preferably 1.1 - 9, more preferably 1.2- 8, more preferably 1.5 - 7, more preferably 2 - 4.5, wherein the
15 phosphonic acid is at a concentration in the formula of about 0.1% - 70%, preferably, 0.2%- 50%, more preferably 0.3 -35%, more preferably 0.5-20%.
3. Formic acid 0.1% - 98%, preferably 0.2%- 70%, more preferably 0.2% -50%, more preferably 0.2% - 30%, more preferably 0.2% - 20%, more preferably 0.2 -10%,
20 more preferably 0.2 - 5%.
4. Citric acid 0.1% - 50%, preferably 0.15%- 40%, more preferably 0.2% -30%, more preferably 0.25% - 20%, more preferably 0.3%-10%.
5. Alkyl polyglycoside surfactants 0.001% - 10%, preferably 0.01% - 7%, more preferably 0.1%- 5%.

25

Example 10

A composition for enhancing the brightness of sweet potatoes and other fruit and vegetables was prepared as set forth below:

1. Hydrogen Peroxide 0.01% - 70%, preferably 0.2%- 50%, more preferably 0.25 -35%,
30 more preferably 0.3-20%.
2. Phosphonic acid neutralized with KOH and/or ammonium hydroxide to a pH of 1-10, preferably 1.1 - 9, more preferably 1.2- 7, more preferably 1.5 - 5, more preferably 2 - 4.5, wherein the phosphonic acid is at a concentration in the formula of about 0.1% - 70%, preferably, 0.2%- 50%, more preferably 0.3 -35%, more preferably 0.5-20%.

3. Phosphoric acid at a concentration of 0.1% - 70%, preferably 0.2%- 50%, more preferably 0.3 -35% - 0.5-20%
4. Formic acid 0.1% - 98%, preferably 0.2%- 70%, more preferably 0.2% -50%, more preferably 0.2% - 30%, more preferably 0.2% - 20%, more preferably 0.2 -10%, more preferably 0.2 - 5%.
5. Citric acid 0.01% - 50%, preferably 0.10%- 40%, more preferably 0.2% -30%, more preferably 0.25% - 20%, more preferably 0.3%-10%.
6. Alkyl polyglycoside surfactants 0.001% - 10%, preferably 0.01% - 7%, more preferably 0.1%- 5%.

Example 11

A composition for enhancing the brightness of sweet potatoes and other fruit and vegetables was prepared as set forth below:

1. Hydrogen Peroxide 0.01% - 70%, preferably 0.2%- 50%, more preferably 0.25 -35%, more preferably 0.3-20%.
2. Phosphonic acid neutralized with KOH and/or ammonium hydroxide to a pH of 1-10, preferably 1.1 - 9, more preferably 1.2- 7, more preferably 1.5 - 5, more preferably 2 - 4.5, wherein the phosphonic acid is at a concentration in the formula of about 0.1% - 70%, preferably, 0.2%- 50%, more preferably 0.3 -35%, more preferably 0.5-20%.
3. Citric acid 0.01% - 50%, preferably 0.15%- 40%, more preferably 0.2% -30%, more preferably 0.25% - 20%, more preferably 0.3%-10%.
4. Alkyl polyglycoside surfactants 0.001% - 10%, preferably 0.01% - 7%, more preferably 0.1%- 5%.

To the above composition, formic acid may be added by mixing on site for a few seconds up to few hours before the application or immediately before the application with or without heating the mixed formula up to about 80°C for a few seconds or minutes. Formic acid is added at the following concentration ranges: 0.1% - 98%, preferably 0.2%- 70%, more preferably 0.2% -50%, more preferably 0.2% - 30%, more preferably 0.2% - 20%, more preferably 0.2 -10%, more preferably 0.2 - 5%.

Example 12

A composition for enhancing the brightness of sweet potatoes and other fruit and vegetables was prepared as set forth below:

1. Hydrogen Peroxide 0.01% - 70%, preferably 0.2%- 50%, more preferably 0.25 -35%, more preferably 0.3-20%.
2. Phosphonic acid neutralized with KOH and or ammonium hydroxide to a pH of 1-10, preferably 1.1 - 9, more preferably 1.2- 7, more preferably 1.5 - 5, more preferably 2
5 - 4.5, wherein the phosphonic acid is at a concentration in the formula of about 0.1% - 70%, preferably, 0.2%- 50%, more preferably 0.3 -35%, more preferably 0.5-20%.
3. Phosphoric acid at a concentration of 0.1% - 70%, preferably 0.2%- 50%, more preferably 0.3 -35% - 0.5-20%
4. Citric acid 0.01% - 50%, preferably 0.15%- 40%, more preferably 0.2% -30%, more
10 preferably 0.25% - 20%, more preferably 0.3%-10%.
5. Alkyl polyglycoside surfactants 0.001% - 10%, preferably 0.01% - 7%, more preferably 0.1%- 5%.

To the above composition, formic acid may be added as described in Example 11.

Example 13

A composition for enhancing the brightness of sweet potatoes and other fruit and vegetables was prepared as set forth below:

1. Phosphonic acid neutralized with KOH and/or ammonium hydroxide to a pH of 1-10, preferably 1.1 - 9, more preferably 1.2- 7, more preferably 1.5 - 5, more preferably 2
20 - 4.5, wherein the phosphonic acid is at a concentration in the formula of about 0.1% - 70%, preferably, 0.2%- 50%, more preferably 0.3 -35%, more preferably 0.5-20%.
2. Formic acid 0.01% - 98%, preferably 0.2%- 70%, more preferably 0.2% -50%, more preferably 0.2% - 30%, more preferably 0.2% - 20%, more preferably 0.2 -10%,
25 more preferably 0.2 - 5%.
3. Citric acid 0.01% - 50%, preferably 0.15%- 40%, more preferably 0.2% -30%, more preferably 0.25% - 20%, more preferably 0.3%-10%.
4. Alkyl polyglycoside surfactants 0.001% - 10%, preferably 0.01% - 7%, more preferably 0.1%- 5%.

To the above composition, hydrogen peroxide (H₂O₂) may be added by mixing on site for a few seconds up to few hours before the application or immediately before the application with or without heating the mixed formula up to about 80°C for a few seconds or

minutes. H_2O_2 is added at the following concentration ranges: 0.1% - 70%, preferably 0.2%-50%, more preferably 0.25 -35%, more preferably 0.3-20%.

Example 14

A composition for enhancing the brightness of sweet potatoes and other fruit and vegetables was prepared as set forth below:

1. Phosphonic acid neutralized with KOH to a pH of 1-10, preferably 1.1 - 9, more preferably 1.2- 7, more preferably 1.5 - 5, more preferably 2 - 4.5, wherein the phosphonic acid is at a concentration in the formula of about 0.1% - 70%, preferably, 0.2%- 50%, more preferably 0.3 -35%, more preferably 0.5-20%.
2. Formic acid 0.1% - 98%, preferably 0.2%- 70%, more preferably 0.2% -50%, more preferably 0.2% - 30%, more preferably 0.2% - 20%, more preferably 0.2 -10%, more preferably 0.2 - 5%.
3. Alkyl polyglycoside surfactants 0.001% - 10%, preferably 0.01% - 7%, more preferably 0.1%- 5%.

To the above composition, hydrogen peroxide (H_2O_2) may be as described in Example 13.

Example 15

A composition for enhancing the brightness of sweet potatoes and other fruit and vegetables was prepared as set forth below:

1. Phosphonic acid neutralized with KOH to a pH of 1-10, preferably 1.1 - 9, more preferably 1.2- 7, more preferably 1.5 - 5, more preferably 2 - 4.5, wherein the phosphonic acid is at a concentration in the formula of about 0.1% - 70%, preferably, 0.2%- 50%, more preferably 0.3 -35%, more preferably 0.5-20%.
2. Formic acid 0.1% - 98%, preferably 0.2%- 70%, more preferably 0.2% -50%, more preferably 0.2% - 30%, more preferably 0.2% - 20%, more preferably 0.2 -10%, more preferably 0.2 - 5%.
3. Alkyl polyglycoside surfactants 0.001% - 10%, preferably 0.01% - 7%, more preferably 0.1%- 5%.

To the above composition, hydrogen peroxide (H_2O_2) and citric acid may be added as described in Example 13. H_2O_2 is added at the following concentration ranges: 0.1% - 70%,

preferably 0.2%- 50%, more preferably 0.25 -35%, more preferably 0.3-20%. Citric acid is added at a concentration of 0.1% - 50%, preferably 0.15%- 40%, more preferably 0.2% - 30%, more preferably 0.25% - 20%, more preferably 0.3%-10%.

5 Example 16

A composition for enhancing the brightness of sweet potatoes and other fruit and vegetables was prepared as set forth below:

1. Phosphonic acid neutralized with KOH to a pH of 1-10, preferably 1.1 - 9, more preferably 1.2- 7, more preferably 1.5 - 5, more preferably 2 - 4.5, wherein the
10 phosphonic acid is at a concentration in the formula of about 0.1% - 70%, preferably, 0.2%- 50%, more preferably 0.3 -35%, more preferably 0.5-20%.
2. Formic acid 0.1% - 98%, preferably 0.2%- 70%, more preferably 0.2% -50%, more preferably 0.2% - 30%, more preferably 0.2% - 20%, more preferably 0.2 -10%, more preferably 0.2 - 5%.
- 15 3. Alkyl polyglycoside surfactants 0.001% - 10%, preferably 0.01% - 7%, more preferably 0.1%- 5%.

In any of examples 9-16, potassium carbonate may be added to some of the formic acid containing formulas in order to create extra omission of CO₂ so as to treat under
20 controlled atmosphere (CA) fruit & Vegetable storage rooms.

Furthermore, in any of examples 9-16, HEDP (hydroxyethylidene-1,1-diphosphonic acid) may be added at a concentration range of 0.001% - 5% either into the solutions or as to the treated washing water.

While certain embodiments of the invention have been hereinbefore particularly
25 described, it will be apparent to anyone skilled in the art that many modifications and variations may be made, that do not deviate from the main features or spirit of the invention. The invention is accordingly not to be construed as restricted to such embodiments, but rather to its concept, spirit and general scope.

CLAIMS

What is claimed is:

1. A method of improving the appearance of edible plant matter, the method comprising the step of contacting the edible plant matter with a composition comprising phosphonic acid and/or a salt thereof, during one or more stages of storage, handling and marketing, wherein the contacting step is carried out by at least one of dipping or immersing the edible plant matter in the composition, spraying the composition onto the edible plant matter, or exposing the edible plant matter to a fog or a gas comprising the composition,
wherein the contacting step comprises at least one exposure to said composition at a temperature below about 30°C during handling; and/or at least one exposure to said composition below about 20°C during long-term storage.
2. The method according to claim 1, wherein the contacting step comprises exposing the plant matter to said composition for about 1 second to about 30 minutes, preferably for about 15 to 30 about minutes at a temperature below about 30°C, preferably at a temperature of about 18°C to about 24°C.
3. The method according to claim 1, further comprising the step of exposing the edible plant matter to said composition during handling and short-term storage, daily for about 1 to 7 days for at least a portion of each day, and at ambient temperature or above.
4. The method according to claim 1, further comprising the step of exposing the edible plant matter to said composition during handling and short-term storage, daily for about 1 to 7 days for at least a portion of each day, at a temperature from about 30°C to about 70°C, alternatively 30°C to about 50°C, preferably a temperature of about 35°C.
5. The method according to any of claims 1 to 4, further comprising the step of exposing the edible plant matter to said composition during long-term storage, at least once every two to four weeks at a temperature of below about 20°C, preferably at a temperature of about 0.5°C to about 14°C.
6. The method according to any of the preceding claims, comprising the step of exposing the edible plant matter to said composition for about 6 to 12 hours a day for about 4

to 7 days during handling/short-term storage, followed by treatment every 2 to 4 weeks during long-term storage.

7. The method according to claim 1, wherein the one or more stages of storage, handling and marketing includes pre and post harvest, pre and post planting, pre and during storage, distribution, packing lines and marketing.

8. The method according to claim 1, wherein the composition further comprises a surfactant.

9. The method according to claim 8, wherein the surfactant is an alkyl poly glycoside.

10. The method according to claim 1, wherein the composition further comprises hydrogen peroxide (H_2O_2), preferably wherein the concentration of hydrogen peroxide is between about 0.01% and 20% by weight of the composition.

11. The method according to claim 1, wherein the composition is an aqueous composition.

12. The method according to claim 1, wherein the amount of phosphonic acid and/or salt thereof in the composition is about 0.01% to about 70% by weight of the composition.

13. The method according to claim 12, wherein the amount of phosphonic acid and/or salt thereof in the composition is about 0.1% to about 4% by weight of the composition, preferably wherein the amount of phosphonic acid and/or salt thereof in the composition is about 0.2 to about 0.4% by weight of the composition.

14. The method according to claim 1, wherein the composition comprises (a) phosphonic acid and/or a salt thereof, (b) hydrogen peroxide (H_2O_2); and (c) a surfactant, wherein the surfactant is preferably an alkyl polyglycoside.

15. The method according to claim 14, wherein the composition further comprises at least one metal or metallic ion selected from silver, copper, titanium and zinc, present in an amount of about 1 ppb to about 1,000 ppm.

16. The method according to claim 14 or 15, wherein the composition further comprises at least one of citric acid, phosphoric acid, sulfuric acid, acetic acid or formic acid.

17. The method according to claim 1, wherein the composition further comprises an effective amount of performic acid or a precursor thereof.

18. The method according to claim 1, wherein improving the appearance includes increasing or enhancing the brightness, color intensity, pigmentation, vividness, brilliance,
5 clarity, glow or texture of said edible plant matter, or any combination thereof.

19. The method according to claim 18, wherein improving the appearance includes increasing or enhancing the brightness of said edible plant matter.

20. The method according to claim 1, wherein the edible plant matter is a fruit or a vegetable.

10 21. The method according to claim 20, wherein the edible plant matter is selected from the group consisting of potatoes, sweet potatoes, yams, citrus fruit, tomato, carrot, onions, garlic, cucumber, radish, avocado, mango, persimmon, grapes, cherries, figs, plums, apricot, peach, banana, celery, turnip, lettuce, green leafy vegetables, leek, cabbage, cauliflower, apple, pear, plum, kiwi, tropical fruit, kohlrabi, pepper, berries, melon, watermelon seeds and
15 grains.

22. The method according to claim 21, wherein the citrus fruit is selected from oranges, grapefruit, lemon, lime, clementine, mandarin, tangerine and pomelo, and wherein the berries are selected from strawberry, blackberry, raspberry, blueberry, bilberry, boysenberry, cranberry, white and red currants, gooseberry and huckleberry.

20 23. The method according to claim 1, wherein the composition further comprises one or more of a stabilizer, modifier or a pH regulator.

24. The method according to claim 1, wherein the composition further comprises at least one of citric acid, phosphoric acid, sulfuric acid, peracetic acid, nitric acid, salicylic acid, tartaric acid, boric acid, stannic acid, hydrochloric acid, formic acid, performic acid,
25 hydrobromic acid, HEDP (1-hydroxyethane 1,1-diphosphonic acid) EDTA or ethyl acetate.

25. The method according to claim 1, wherein the composition comprises a base selected from the group consisting of ammonium hydroxide, potassium hydroxide, sodium hydroxide,

magnesium hydroxide calcium carbonate, magnesium carbonate, ammonium carbonate and sodium carbonate.

26. The method according to claim 1, wherein the pH of the composition is no greater than about 6, preferably wherein the pH of the composition is about 1 to 4.

5 **27.** The method according to claim 1, wherein the pH of the composition is equal to or greater than 6, preferably wherein the pH of the composition is about 7 to 11.

28. The method according to claim 1, wherein the composition consists of (a) phosphonic acid and/or a salt thereof; and (b) an aqueous vehicle.

10 **29.** The method according to claim 1, wherein the composition consists of (a) phosphonic acid and/or a salt thereof, (b) hydrogen peroxide (H_2O_2); (c) a surfactant, wherein the surfactant is preferably an alkyl polyglycoside; and (d) an aqueous vehicle.

15 **30.** The method according to claim 1, wherein the composition consists of (a) phosphonic acid and/or a salt thereof, (b) hydrogen peroxide (H_2O_2); (c) a surfactant, wherein the surfactant is preferably an alkyl polyglycoside; (d) at least one metal or metallic ion selected from silver, copper, titanium and zinc, present in an amount of about 1 ppb to about 1,000 ppm; and (e) an aqueous vehicle.

20 **31.** The method according to claim 1, wherein the composition consists of (a) phosphonic acid and/or a salt thereof, (b) hydrogen peroxide (H_2O_2); (c) a surfactant, wherein the surfactant is preferably an alkyl polyglycoside; (d) at least one of citric acid, phosphoric acid, sulfuric acid, acetic acid or formic acid; and (e) an aqueous vehicle.

32. The method according to claim 1, wherein the composition consists of (a) phosphonic acid and/or a salt thereof, (b) hydrogen peroxide (H_2O_2); (c) a surfactant, wherein the surfactant is preferably an alkyl polyglycoside; (d) at least one metal or metallic ion selected from silver, copper, titanium and zinc, present in an amount of about 1 ppb to about 1,000 ppm; (e) EDTA and/or HEDP; and (f) an aqueous vehicle.

25



FIGURE 1



FIGURE 2

3/6



FIGURE 3

4/6



FIGURE 4

FIGURE 5A

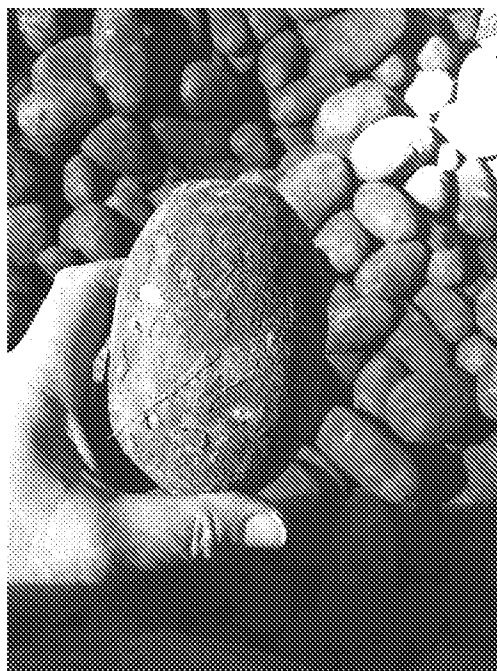


FIGURE 5B



FIGURE 6A

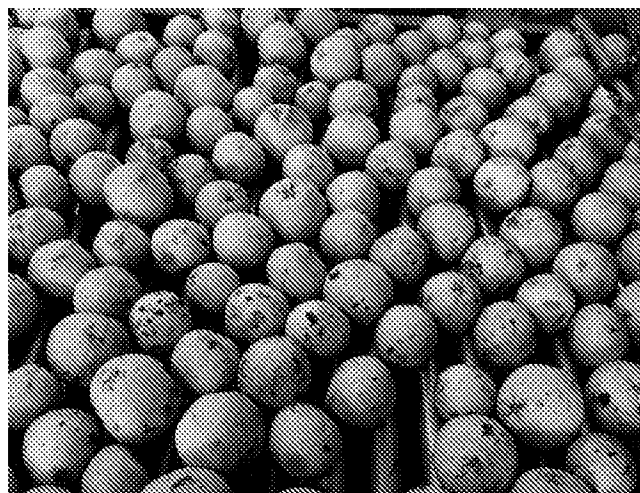


FIGURE 6B



INTERNATIONAL SEARCH REPORT

International application No.

PCT/IL 12/50189

A. CLASSIFICATION OF SUBJECT MATTER

IPC(8) - A23F 3/00 (2012.01)

USPC - 426/49

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

USPC-426/49

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

USPC-426/70; 424/616,601

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

PubWest (PGPB, USPT, USOC, EPAB, JPAB, DWPI, TDBD), FreePatentsOnline (US Pat, PgPub, EPO, JPO, WIPO, NPL), GoogleScholar (PL, NPL); search terms: EDIBLE PLANT MATTER phosphonic acid potatoes peroxide storage low temperature alkyl polyglycoside EDTA

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X -- Y	US 2010/0119669 A1 (Ben Yehuda et al.) 13 May 2010 (13.05.2010) para [0002], [0098]-[0104], [0143]	1-5, 7, 10-13, 18-28 ----- 8-9, 14-17, 29-32
Y	US 2007/0241306 A1 (Wehner et al.) 18 October 2007 (18.10.2007) para [0142], [0726]	8-9, 14-16, 29-32
Y	EP0884950 B1(Johansen et al.)12 March 2003 (12.03.2003) para [0055], [0074], [0104], [0128]	17

☐ Further documents are listed in the continuation of Box C.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

8 September 2012 (08.09.2012)

Date of mailing of the international search report

01 OCT 2012

Name and mailing address of the ISA/US

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Authorized officer:

Lee W. Young

PCT Helpdesk: 571-272-4300
PCT OSP: 571-272-7774

INTERNATIONAL SEARCH REPORT

International application No.

PCT/IL 12/50189

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:
2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:
3. ☒ Claims Nos.: 6
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:
4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.
- ☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.
- ☐ No protest accompanied the payment of additional search fees.