

METHODS FOR PRESERVING FRESH PRODUCE

This application claims priority to provisional US Application Serial No. 60/386,574 filed June 7, 2002, and provisional US Application Serial No. 60/440196 filed January 15, 2003; both of which are fully incorporated herein by reference.

Background of the Invention

Fresh produce rapidly deteriorates particularly when the flesh of the fruit or vegetable is exposed, such as by peeling the or by slicing the produce. The appearance, flavor, texture, and crispness rapidly degrades. Within hours, produce, such as apples, begin to turn brown and lose their distinctive flavor. The produce loses its texture and firmness; the produce becomes soft and loses its characteristic crispness.

Many methods of preservation involve cooking, which changes flavor and texture; typically appearance is also changed. Freezing substantially preserves flavor; however, texture and crispness are affected. Furthermore, frozen foods need to be continually stored and require freezers for storage. Drying often preserves flavor, but texture, crispness and appearance are substantially affected. Refrigeration helps to preserve crispness, texture and flavor for a limited number of hours, but does not prevent browning. Chemical preservatives are often used alone or in conjunction with these methods of preserving; however, they typically leave a residual taste.

One method employs four active ingredients: an acidulant such as citric acid; a metal sequesterant or chelant, such as sodium acid polyphosphate; an enzyme inhibitor such as calcium chloride; and an antioxidant such as ascorbic acid. However, the fruit has an unpleasant taste and the produce typically turns brown within 5 days.

Citric acid, which is present in lemon juice, has been used to delay browning in fruits; however, the fruit tastes sour, becomes soft and soggy, and typically the fruit turns brown within hours.

Sodium ascorbate has also been used to preserve fruit; while the color degradation is delayed, the fruit has a noticeable taste.

Other methods often involve forming a film on the surface of the fruit; however such films often leave an unacceptable gummy feel when eaten.

1 It would be desirable to have a method for preserving produce,
2 particularly cut produce, which preserves the appearance, color, texture
3 crispness and flavor, yet does not leave an after taste nor require
4 cooking, drying or freezing.

5 Summary of the Invention

6 The present invention pertains to methods of preserving
7 fresh produce with a produce preservative which extends the shelf life
8 of fresh produce, particularly cut fresh produce. The produce
9 preservative preserves the texture, flavor, appearance, crispness, and
10 color of the fresh produce, particularly the exposed surface of the
11 fresh produce. The method comprises the following steps: providing a
12 solution of produce preservative comprising: water, magnesium ions or
13 zinc ions or tin ions or mixtures thereof, and ascorbate ions, or
14 erythorbate ions; wherein the ascorbate ions, and the magnesium ion or
15 zinc ions or tin ions, are present in a ion ratio of preferably from
16 0.2:1 to 8:1, more preferably 0.75:1 to 8:1, even more preferably from
17 1:1 to 4:1, most preferably 1.5:1 to 3:1; applying said produce
18 preservative to the produce.

19 The produce preservative solution contains preferably from 0.02%
20 to a saturated solution, more preferably from 0.02% to 30%, even more
21 preferably from 0.05 to 20%, even more preferably from 0.2% to 10%,
22 yet more preferably from 0.5% to 8%, most preferably from 0.6% to
23 5%, by weight, magnesium salt or zinc salt or tin salt; and preferably
24 from 0 % to 40%, more preferably from 0.1% to 40%, even more
25 preferably from 0.1% to 30%, yet more preferably from 0.5% to 15%,
26 most preferably from 1.0% to 5%, by weight, ascorbic acid or the
27 stereo isomer of ascorbic acid, erythorbic acid.

28 Preferably the produce is then stored at a temperature which will
29 not freeze the produce; preferably the produce is stored at temperatures
30 of between -6 to room temperature.

31 The invention also relates to fresh produce preserved with the
32 produce preservatives.

33 Detailed Description of the Invention

34 The present invention pertains to methods of preserving fresh
35 produce, that is, uncooked fruit and vegetables with a fresh produce
36 preservative which extends the shelf life of the fresh produce,
37 particularly cut fresh produce. The produce preservative preserves the
38 texture, flavor, appearance, crispness, color of the tree fruits, such

1 as for example, avocado and pome fruits such as apples and pears. The
2 preservative also preserves the texture, flavor, appearance, crispness,
3 color of vegetables, particularly the following vegetable families :
4 the Solcanaceae family, for example, potatoes, peppers, eggplants and
5 tomatoes; the Alliaceae family, such as onions; and the Brassiaceae
6 family also referred to as the Cruciferae family, for example cabbage;
7 the Cucurbitaceae family, for example cucumbers; the Apiaceae family
8 also referred to as the Umbelliferae family, for example celery; and
9 the Compositae family, also referred to as the Asteraceae family, for
10 example, lettuce. The produce preservative also preserves edible
11 fungi of the Ascomycetes/Basidiomycetes classes, such as edible
12 mushrooms. Unless other wise noted, the term "vegetable" shall include
13 the edible fungi in addition to the conventional vegetables.

14 The method comprises the following steps: providing a solution of
15 produce preservative comprising: water, magnesium ions or zinc ions or
16 tin ions; and ascorbate ions or erythorbate ions, wherein the ascorbate
17 ion or erythorbate ion, and the magnesium ions or zinc ions or tin ions,
18 are present in a ion ratio of preferably from 0.2:1 to 8:1, and,
19 applying such produce preservative to the produce. The produce
20 preservative is applied using conventional techniques preferably for a
21 time sufficient to coat the produce with the produce preservative.
22 Suitable techniques are spraying, sprinkling and dipping. Preferably
23 the produce is then stored at a temperature which will not freeze the
24 produce; temperatures of -6°C have been found not to freeze the apples.
25 Preferably the produce is stored at temperatures of between -7 to room
26 temperature, 20°C, more preferably -2 to 7°C, most preferably from 2
27 to 5°C. Fresh produce preserved with produce preservative which is stored
28 at room temperature will maintain color, flavor, texture and taste,
29 however after extended periods may have a microbial content that is not
30 desirable.

31 The method inhibits freshly cut produce from browning; for example,
32 when magnesium ascorbate is used, produce is typically prevented from
33 browning for at least 1 week, preferably 2 weeks or more while
34 maintaining the freshness, crispness, texture, color and flavor of the
35 produce without any residual taste. The exact length of the period of
36 preservation depends upon the initial produce quality, the species and
37 the variety of the produce and growing conditions of the produce. The
38 method of the present invention offers the advantage in that the

1 preserved produce may be stored under standard atmospheric pressure and
2 standard atmospheric conditions; that is, the method does not require
3 that the produce be stored under vacuum or inert atmosphere. The method
4 of preserving produce does not require that the food be cooked, dried or
5 frozen. The method offers the advantage in that it does not require
6 preservatives such as sulfites. However, after the produce is preserved
7 with the produce preservative, it may be dried or freeze-dried for use
8 such as, for example, food or potpourri; the produce preservative will
9 further delay the browning that eventually occurs in dried and freeze
10 dried produces. In the event that such dried or freeze dried produce is
11 reconstituted, the produce will be less brown than had the produce not
12 been preserved with the produce preservative.

13 The Produce Preservative

14 The produce preservative is preferably a solution which contains:
15 water; a cation which is either a magnesium ion, tin ion or zinc ion or
16 mixtures thereof; and ascorbate ions or erythorbate ions or mixtures
17 thereof. The source of the magnesium ion is, preferably, a magnesium
18 hydroxide or a magnesium salt or a mixture thereof. Suitable magnesium
19 salts are, for example, magnesium ascorbate, magnesium erythorbate,
20 magnesium chloride, magnesium carbonate, magnesium phosphate, magnesium
21 oxide, magnesium acetate, magnesium gluconate, magnesium
22 glycerophosphate, magnesium lactate, and mixtures thereof.

23 The source of the zinc ion is, preferably, a zinc hydroxide or a
24 zinc salt or a mixture thereof. Suitable zinc salts are, for example,
25 zinc ascorbate, zinc erythorbate, zinc chloride, zinc carbonate, zinc
26 phosphate, zinc oxide, zinc acetate, zinc gluconate, zinc
27 glycerophosphate, zinc lactate, and mixtures thereof.

28 The source of the tin ion is, preferably, a tin hydroxide or a tin
29 salt or a mixture thereof. Suitable tin salts are, for example, tin
30 ascorbate, tin erythorbate, tin chloride, tin carbonate, tin phosphate,
31 tin oxide, tin acetate, tin gluconate, tin glycerophosphate, tin
32 lactate, and mixtures thereof.

33 The source of the ascorbate ion is ascorbic acid, erythorbic acid,
34 or an ascorbate or erythorbate salt such as magnesium ascorbate, zinc
35 ascorbate, tin ascorbate, or magnesium erythorbate, zinc erythorbate or
36 tin erythorbate. Preferably magnesium ascorbate or tin ascorbate or
37 zinc ascorbate is the source for both the zinc ion and the ascorbate
38 ion.

1 When added to water the ascorbic acid disassociates at least
2 partially into the ascorbate ion and a hydrogen ion. Similarly, the
3 magnesium salt disassociates into the magnesium ion and the
4 corresponding anion; the zinc salt disassociates into the zinc ion and
5 the corresponding anion; and the tin salt disassociates into the tin ion
6 and the corresponding anion. Where the magnesium ascorbate, magnesium
7 erythorbate, zinc ascorbate, zinc erythorbate, tin ascorbate, or tin
8 erythorbate is employed, the produce preservative may also be used in
9 the dry form; in the dry form the produce preservative is preferably
0 powdered or granular. Preferably, the dry form preservative contains at
1 least 1%, more preferably at least 2%, even more preferably at least 4%
2 most preferably at least 5% of the produce preservative.

3 The percentage of the dry ingredients, exclusive of water, in the
4 produce preservative are preferably: from 1% to 100%, more preferably
5 from 10% to 50%, even more preferably from 20% to 40%, most
6 preferably from 15% to 35% of a magnesium salt or zinc salt or tin
7 salt; where the magnesium salt or zinc salt or tin salt is a salt other
8 than an ascorbate or erythorbate salt, there is preferably from 30% to
9 99%, more preferably 50% to 88%, more preferably from 60% to 85%,
0 most preferably from 65% to 75% ascorbic acid. Where the salt is an
1 ascorbate or erythorbate salt, ascorbic acid is not necessary and is not
2 preferred.

3 Where the salt is magnesium chloride, or zinc chloride or tin
4 chloride, the percentage of the dry ingredients, exclusive of water, in
5 the produce preservative is preferably from 25% to 98%, more
6 preferably from 40% to 80%, most preferably from 50% to 67%,
7 ascorbic acid or erythorbic acid, and from 2% to 75%, more preferably
8 from 10% to 35%, most preferably from 25% to 30%, magnesium
9 chloride, zinc chloride or tin chloride.

0 Where the magnesium or zinc or tin source is magnesium hydroxide or
1 zinc hydroxide or tin hydroxide, the percentage of dry ingredients, in
2 the produce preservative is preferably from 30% to 98%, more
3 preferably from 60% to 88%, most preferably from 80% to 85%, ascorbic
4 acid, and from 2% to 70%, more preferably from 16% to 25%, most
5 preferably from 12% to 20%, magnesium hydroxide, or zinc hydroxide or
6 tin hydroxide.

7 Where the magnesium salt or zinc salt or tin salt is a carbonate,
8 the percentage of dry ingredients, in the produce preservative is

preferably from 40% to 96%, more preferably from 65% to 90%, most preferably from 70% to 85%, ascorbic acid or erythorbic acid and from 4% to 40%, more preferably from 15% to 25%, most preferably from 20% to 23%, magnesium carbonate or zinc carbonate or tin carbonate.

The produce preservative solution contains preferably from 0.02% to a saturated solution, more preferably 0.02 to 20%, more preferably from 0.225% to 15%, even more preferably from 0.375% to 6%, magnesium salt or zinc salt or tin salt; and preferably from 0.2% to 40%, more preferably from 0.5% to 20%, even more preferably from 1.0% to 10%, most preferably from 1.6% to 5%, ascorbic acid or the stereo isomer of ascorbic acid, erythorbic acid.

The produce preservative solution preferably has an ion ratio of ascorbate ion or erythorbate ion, to magnesium ion, zinc ion or tin ion, of from 0.2:1 to 8:1, more preferably from 0.75:1 to 8:1, more preferably from 1:1 to 4:1, most preferably 1.5:1 to 3:1.

The preferred embodiment of the produce preservative solution preferably has from 0.2% to saturated solution, more preferably from 0.2% to 35%, even more preferably from 1.5% to 20%, most preferably from 2.5% to 6% magnesium ion and ascorbate ion. The pH range of the produce preservative solution is preferably from 1 to 10, more preferably from 2 to 8, most preferably 3 to 7.5. The pH is adjusted if needed with conventional reagents such as for example, ascorbic acid, hydrochloric acid, sodium hydroxide, potassium hydroxide magnesium hydroxide or any food grade acid or alkali.

For the best taste, the produce preservative preferably does not have a chloride concentration greater than 35%, more preferably not greater than 15%, even more preferably not greater than 5%; even more preferably not greater than 1%, most preferably not greater than 0.1% by weight, excluding water.

Similarly, for the best taste, the produce preservative preferably does not have a sodium ion concentration greater than 10%; more preferably not greater than 1%; even more preferably not greater than 0.5%, yet preferably not greater than 0.3%, most preferably not greater than 0.1% by weight, excluding water.

The produce preservative preferably does not have a potassium ion concentration greater than 20%; more preferably not greater than 5%; more preferably not greater than 1%, even more preferably not greater

1 than 0.3%, yet preferably not greater than 0.1%, most preferably not
2 greater than 0.01% by weight, excluding water.

3 Preferably, the produce preservative does not have a concentration
4 of citric acid, citrate ion, acetic acid, acetate ion, lactic acid,
5 lactate ion, malic acid, malate ion, or other acids or acid ions, with
6 the exception of ascorbic acid and erythorbic acid, greater than 35%,
7 more preferably not greater than 15%, more preferably not greater than
8 5%, more preferably not greater than 0.5%, more preferably not
9 greater than 0.3%, yet more preferably not greater than 0.1%; most
0 preferably not greater than 0.01% by weight, excluding water.

1 Again, for best taste, the produce preservative solution does not
2 have a metal ion sequestrant, particularly an acidic polyphosphate metal
3 ion sequestrant or chelant concentration greater than 5%, more
4 preferably not greater than 2%, even more preferably not greater
5 than 0.5%, yet more preferably not greater than 0.1%; most preferably
6 not greater than 0.01%, by weight.

7 Preferably the produce preservative solution does not have a
8 sulfite concentration greater than 5%, more preferably not greater
9 than 2%, even more preferably not greater than 0.5%, yet more
10 preferably not greater than 0.1%; most preferably not greater than
11 0.01% by weight. Sulphites include, for example, sodium
12 metabisulphate, potassium metabisulphite, sodium bisulphite, sodium
13 disulphite, and calcium bisulphite.

14 The produce preservative solution preferably does not have a
15 flavonoid, rose hips, or pineapple juice concentration greater than 5%,
16 more preferably not greater than 2%, more preferably not greater 0.5%,
17 more preferably not greater than 0.1%; even more preferably not
18 greater than 0.01%, even more preferably not greater than 0.005%, most
19 preferably not greater than 0.001% by weight.

20 It is also preferred that the produce preservative solution lacks
21 agents which affect the "mouth feel" of the cut vegetable and impart a
22 waxy or slippery feel to the vegetable, such as gelling agents, film
23 forming agents, waxes, gums, polysaccharides, such as hydroxymethyl
24 cellulose, methyl cellulose, microcrystalline cellulose, alginates,
25 carrageenans, lipids, pectins, modified starches, locust bean gum,
26 xanthum gum, gellan gum, guar gum, and tragacaths. The preservative
27 solution preferably does not have a concentration of such an agent
28 greater than 5%, more preferably not greater than 2%, even more
29
30

1 preferably not greater than 0.5%, yet more preferably not greater
2 than 0.1%; most preferably not greater than 0.01% by weight.

3 It is also preferred that the produce preservative solution does
4 not have a lecithin, emulsifier, protein, or individual amino acids,
5 such as cysteine, more specifically L-cysteine, concentration greater
6 than 5%, more preferably not greater than 2%, even more preferably
7 not greater than 0.5%, yet more preferably not greater than 0.1%;
8 most preferably not greater than 0.01%, by weight.

9 Preferably the produce is not treated with other preservatives
10 containing: chloride ion; sodium ion; potassium ion; citric acid;
11 citrate ion; acetic acid; acetate ion; lactic acid; lactate ion; malic
12 acid; malate ion; or other acids or acid ions, with the exception of
13 ascorbic acid and erythorbic acid; metal ion sequestrant, particularly
14 an acidic polyphosphate metal ion sequestrant or chelant; sulfite;
15 flavonoid; rose hips; pineapple juice; or lecithin; emulsifier;
16 protein; or individual amino acids, such as cysteine, more specifically
17 L-cysteine; gelling agents; film forming agents; waxes; gums;
18 polysaccharides; such as hydroxymethyl cellulose; methyl cellulose;
19 microcrystalline cellulose; alginates; carrageenans; lipids; pectins;
20 modified starches; locust bean gum; xanthum gum; gellan gum; guar gum;
21 and tragacaths; either before, during or after being preserved with the
22 produce preservative, particularly in the concentrations noted above.

23 24 The Method of Preserving Produce with the Produce Preservative

25 The fresh produce is preferably first sanitized to reduce or
26 eliminate microorganisms on the surface of the skin. Good results have
27 been obtained using a 50-150 ppm sodium hypochlorite solution. The
28 produce is then processed such as for example, by paring, slicing,
29 coring, dicing, peeling or a combination thereof; and then the produce
30 preservative is applied. The produce preservative is applied,
31 preferably at ambient temperature, by conventional techniques such as
32 spraying, dipping, sprinkling, tossing, immersing or drenching. Dipping
33 involves immersing the produce into a solution of produce preservative
34 and is generally preferred. Good results have been obtained by dipping
35 produce 1-5 minutes. Longer dipping times can also be employed.

36 The produce is then preferably placed in conventional packaging
37 to prevent or reduce drying of the produce, particularly if it is not
38 to be consumed within several hours, such as where the produce is to be
39 transported or displayed on a shelf. The produce is then preferably

1 placed in package to prevent or reduce drying where the produce is to be
2 transported or sitting on a shelf.

3 Preferably the produce is stored at a temperature which will not
4 freeze the produce; for example, temperatures of -6°C have been found not
5 to freeze the apples. Preferably the fresh produce is preferably stored
6 at below 30°C, more preferably below 25°C, even more preferably below
7 10°C, even more preferably below 5°C, to reduce microbial growth. While
8 the produce may be stored at ambient temperatures around 20°C, shelf life
9 is increased by storing below 20°C, preferably below 10°C. The produce
10 is preferably stored above 0°C. Preferably the produce is stored at
11 temperatures of between -7 to room temperature, that is 20°C, more
12 preferably -2 to 7°C, most preferably from 2° to 5°C.

13 Preferably the produce is not frozen, cooked or canned before,
14 during, or after being preserved with produce preservative. Where the
15 produce is to be eaten it is preferably not dried before, during, or
16 after being preserved with produce preservative.

17 Evaluation of Preserved Produce

18 As a result of being preserved with produce preservative, the
19 degradation of the color of the produce is substantially reduced.

20 The firmness or hardness of the fruit is the force required for a
21 probe to penetrate the fruit a given distance into the fruit. The
22 firmness is determined using a Quality and Test System 25 and TA 40
23 probe from Stevens Company. The TA 40 probe a black acetate, 4.5 mm
24 diameter, 20 mm long rod probe having a flat end. The following
25 settings were employed in the QTS system: the test type is a compression
26 test of one cycle, 0 second hold time, 0 second recovery, 5 g trigger
27 point, 30 mm/min test speed, target unit distance, and a target value of
28 3 mm. The apple pieces were 1 cm thick.

29 The texture, flavor, and moistness of the fruit were evaluated by
30 tasting fruit samples. The color and/or appearance was also evaluated
31 by visual inspection. The color, texture, moistness and flavor were
32 then evaluated according to a scale of either 1 to 10, with 10 being the
33 value assigned to a freshly cut piece of comparative fruit or vegetable.
34 A value of less than 7 is not acceptable.

35 The following mixtures containing the dry ingredients of the
36 produce preservatives are typical Examples and not intended to be
37 limiting.

While certain cations, for example tin, may not be suitable for preserving produce that is to be eaten, they may be suitable for preserving produce used in potpourris and crafts, particularly where such produce is dried.

Methods of Preserving Fresh Produce Using the Produce preservative

Example 1

Red Delicious apples were preserved with the produce preservative. First, the whole apples free from blemishes or bruises were rinsed with tap water sanitized with 100 parts per million of sodium hypochlorite solution for one minute, then peeled, cored, and sliced. The slices were immersed in water for 30 to 120 seconds.

A produce preservative solution was prepared containing 2.25% ascorbic acid and 0.25% MgO. The apple slices were dipped into the produce preservative solution for 1 to 2 minutes. The apples were then removed from the solution and drained for one to two minutes. The apple slices were placed in 2 mil polyethylene bags, and stored at 2-5°C. The apple slices were evaluated several times over a 14 day period. The appearance specifically the color, of the apples was scored on a scale of 1-10, 10 being the best. A score which is lower than 7 is not acceptable, that is it developed significant browning.

For comparison, similarly prepared apple slices were placed in one of several control preservatives. The first preservative solution was a 2.5% w/v aqueous solution of calcium ascorbate. The second preservative solution was a 5% by weight per volume solution of calcium ascorbate.

The results are shown in Table 1.

Example 2

Red delicious apples were preserved as in Example 1, except that the apple slices were dipped into a preservative solution containing 4.5% ascorbic acid and 0.5% MgO. The results are shown in Table 1.

Example 2a

The procedure of example 2 was repeated except that moistness, texture color and flavor were evaluated at 5 days. The results are shown in Table 2.

Example 3

Red delicious apples were preserved as in Example 1, except that the apple slices were dipped into a preservative solution containing 2.175% ascorbic acid and 0.325% ZnO. The results are shown in Table 1.

Example 4

Red delicious apples were preserved as in Example 1, except that the apple slices were dipped into a preservative solution containing 4.35% ascorbic acid and 0.65% ZnO. The results are shown in Table 1.

Table 1

Evaluation of Sliced Apples
Preserved with Produce preservative

Treatment	Day 1 30 minutes	Day 2	Day 8	Day 15
Untreated apple slices Color	Less than 7	Less than 7		
Untreated apple slices Firmness (grams)	-	-	-	-
Example 1 Color		8.89	6.88	6.125
Example 1 Firmness(grams)		1705	1286	1160
Example 2 Color		9.78	9.125	8.125
Example 2 Firmness(grams)		1531	1187	1136
Example 3 Color		9.78	7.5	4.5
Example 3 Firmness(grams)		1496	1164	1060
Example 4 Color		10	8.0	5
Example 4 Firmness(grams)		1466	1183	946
Comparative Solution 1 Color		9.89	9.63	9
Comparative Solution 1 Firmness(grams)		1635	1271	1340
Comparative Solution 2 Color		10	10	10
Comparative Solution 2 Firmness(grams)		1704	1271	1497

Table 2
Evaluation of Sliced Apples
Preserved with Produce Preservative

	Color	Flavor	Texture	Moistness
Example 2a magnesium ascorbate	8.4375	8.25	7.9375	8.4375
comparative solution	9	8.375	8.5625	8.3125

*Score 10 is the best. Score which is lower than 7 is not acceptable.

Example 5

Bartlett pears were preserved as in Example 1, except that the pear slices were dipped into a preservative solution containing 4.5% ascorbic acid and 0.5% MgO. Also, the only comparative solution was control was a 7% ascorbic acid solution. The pear slices were evaluated for color. The results are shown in Table 3.

Example 6

Hass avocados were preserved as in Example 1, except that the avocado slices were dipped into a preservative solution containing 5.8% ascorbic acid and 4.2% $\text{MgCl}_2 \cdot 6\text{H}_2\text{O}$. Also, the control was a 10% solution of calcium ascorbate. The avocado slices were evaluated for color. The results are shown in Table 3.

Example 7

Hass avocados were preserved as in Example 1, except that the avocado slices were dipped into a preservative solution containing 8.7% ascorbic acid and 6.3% $\text{MgCl}_2 \cdot 6\text{H}_2\text{O}$. Also, the control was a 10% solution of preservative 1. The avocado slices were evaluated for color. The results are shown in Table 3.

Table 3
Appearance of Sliced Pears and Avocados
Preserved with Produce Preservative

Solution	Day 1 4 hours	Day 2	Day 7
Pears untreated	Less than 7	-	-
Ascorbic acid		9	5.5
Example 5		10	10

Avocadoes Untreated	Less than 7 at 1-2 hours	-	-
Comparative Calcium ascorbate		9.5	8.5
Example 6		9.5	6
Example 7		10	9.5

Example 8

Celery was washed with tap water to remove dirt and soil, then sanitized with 100-150 parts per million sodium hypochlorite water for 1 minute. The celery was drained and cut into three inch by 0.25 to 0.3 sticks. The celery was again sanitized with 75 parts to 100 parts per million sodium hypochlorite water for 1 minute. The celery sticks were immersed in a preservative solution containing 4.8 grams ascorbic acid and 0.54 grams magnesium oxide in 100 ml water, to provide magnesium ascorbate solution having an ascorbate ion: magnesium ion molar ratio of 2:1 and a pH of 5.02. The celery was immersed into the preservative solution for 2-3 minutes and drained for 2-3 minutes. The celery sticks were packed in 3 mil polyethylene bags which were heat sealed and then stored at 2-5°C.

Untreated sticks were used as controls. Also, for comparison, sticks were treated with a calcium ascorbate solution containing 4.8 grams ascorbic acid and 1.2 grams calcium carbonate; the molar ratio of ascorbate ion: calcium ion was 2:1. The celery sticks were evaluated visually for color. The results are shown in Table 4.

Example 9

Celery was preserved as in Example 8, except that the celery slices were dipped into a preservative solution containing 4.8% ascorbic acid and 0.74 grams ZnO, to provide a zinc ascorbate solution having an ascorbate ion to zinc ion molar ratio of 3:1, and a pH of 4.15. The results are shown in Table 4.

Table 4
Color of Sliced Celery
Preserved with Produce Preservative

Treatment	Day 2	Day 6	Day 10
Untreated celery	8	6	6
Comparative	9.25	8	6
Example 8	8.75	7	6
Example 9	8.25	3	2

Example 10

Iceberg lettuce, with exterior damaged leaves removed, was washed with tap water to remove dirt and soil, then sanitized with 100-150 parts per million sodium hypochlorite water for 1 minute. The lettuce was drained 3-5 minutes and cut into 1 by 1 inch pieces. The lettuce was immersed in into a preservative solution containing 4.0 grams ascorbic acid and 0.95 grams magnesium carbonate to provide a magnesium ascorbate solution having an ascorbate ion to magnesium ion molar ratio of 2:1, and a pH of 4.74. The lettuce was immersed into the preservative solution for 30 to 60 seconds, then drained for 2-3 minutes and then spun in a salad spinner. The lettuce pieces were packed in 3 mil polyethylene bags which were heat sealed and then stored at 2-5°C. The results are shown in Table 5.

Example 11

Iceberg lettuce was preserved as in Example 10, except that the lettuce slices were dipped into a preservative solution containing 4.0 grams ascorbic acid and 0.30 grams magnesium oxide in 100 ml water, to provide a magnesium ascorbate solution having an ascorbate ion to magnesium ion molar ratio of 3:1, and a pH of 4.15. The results are shown in Table 5.

Example 12

Iceberg lettuce was preserved as in Example 10, except that the lettuce slices were dipped into a preservative solution containing 4.0 grams ascorbic acid and 0.46 grams zinc oxide in 100 ml water, and having an ascorbate ion to zinc ion molar ratio of 4:1, and a pH of 3.90. The results are shown in Table 5.

Table 5

Color of Sliced Lettuce
Preserved with Produce Preservative

	Day 3	Day 7	Day 9	Day 11	Day 14
Control Lettuce	6	6	4	4	4
Example 10	9.5	9.5	9.5	9.5	8
Example 11	9.5	9.5	9.5	9.25	8
Example 12	5	5	3	2	2

Example 13:

Russet potatoes were washed with tap water to remove dirt, peeled then cut into 0.5 by 0.5 inch pieces. The potatoes were rinsed with tap water to remove surface starch and drained for 2-3 minutes. The potato pieces were then immersed in a preservative solution containing 1.25 grams ascorbic acid, 0.75 grams citric acid and 1.12 grams $\text{MgCl}_2 \cdot 6\text{H}_2\text{O}$ in 100 ml water, for 1-2 minutes. They were drained for 2-3 minutes, then packed in 3 mil polyethylene bags which were heat sealed. The bags were stored at 2-5°C.

For comparison a solution was prepared containing: 1.25 grams ascorbic acid, 0.75 grams citric acid, and 0.75 grams sodium chloride in 100 ml water. The results are shown in Table 6.

Example 14

Russet potatoes were preserved as in Example 13, except that the potato slices were dipped into a preservative solution containing 1.25 grams ascorbic acid, 0.75 grams citric acid and 0.75 grams zinc chloride in 100 ml water. The results are shown in Table 6.

Table 6

Color of Sliced Potatoes
Preserved with Produce Preservative

	Day 2	Day 3	Day 5	Day 8	Day 12
Untreated Potato	5	Less than 4	Less than 4	Less than 4	Less than 4

Comparative Solution	9	9	9	8	8
Example 13	8	8	8	8	6
Example 14	8	6.5	3	3	3

Example 15

Russet potatoes were preserved as in Example 13, except that the potato slices were dipped into a preservative solution containing 4 grams ascorbic acid, and 1.07 grams magnesium chloride in 100 ml water. Untreated sliced potatoes were used as controls; no comparative solutions were used. The results are shown in Table 7.

Example 16

Russet potatoes were preserved as in Example 15, except that the potato slices were dipped into a preservative solution containing 4 grams ascorbic acid, and 0.45 grams magnesium oxide in 100 ml water. The results are shown in Table 7.

Example 17

Russet potatoes were preserved as in Example 15, except that the potato slices were dipped into a preservative solution containing 4 grams ascorbic acid, and 0.64 grams zinc oxide in 100 ml water. The results are shown in Table 7.

Example 18

Russet potatoes were preserved as in Example 15, except that the potato slices were dipped into a preservative solution containing 4 grams ascorbic acid, and 1.03 grams zinc chloride in 100 ml water. The results are shown in Table 7.

Table 7
Color of Sliced Potato
Preserved with Produce preservative

Formulas tested	Day 2	Day 4	Day 9	Day 16
Untreated Potato	5	4	4	4
Example 15	10	10	10	9.5
Example 16	10	10	9	8
Example 17	7	6	2	2
Example 18	10	10	5	2

Example 19

Whole mushrooms were washed with a 0.25% sodium carbonate solution for 30 seconds to remove dirt and drained 20 - 30 seconds. The mushrooms were dipped into a preservative solution containing 4.0 grams ascorbic acid and 0.45 grams magnesium oxide in 100 ml water. Also, for comparison, mushrooms were treated with a calcium ascorbate solution containing 4 grams ascorbic acid and 0.75 grams calcium carbonate in 100 ml water. The results are shown in Table 8.

Example 20

Mushrooms were preserved as in Example 19, except that the mushrooms were dipped into a preservative solution containing 4.0 grams ascorbic acid and 0.30 grams magnesium oxide. The results are shown in Table 8.

Example 21

Mushrooms were preserved as in Example 19, except that the mushrooms were dipped into a preservative solution containing 4.0 grams ascorbic acid and 0.64 grams zinc oxide. The results are shown in Table 8.

Table 8
Color of Whole Mushrooms
Preserved with Produce Preservative

Treatment	Day 2	Day 5	Day 7	Day 9
Untreated mushroom	8	7	7	7
Comparative	9.5	9	9	7
Example 19	8	6	6	5
Example 20	9	8.5	8.5	7.5
Example 21	7	2	2	2

Example 22

Celery sticks were preserved as in Example 8, except that the celery sticks were dipped into a preservative solution containing 4.0 grams ascorbic acid and 1.07 grams magnesium chloride in 100 ml water. No comparative solution was used. The results are shown in Table 9.

Example 23

Celery sticks were preserved as in Example 8, except that the celery sticks were dipped into a preservative solution containing 4.0 grams

ascorbic acid and 0.45 grams magnesium oxide in 100 ml water. The results are shown in Table 9.

Example 24

Celery sticks were preserved as in Example 8, except that the celery sticks were dipped into a preservative solution containing 4.0 grams ascorbic acid and 0.64 grams zinc oxide in 100 ml water. The results are shown in Table 9.

Example 25

Celery sticks were preserved as in Example 8, except that the celery sticks were dipped into a preservative solution containing 4.0 grams ascorbic acid and 1.03 grams zinc chloride in 100 ml water. The results are shown in Table 9.

Table 9
Color of Celery
Preserved with Produce Preservative

Formulas	Day 4	Day 6	Day 11
Example 22	9.5	7	5
Example 23	8	7	6
Example 24	7	6	5
Example 25	9	6	3
Untreated celery	9	6	6

Example 26

Russet potatoes were preserved as in Example 13, except that the potatoes were dipped into a preservative solution containing 4.0 grams ascorbic acid and 2.57 grams stannous chloride dihydrate. The results are shown in Table 10.

Table 10
Color of Potato Slices
Preserved with Produce Preservative

Example	Day 2	Day 6	Day 8	Day 12
Example 26	10	10	10	10
Control	5	4	4	4

1 What is claimed is:

2
3 1. A method for preserving fresh produce comprising the following
4 steps:

5 a. providing a produce preservative solution comprising:
6 magnesium ion;

7 and an anion selected from the group consisting of: ascorbate
8 ions; erythorbate ions; and mixtures thereof; and
9 water;

10 wherein: the anion and magnesium are present in a mole ratio of from
11 0.2:1 to 8:1; and the produce preservative has less than 5% flavonoid
12 and metal ion sequestrant;

13
14 b. applying said produce preservative to the produce.
15

16 2. The method of Claim 1, wherein the preservative solution
17 preservative solution has less than 1% sodium ions and less than 1%
18 potassium ions.
19

20 3. The method of Claim 1, wherein the preservative solution
21 preservative solution has less than 0.5% of citric acid, or citrate
22 ions, and less than 0.5% malic acid and malate ions.
23

24 4. The method of Claims 1, 2, or 3, wherein the cation is the magnesium
25 ion and the anion and magnesium ion are present in a mole ratio of from
26 0.75:1 to 8:1.
27

28 5. The method of Claims 1, 2, or 3, wherein the cation is the
29 magnesium ion and the preservative solution comprises:

30 from 0.1 % to 30% of the magnesium ion; and

31 from 0.1% to 40% of the anions; wherein the anion and magnesium
32 ion are present in a mole ratio of from 1:1 to 4:1.
33

34 6. The method of Claims 1, 2, or 3, wherein the cation is the
35 magnesium ion and the preservative has less than 5% of film forming
36 agents, lactic acid and cysteine.
37

38 7. The method of Claims 1, 2, or 3, wherein the cation is the
39 magnesium ion and the preservative solution comprises from 0.1% to

1 10% magnesium ions, from 0.5% to 15% ascorbate ions or erythorbate
2 ions; wherein the anion and magnesium ion are present in a mole ratio of
3 from 1.5:1 to 3:1 and the produce is a member of the Solcanaceae
4 family, the Amaryllidaceae family, the Brassicaceae family, the
5 Cucurbitaceae family, the Ascomycetes/Basidiomycetes classes or the
6 tree fruits.

7
8 8. The method of Claims 1, 2, or 3 wherein:
9 the cation is the magnesium and the preservative solution comprises
10 from 0.2% to 3% magnesium ions, and from 1% to 5% ascorbate
11 ions or erythorbate ions;
12 the produce is selected from the group consisting of peppers, onion,
13 tomatoes, cucumbers, mushrooms, celery, potatoes, lettuce, apples,
14 pears, avocados and mixtures thereof;
15 the produce is cut, and;
16 the cut produce is not frozen, dried, cooked or canned after step b.

17
18 9. A cut fruit of vegetable preserved according to the method of Claims
19 1, 2, or 3.

20
21 10. The method of Claims 1, 2, or 3, wherein the cation is zinc, and
22 anion and cation are present in a mole ratio of from 0.75:1 to 8:1.

23
24 11. The method of Claims 1, 2, or 3, wherein the cation is tin, and the
25 anion and cation are present in a mole ratio of from 0.75:1 to 8:1.

26
27 12. A method for preserving fresh produce comprising the following
28 steps:

29 a. providing a produce preservative solution **consisting essentially of**
30 :

31 a cation selected from the group consisting of: magnesium
32 ion; zinc ion; tin ion; and mixtures thereof;

33 and an anion selected from the group consisting of: ascorbate
34 ions; erythorbate ions; and mixtures thereof; and

35 water;

36 wherein the anion and cation ion are present in a mole ratio of from
37 0.2:1 to 8:1;

38 b. applying said produce preservative to the produce.

1
2 13. The method of Claim 12, wherein the cation is magnesium, and the
3 anion and cation are present in a mole ratio of from 0.75:1 to 8:1.
4

5 14. The method of Claim 12, wherein the cation is zinc, and anion and
6 cation are present in a mole ratio of from 0.75:1 to 8:1.
7

8 15. The method of Claim 12, wherein the cation is tin, and the anion and
9 cation are present in a mole ratio of from 0.75:1 to 8:1.
10

11 16. The method of Claim 12, wherein the cation is magnesium, and the
12 preservative solution preservative solution contains:

13 from 0.1 % to 15% of the cation; and
14 from 0.1% to 30% of the anion; wherein the anion and
15 cation are present in a mole ratio of from 1:1 to 4:1.
16

17 17. The method of Claim 12, wherein: the cation is magnesium; the
18 preservative solution comprises from 0.1% to 10% of the cation, and
19 from 0.5% to 15% anion; wherein the anion and cation are present in a
20 mole ratio of from 1.5:1 to 3:1; the produce is a member of the
21 Solcanaceae family, the Amaryllidaceae family, the Brassicaceae family,
22 the Cucurbitaceae family, the Ascomycetes/Basidiomycetes classes or the
23 tree fruits;
24 and the cut produce is not frozen, cooked or canned after step b.
25
26