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(54) **POLYMER FOOD PACKAGING**

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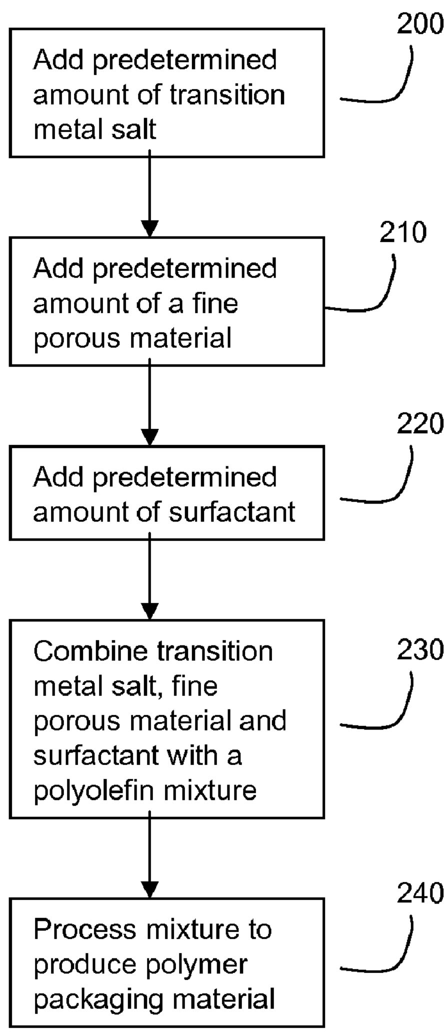
CPC *B65D 81/28* (2013.01)
USPC **524/398**

(57) **ABSTRACT**

A polyolefin composition comprising a predetermined amount of an ethylene inhibitor for binding 1-aminocyclo-propane-1-carboxylic-acid (ACC) to reduce an amount of ACC available for an ethylene biosynthetic pathway.



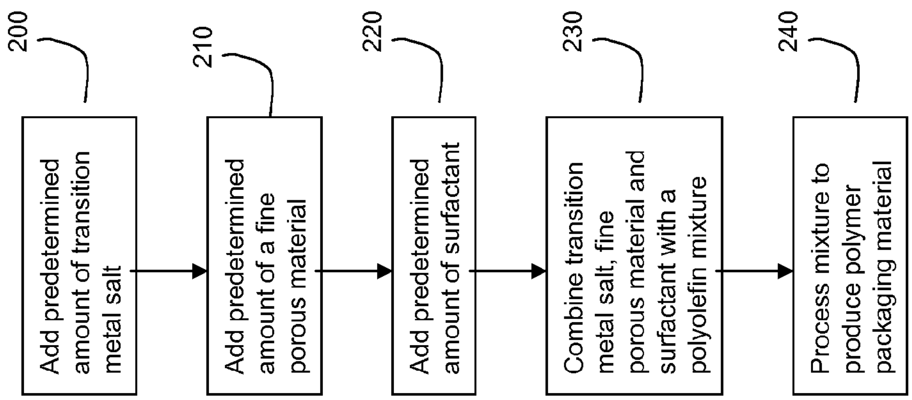

200
Add predetermined amount of transition metal salt
210
Add predetermined amount of a fine porous material
220
Add predetermined amount of surfactant
230
Combine transition metal salt, fine porous material and surfactant with a polyolefin mixture
240
Process mixture to produce polymer packaging material

Fig. 2

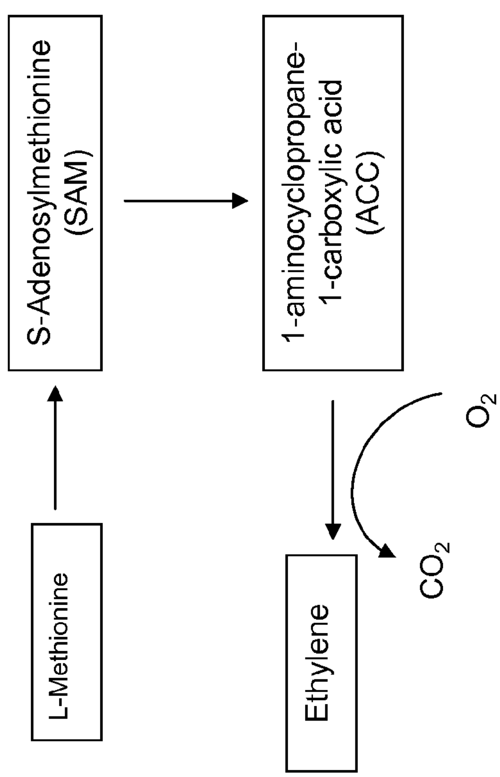

L-Methionine
S-Adenosylmethionine (SAM)
1-aminocyclopropane-1-carboxylic acid (ACC)
O_2
CO_2
Ethylene

Fig. 1

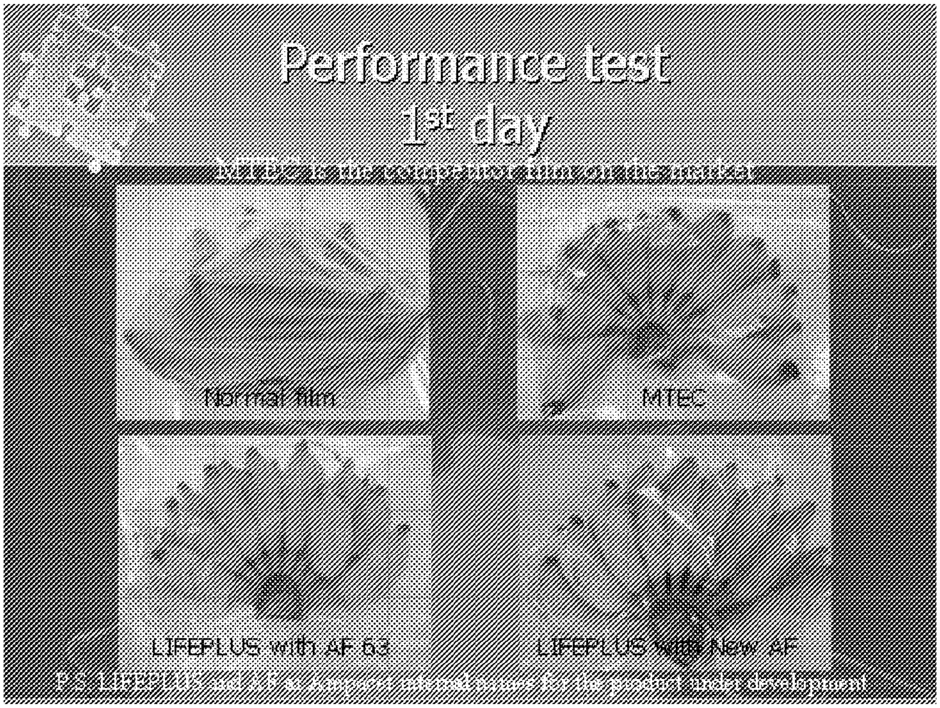

Performance test
1st day
MTEC is the competitor film on the market
Normal film
MTEC
LIFEPLUS with AF 63
LIFEPLUS with New AF

Fig. 3

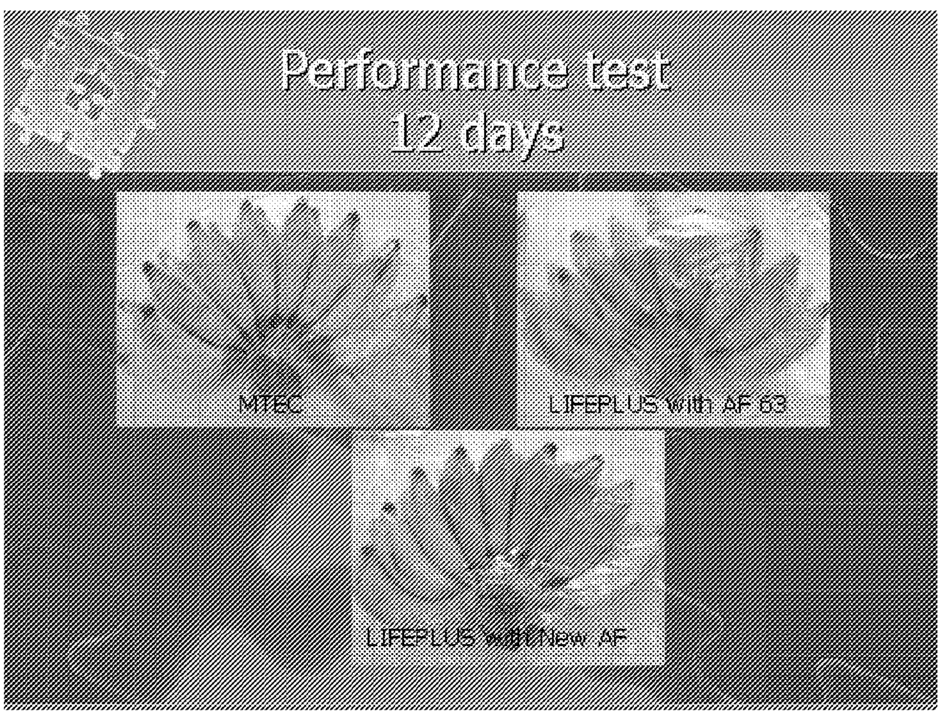

Performance test
12 days
MTEC
LIFEPLUS with AF 63
LIFEPLUS with New AF

Fig. 4

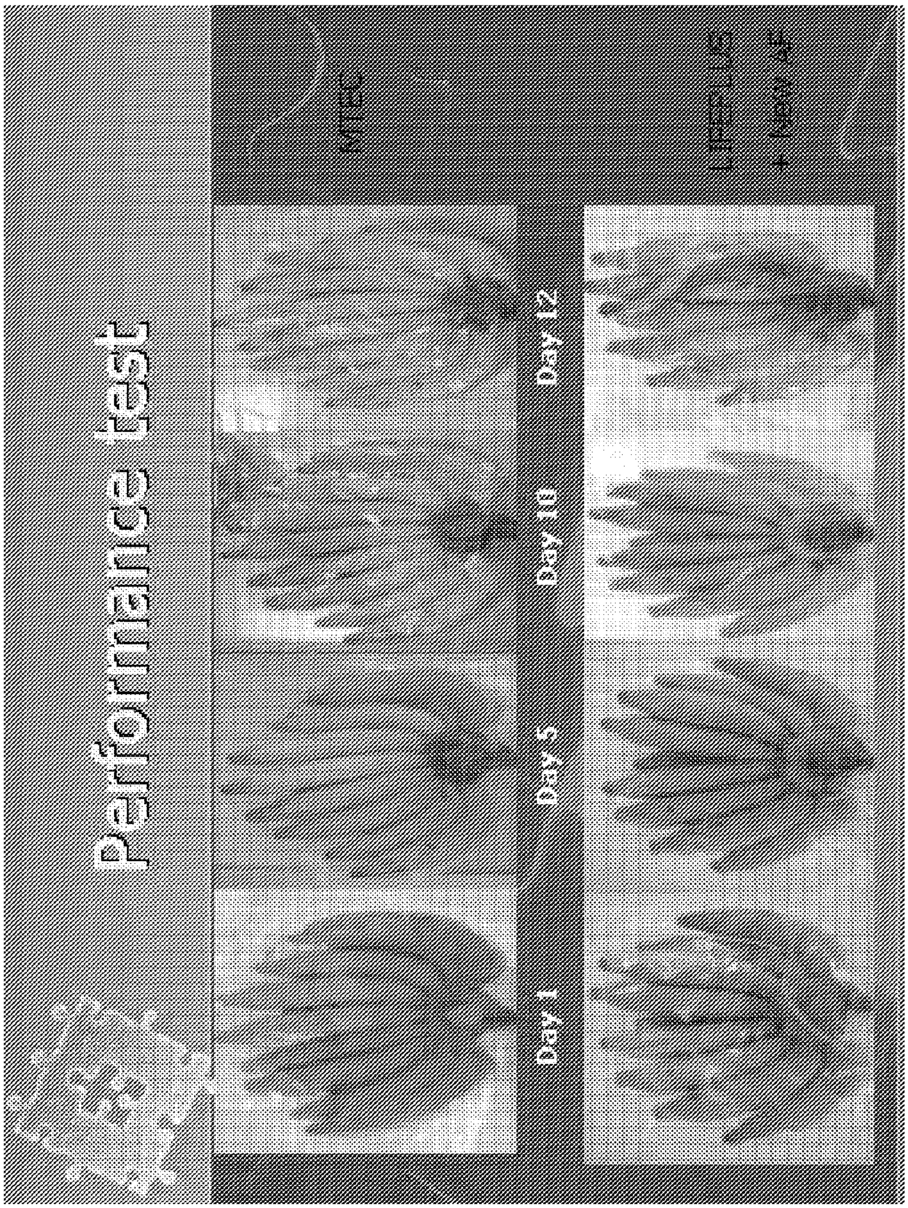


Fig. 5

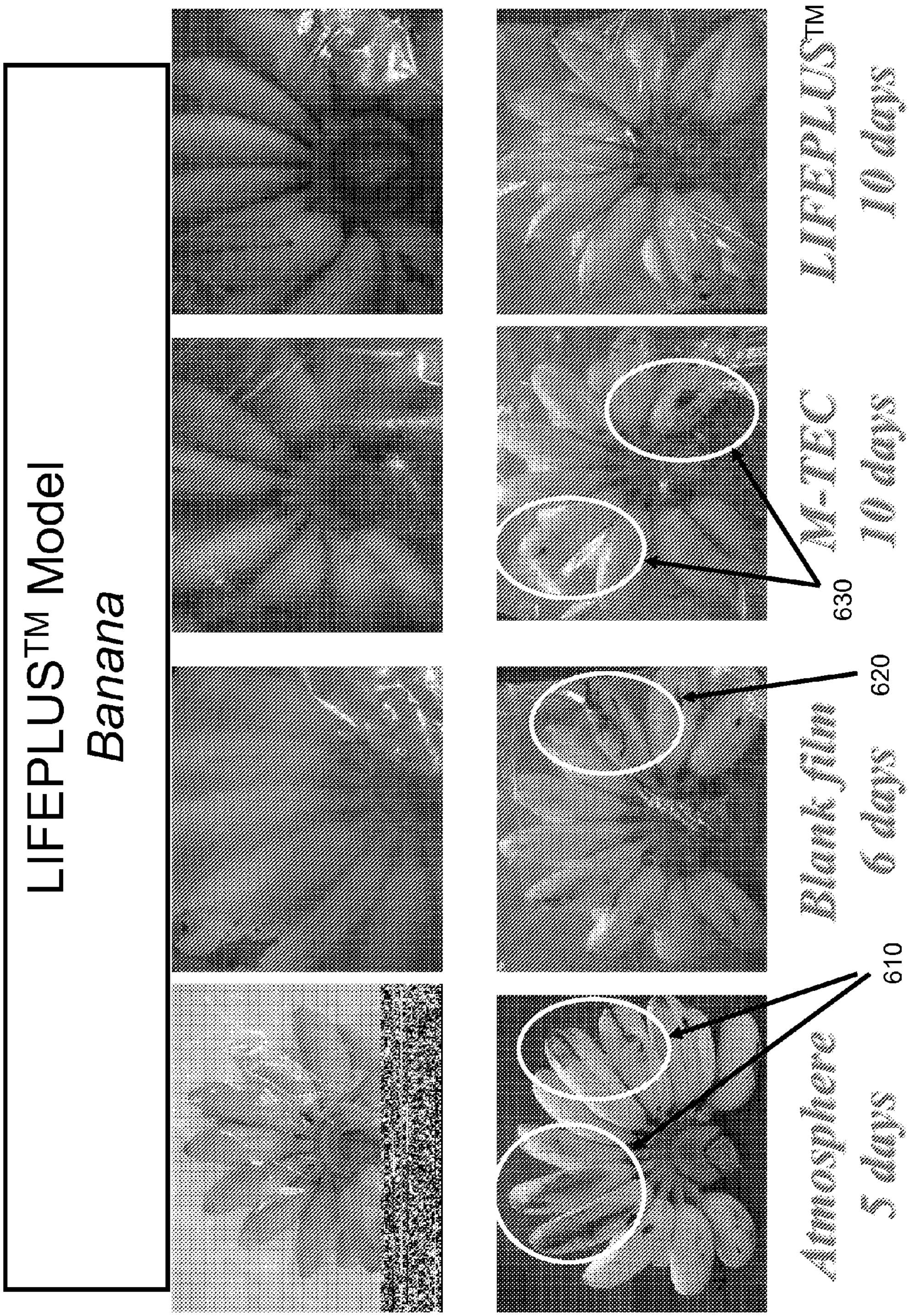

LIFEPLUS™ Model
Banana
Atmosphere
5 days
Blank film
6 days
M-TEC
10 days
LIFEPLUS™
10 days
610
620
630

Fig. 6

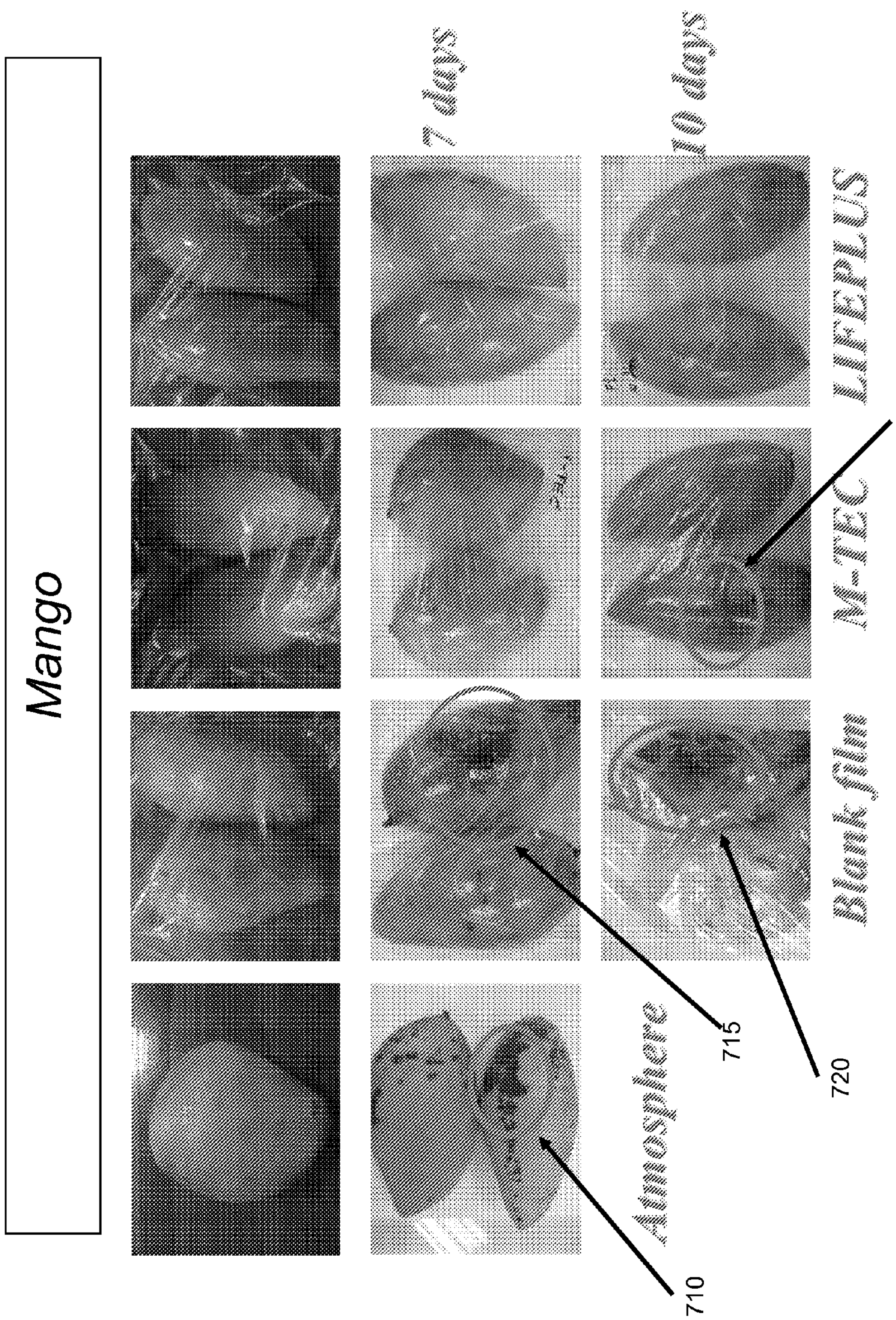

Mango
7 days
10 days
Atmosphere
Blank film
M-TEC
LIFEPLUS
710
715
720
730

Fig. 7

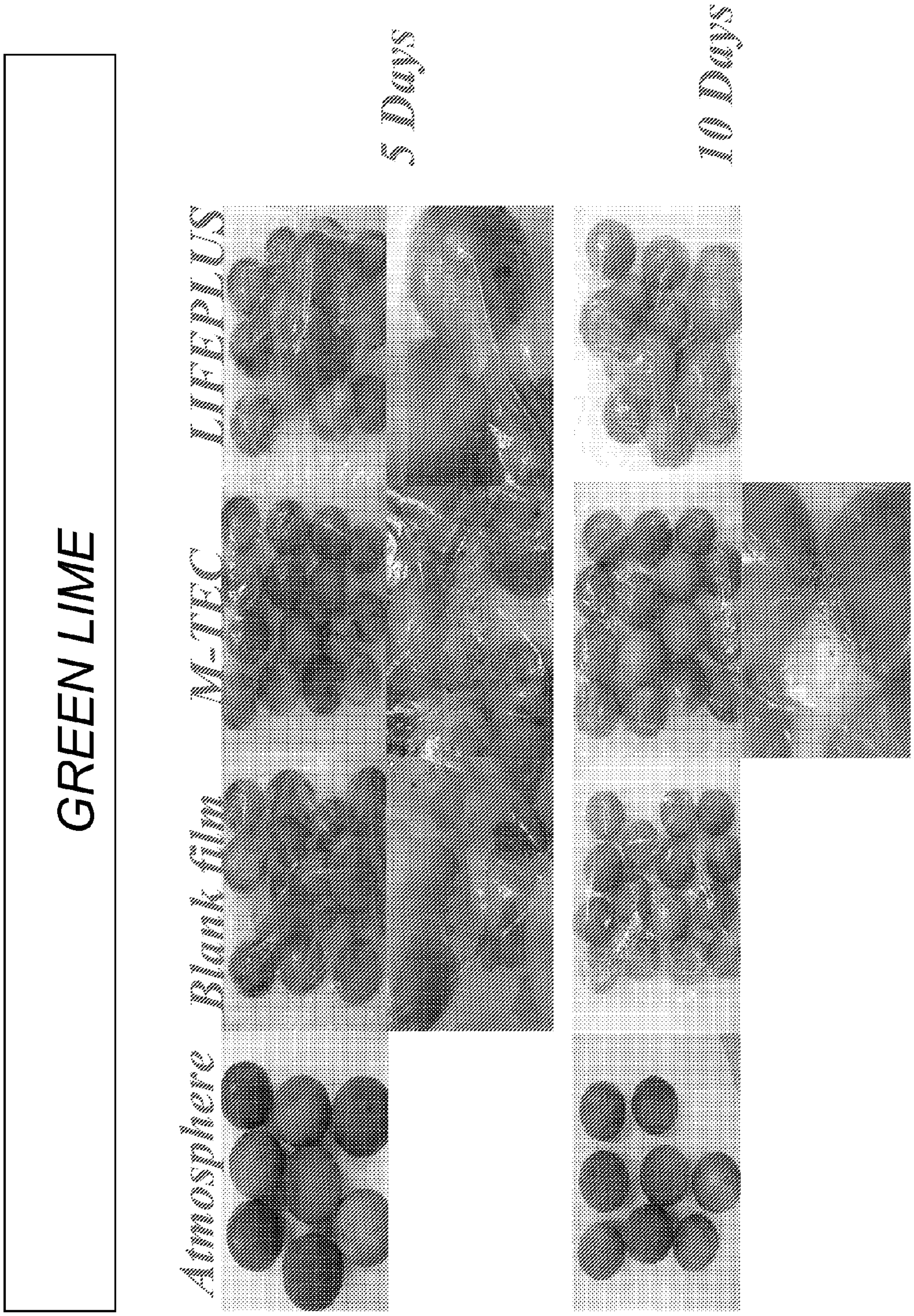

GREEN LIME
Atmosphere
Blank film
M-TEC
LIFEPLUS
5 Days
10 Days

Fig. 8

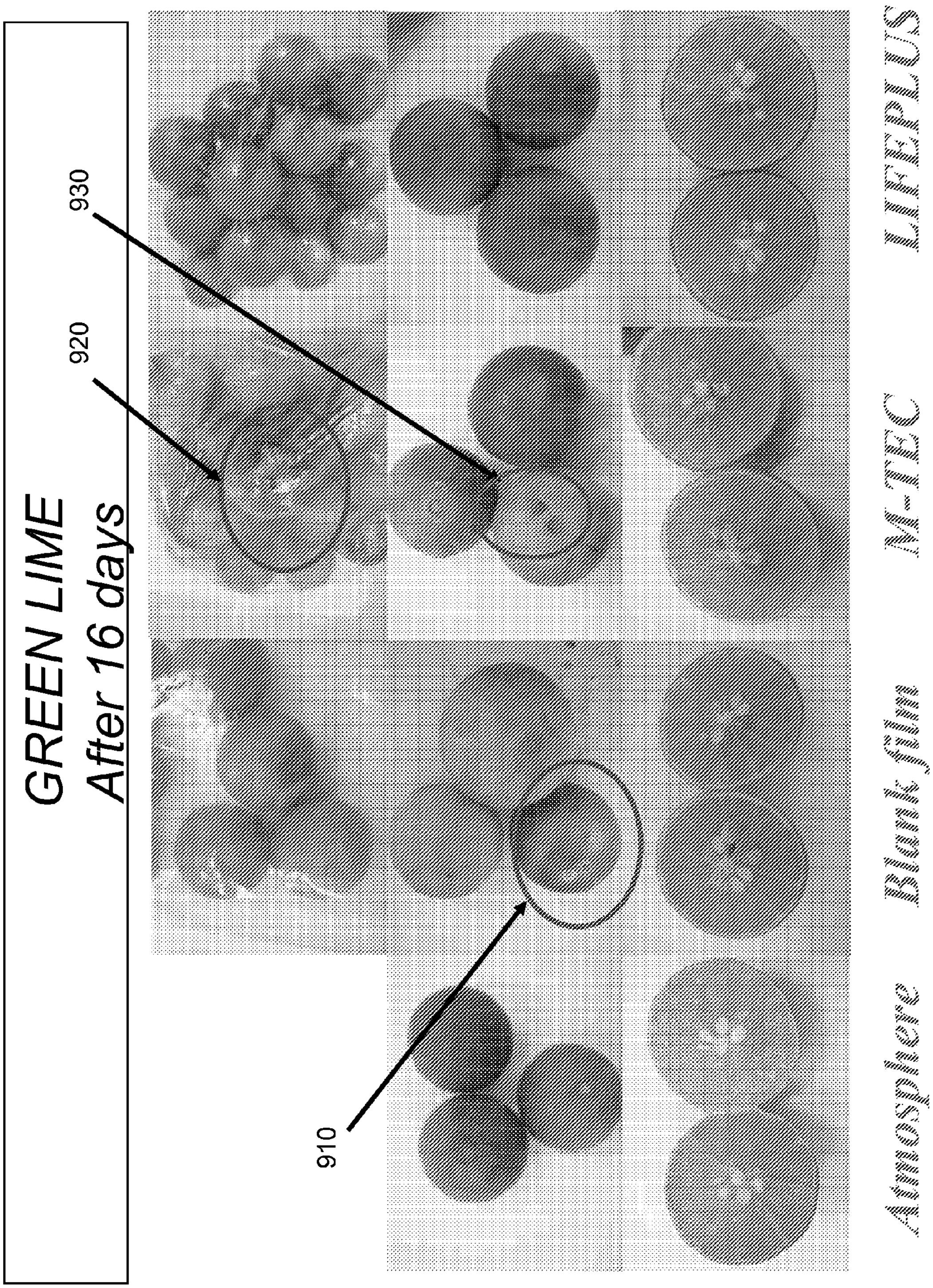

GREEN LIME
After 16 days
910
920
930
Atmosphere
Blank film
M-TEC
LIFEPLUS

Fig. 9

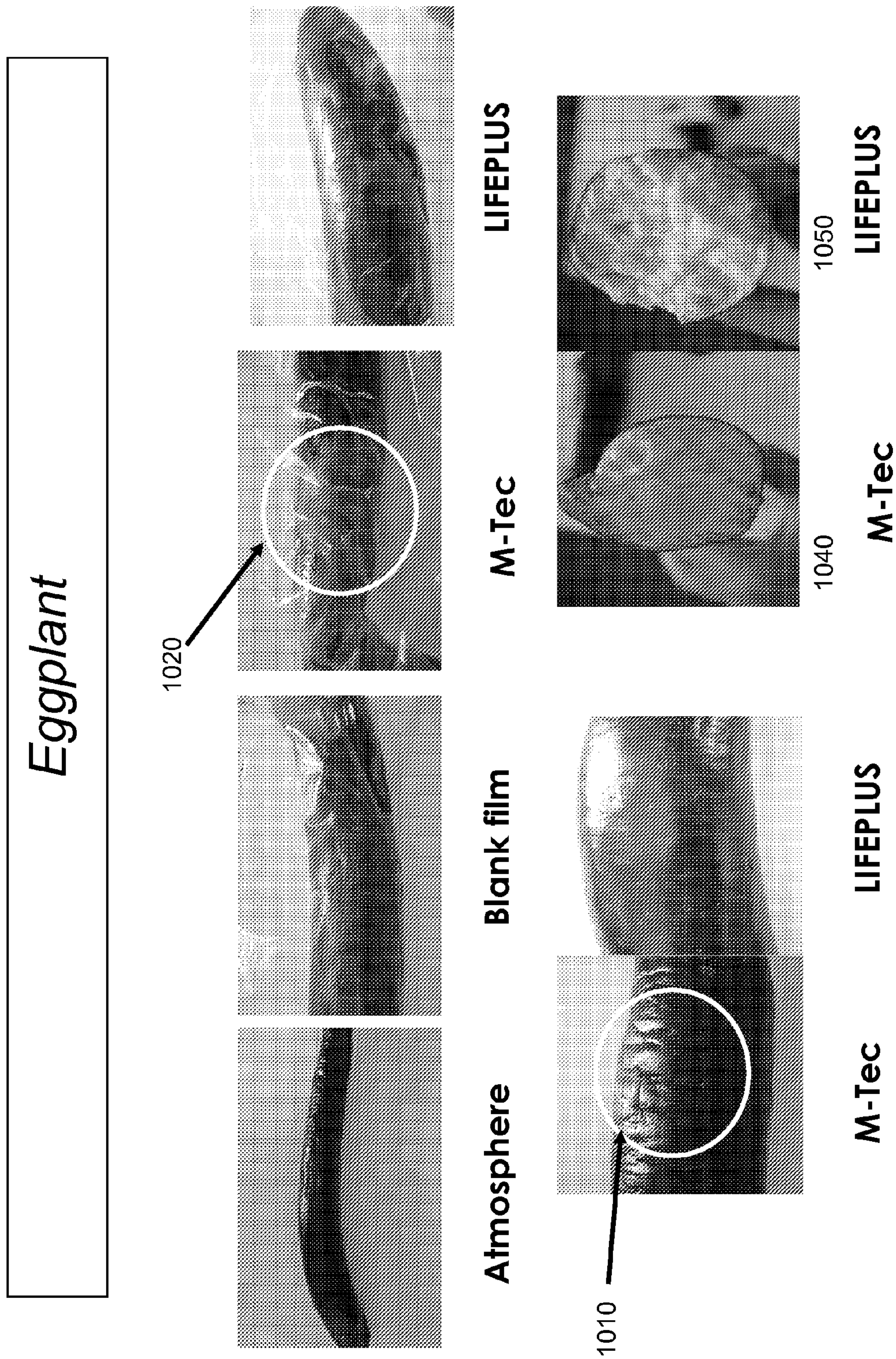

Eggplant
Atmosphere
Blank film
M-Tec
1020
LIFEPLUS
M-Tec
1010
LIFEPLUS
M-Tec
1040
LIFEPLUS
1050

Fig. 10

Sweet pepper

Sweet Pepper- the result after 20 days

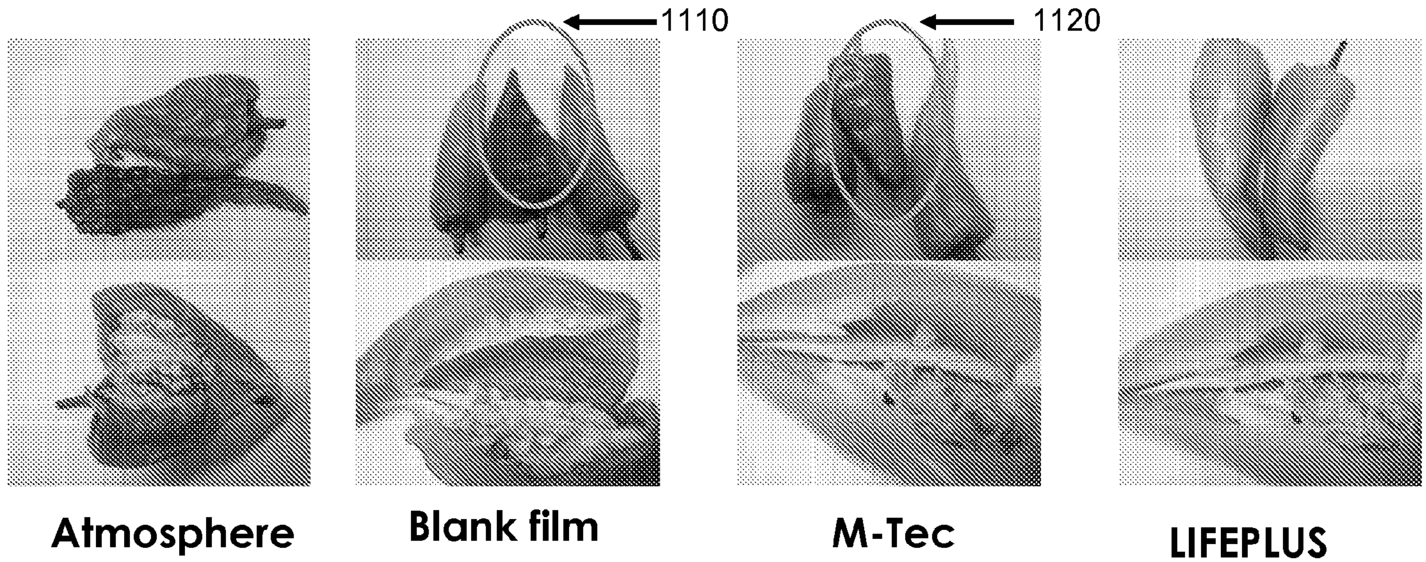


Fig. 11

POLYMER FOOD PACKAGING

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] This application claims priority from U.S. Provisional Patent Application Ser. No. 61/055,502 filed on May 23, 2008 by C. Chulamanee et al.

FIELD OF THE INVENTION

[0002] The present invention relates generally to a polymer film for use as food packaging and, more specifically, to a polymer packaging that extends the shelf life of the food packaged therein.

BACKGROUND OF THE INVENTION

[0003] The use of polymer-based packaging for various food products including fruits and vegetables is known. Depending on the type of food article to be packaged, different polymer films may be utilized in order to maximize the life and freshness of the food product. These polymer films are generally intended to wrap or cover food product and reduce the amount of air and/or water vapor that contacts the food product during transport or while on the shelf. Examples of polymer based food packaging include polyethylene, polypropylene, rubber hydrochloride, cellulose acetate, polyvinylidene chloride, polyvinyl chloride and polyethylene terephtalate. These materials can exist in many forms, depending upon such variables as identity and mixture of polymers, degree of polymerisation and molecular weight, spatial polymer orientation, use of plasticisers (softeners) and other chemicals. Each of these materials has a low permeability to water vapor and/or other gases and provides a degree of chemical resistance. However, the existing food packaging materials do not effectively prevent the natural metabolism of the food product and thus do not effectively prevent ripening of the food product. By allowing the food product to ripen, the amount of time before spoilage occurs is reduced. This presents a problem to distributors who need to transport fresh food products over long distances because this must occur within a shorter timeframe. Moreover, no existing food packaging material inhibits the ethylene formulation which is a direct cause of ripening. Therefore, a need exists for a packaging that includes elements that interact with chemicals emitted by the food being packaged to prevent the negative ripening affects associated therewith.

[0004] Additionally, certain conventional polymer films may include a transition metal salt as an ingredient of the manufacturing process. The inclusion of a transition metal salt is beneficial because, when combined with certain other chemical elements during the manufacture of a polymer film enhances the biodegradability of the film. However, in order to accomplish this goal, additional chemical elements need to be added to the masterbach used to produce the film. The result may include these chemicals compositions complexing with the transition metal salt facilitating quicker breakdown of the polymer film. The drawback associated with these films is the quick degradation thereof as well as the unavailability of the transition metal salt for bonding/complexing with elements other than those in the polymer film. It therefore desirable to provide a polymer film that maintains the ability of the transition metal salt to complex with a compound that produced by an object around which the polymer is placed. to A composition according to invention principles addresses these deficiencies and associated problems.

BRIEF SUMMARY OF THE INVENTION

[0005] A food packaging film, container or overwrap, either multi or monolayer, is formed from a polymer and extends the shelf-life of fresh food products and particularly fruits and vegetables by controlling the levels of ethylene, moisture and oxygen able to contact the fresh food product. The film includes a predetermined amount of a transition metal salt, and additionally may contain a fine porous material such as silica, and a surfactant. The film enhances the taste of the fruits/vegetables by delaying the maturation process thereof and thereby decreasing the rate at which the fresh food product ripens.

[0006] In one embodiment, a polyolefin composition is provided and includes a predetermined amount of an ethylene inhibitor for binding 1-aminocyclopropane-1-carboxylic-acid (ACC) to reduce an amount of ACC available for an ethylene biosynthetic pathway. The ethylene inhibitor may be a transition metal salt of a fatty acid wherein the transition metal is at least one of Manganese, Cobalt, Iron, Nickel, Silver and Copper and the fatty acid salt is at least one of stearic, olleic, palmitic, myristic and behenic acid. In a further embodiment, the composition includes a predetermined amount of a fine porous inorganic material that may include at least one of silica, zeolite, cristobalite, Calcium carbonate, Kaolin, Talc and Limestone. In yet a further embodiment, the composition includes predetermined amounts of at least one of surfactant, a slip agent, an antistat agent, polyolefinic polymers an antioxidant and a colorant. The composition is formed into a packaging material using at least one of an extrusion process and an injection molding process.

[0007] In another embodiment of the polyolefin packaging material includes a predetermined amount of ethylene inhibitor may is provided within a range of between substantially 0.05% by weight and 3% by weight of the total compositional weight. A predetermined amount of fine porous inorganic material is provided within a range of between substantially 0.05% by weight and 3% by weight of the total composition and a predetermined amount of surfactant is provided within a range of between substantially 0.05% by weight and 3% by weight of the total composition.

[0008] In a further embodiment, a packaging material for a food article is provided and includes a predetermined amount of polyolefin and a predetermined amount of an ethylene inhibitor for binding 1-aminocyclopropane-1-carboxylic-acid (ACC) to reduce an amount of ACC available for an ethylene synthesis by the food article. The ethylene inhibitor is a transition metal salt of a fatty acid and the composition further includes at least one of a predetermined amount of fine porous inorganic material and a predetermined amount of surfactant. The packaging material includes the predetermined amount of ethylene inhibitor ranges between substantially 0.05% by weight and 3% by weight, the predetermined amount of polyolefin ranges between substantially 91% by weight and 99.5% by weight, the predetermined amount of fine porous inorganic material and predetermined amount of surfactant are each provided within a range of between substantially 0.05% by weight and 3% by weight of the total packaging material. Additionally, the packaging material may be formed by at least one of an extrusion process and an injection molding process.

[0009] Yet another embodiment is a masterbatch for use in producing a polyolefin packaging material comprising a predetermined amount of an ethylene inhibitor for binding 1-aminocyclopropane-1-carboxylic-acid (ACC) to reduce an amount of ACC available for an ethylene biosynthetic pathway. The ethylene inhibitor is a transition metal salt of a fatty acid and the masterbatch further includes a predetermined amount of at least one fine porous inorganic material and a surfactant. The masterbatch may also include a predetermined amount of at least one of a slip agent, an antistat agent, an antioxidant and colorants.

[0010] Another embodiment provided is a method of interrupting respiration of a fruit or vegetable to prevent ripening thereof by providing a polyolefin packaging material including a predetermined amount of an ethylene inhibitor for binding 1-aminocyclopropane-1-carboxylic-acid (ACC) to reduce an amount of ACC available for an ethylene biosynthetic pathway and packaging at least one of a fruit and vegetable in the polyolefin packaging material. This method further includes the activity of transporting the at least one packaged fruits and vegetables from one geographical location to a second different geographical location. The ethylene inhibitor may be a transition metal salt of a fatty acid and the activity of providing a packaging material includes providing a packaging material including of a predetermined amount of fine porous inorganic material and a predetermined amount of surfactant.

BRIEF DESCRIPTION OF THE DRAWING FIGURES

[0011] FIG. **1** is a flow diagram detailing ethylene production in fruit;

[0012] FIG. **2** is a flow diagram detailing a production method for producing the polymer food packaging according to invention principles;

[0013] FIG. **3** is a picture showing a testing process used for testing the film at Day 1 according to invention principles;

[0014] FIG. **4** is a picture showing the testing process used for testing the film at Day 12 according to invention principles;

[0015] FIG. **5** is a picture showing the testing process used for testing the film during Days 1-12 according to invention principles;

[0016] FIG. **6** is a picture showing the testing process used for testing the film for wrapping bananas according to invention principles;

[0017] FIG. **7** is a picture showing the testing process used for testing the film for wrapping mangos according to invention principles;

[0018] FIG. **8** is a picture showing the testing process used for testing the film for wrapping limes according to invention principles;

[0019] FIG. **9** is a picture showing the testing process used for testing the film for wrapping limes according to invention principles;

[0020] FIG. **10** is a picture showing the testing process used for testing of film for wrapping eggplants according to invention principles; and

[0021] FIG. **11** is a picture showing the testing process used for testing of film for wrapping sweet pepper according to invention principles.

DETAILED DESCRIPTION OF THE INVENTION

[0022] The polymer composition may be used as an active packaging article, such as a film or stand alone container for extending the shelf life of food, fruits and vegetables after harvest or packing. Specifically, the polymer composition may be used to pack and transport food (mainly fruits and vegetables) between the harvest point and the point of sale to the consumer. Additionally, the polymer composition may be formed as an individual packaging article that may be sold directly to a consumer providing the food item in an individual package which is able to extend the time the food item remains fresh. The packaging article may also be sold to the consumer, who uses it to package fresh fruits and vegetables for home storage.

[0023] The ripening of fruits and some vegetables is exacerbated by ethylene produced by the fruits and vegetables during the ripening process. The biosynthetic production of ethylene during the ripening process is shown in FIG. **1**. Specifically, the amino acid L-Methionine is converted into S-adenosylmethionine (SAM) by the enzyme Met Adenosyltransferase. SAM is then converted to 1-aminocyclopropane-1-carboxylic-acid (ACC) by the enzyme ACC synthase (ACS). After the production of ACC, ACC-oxidase (ACO) interacts with available oxygen to produce ethylene. Upon completion of ethylene production, the rate of the ripening process increases thus reducing the amount of time that a fruit or vegetable can remain viable in the marketplace. There are at least three different ways that may be used to inhibit ethylene production. Specifically, one may attempt to (1) block the synthesis of SAM into ACC; (2) reduce the amount of ACC that is localized in the system or (3) reduce the amount of oxygen localized in the system. The term system as used herein refers to a fresh food product that is packaged within a polymer packaging article. While reducing the amount of oxygen may effectively reduce ACC conversion by ACO into ethylene, there is a significant drawback associated therewith. Specifically, reducing the amount of oxygen in the system will likely promote anaerobic fermentation resulting in the growth of bacteria and thus similarly reduce the market viability of the fruit or vegetable. Additionally, certain difficulties present themselves when attempting to make a polymer packaging material that could block the synthesis of SAM to ACC. To accomplish this, one is required to include a glycine enzyme such as amioethoxyvinyl glycine or methoxyvinyl glycine. However, those chemicals are unable to resist the high temperatures required to process them into the polymeric article, preventing their use as raw materials.

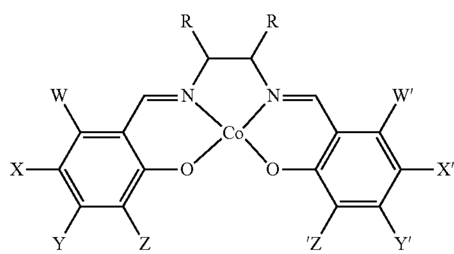
[0024] Therefore, in view of the drawbacks associated with other methods of preventing ethylene production, it is desirable to reduce the amount of active ACC in the system by providing a substance that is able to effectively bind to ACC and prevent the enzymatic activity that produces ethylene from ACC and Oxygen.

[0025] Blocking ethylene production may be accomplished by providing a polymer packaging material including a substance capable of binding ACC thus reducing the amount available for the ethylene biosynthetic pathway. The polymer may be formed as a food packaging film, container or overwrap that is able to reduce the amount of ACC in the system. The polymer may be formed as a monolayer film or as a multi-layer film. The film extends the shelf-life of fresh food products, particularly fruits and vegetables, by controlling the level of ethylene, moisture and oxygen within the system by including a predetermined amount of a transition metal salt.

Specifically, the film may include an amount of a transition metal salt ranging between substantially 0.1% and substantially 10% by weight. The film may also include a fine porous material such as silica, for example. Additionally, the composition may include a surfactant. Thus, because the polymer advantageously reduces the amount of ethylene in the system, the polymer packaging material enhances the taste of the fruits/vegetables by delaying the maturation process.

[0026] The polymer packaging material may include the transition metal salt for directly inhibiting ethylene formation within the system by binding the ACC molecules produced during the ethylene production pathway. The transition metal salt may be any of (but not limited to) a cobalt salt (Co) compound, Manganese (Mg) salt compound, Nickel (Ni) salt compound, Iron (Fe) salt compound or Silver (Ag) salt compound.

[0027] The transition metal salt complexes with ACC thereby preventing the interaction of ACC with Oxygen, a necessary precursor to the formation of ethylene. Thus, the result is a decrease in the amount of ethylene produced. The decreased amount of ethylene reduces the speed at which the fruit or vegetable ripens. An example of a transition metal salt is cobalt stearate ($C_{36}H_{70}CoO_4$) which can release Cobalt ion (Co^{2+}) into the system. The chemical structure of Co^{2+} enables a compound or complex of Cobalt and ACC to be formed. The Cobalt ion can inhibit ACC-dependent ethylene formation by forming a complex with ACC at the amino and carbonyl functional groups as shown below.



[0028] The use of a fine porous material improves the permeability of the polymer to gases such as oxygen, ethylene, carbon dioxide and moisture and also has the effect of absorbing some of the ethylene gas. Thus, the film enables oxygen to permeate the system to maintain the overall health of the food article therein (i.e. prevents anaerobic fermentation) without increasing the amount of ethylene in the system due to the transition metal salt ion which binds the ACC, thus preventing oxygen from being used in the ethylene biosynthetic pathway.

[0029] However, respiration of fruits and/or vegetables may result in some water being formed within the system. This water formation may be harmful to many fruits/vegetables especially in closed packaging. The net chemical equation for the natural respiration is shown below:

$$C_6H_{12}O_6+6O_2\rightarrow 6CO_2+6H_2O$$

Therefore, an antifog additive is needed in the polymer composition. The antifog additive may be a surfactant complex and is included in the composition to prevent the formation of water droplets inside the packaging by means of hydrogen bonding with the water. The surfactant in the polymer composition maintains a suitable moisture level inside the package thus delaying the degradation (rot) of the food while also maintaining package clarity. The inclusion of a surfactant mitigates the formation of water droplets which may subsequently drop on to the food. These water droplets may be harmful to fruits or vegetables wrapped in the packaging material. The surfactant added to the film lowers the surface tension of the water and spreads it on the surface of the packaging. Additionally, the surfactant also has the added benefit of maintaining clarity of the film by preventing the formation of water droplets, or fog on the interior of the package thus enhancing the aesthetic appearance of the package.

[0030] Thus, the polymer composition advantageously reduces or blocks ethylene formation by inhibiting a necessary precursor molecule (ACC) and increases the permeability of the polymer to oxygen and moisture. The polymer also advantageously utilizes the fine porous material to adsorb any ethylene that may be formed and controls the formation of water droplets using the surfactant. The resulting polymer composition provides a packaging material that extends the shelf life of the food article by a multiple of 3 (~15 days as compared to the conventional ~5 days) while preserving the taste of the food article. Thus, the polymer composition reduces the amount of loss due to natural decay and rot while increasing the amount of time available to bring the food article to market. This advantageously increases the time and distance food may be in transit after being harvested without detrimentally affecting the taste and quality of the produce or the health of the population ingesting the produce.

[0031] An exemplary polymer composition for use as a food packaging material that is able to inhibit ethylene production and increase the shelf life of fruits and/or vegetables may be produced as follows:

EXAMPLE 1

[0032]

Element	% by weight
polyolefins (polyethylene or polypropylene)	99.5-91
a transition metal salt	0.05-3
a fine porous inorganic material	0.05-3
a surfactant	0.05-3

[0033] In addition to, or in the alternative, the above polyolefin element may also include polylolefinic copolymers such as EVA, EMA, etc. or other semi-transparent polymers such as EVOH, PLA, PHA, etc. The transition metal salt may include any transition metal, including but not limited to Manganese, Iron, Cobalt, Nickel, Silver or Copper, combined with a fatty acid including but not limited to stearic, oleic, palmitic, myristic, behenic or other fatty acid. The composition may use all derivatives and sources of transition metals because the ethylene inhibitor is the transition metal ion. The fine porous inorganic material may include any of silica, zeolite, cristobalite, Calcium carbonate, Kaolin, Talc and Limestone. The surfactant may be composed of glycerol, glycol, glycerol esters or blends of these or with other polyhydric or straight chain alcohols. The above elements are listed for purposes of example only and any element having substantially similar chemical and structural properties may be used. Furthermore, the composition described in Example 1 may also include other additives, each in amounts ranging between substantially 0.05% and 0.5% by weight. These additives may include slips, antistats, antioxidants, colorants, etc. The slip agent may be added to provide slipperiness to the film so that sheets will not stick to one another. An antistat may be added to repel dust collection. An antioxidant may be added for long term aging protection and colorants may be included for aesthetic purposes.

[0034] The composition described in Example 1 may be formed using a compounding process where all the ingredients are mixed with the polymer melt in an extruder or by adding the various ingredients to the polymer in the form of a masterbatch or concentrate. The masterbatch or concentrate is a predispersion of all the ingredients in the polymer in highly concentrated form which is subsequently let down with resin in the extruder to achieve the proper levels. Moreover, packaging material may be produced as a film by melting and extruding the ingredients via a blown film process (extrusion through an annular die) or cast process (extrusion through a slot die). Furthermore, the article can also be produced as a rigid container via an injection molding or blow molding process.

[0035] To form the composition of Example 1 as a film, the film structure has a thickness ranging between 10 and 200 microns but more preferably ranges between 15 and 60 microns. The film may be composed of a single layer but also may be multilayered including up to 4 layers. In the case of multiple layers, each layer comprises different blends of the additives and the polymer. An exemplary multilayer packaging material may include a first layer for contacting the fruit and/or vegetable that may include the transition metal salt, silica and surfactant and a second layer that includes the polymer with the surfactant. In this exemplary formulation, the first layer inhibits ethylene production and both the first and second layers provide antifog action. Once produced, the films may be formed as a bag, used as an over-wrap or used as a cover on the top of a tray to pack/protect the food.

[0036] To form the composition as a rigid container, the fine porous material such as amorphous silica a, transition metal salt (stearate salt type) and a surfactant blend are melt mixed into a polymer and formed into a packaging article. The transition metal salt will react with carboxylic acid that is evolved from the ripening fruit, thereby preventing the formation of ethylene. The fine porous material and the surfactant blend will add permeability and adsorptive properties to the article, maintaining proper levels of oxygen and moisture, while preventing the formation of water droplets.

[0037] FIG. **2** is a flow diagram detailing the process of producing the polymer food packaging material. A predetermined amount of each of a transition metal salt, fine porous inorganic material and a surfactant is added to a mixture in steps S**200**-S**220**. The mixture including the transition metal salt, fine porous inorganic material and surfactant is combined with a polyolefin mixture in step S**230**. This mixture is then processed according to many known processes for producing a polyolefin article to produce a packaging material. The packaging material may be formed by extrusion, blow molding, or injection molding depending on the type of packaging article desired. The steps at which the elements are added to the mixture are shown for purposes of example only and there is no specific order in which the elements need to be added to form the packaging material.

[0038] A product test on three different packaging articles was performed. This evaluated various characteristics typically associated with those packaging articles. The test included a conventional polymer packaging bag, a first polymer packaging film produced by Ampacet Corporation being internally identified as Lifeplus with AMFOG 63 (hereinafter "Lifeplus 63"), and a second polymer film produced by Ampacet Corporation being internally identified as Lifeplus with AMFOG (hereinafter, "Lifeplus"). The Lifeplus packaging materials correspond to the polyolefin packaging material described in Example 1. The food article tested in this example was Bananas and visual evaluations of these fruits may be seen in FIGS. **3**-**5**.

TABLE 1

Test Results

Item	Normal shopping bag	MTEC	LIFEPLUS with AMFOG 63	LIFEPLUS with new AMFOG
Shelf life	7 days	12 days	15 days	15 days
Antifog level	Poor	Very good	Very good	excellent
Taste	Good	Acceptable	Acceptable	Good

[0039] The test evaluated the shelf life of the food product packaged within the polymer packaging article and the results are shown in number of days that the food article remained viable for sale. The test also evaluated the antifog level of the packaging as well as the taste of the food article within the package. The level of antifog should be maintained at a sufficiently high level in order to prevent the formation of water droplets which can then drop on to the food and cause it to rot. The tasting of the food article was performed on the last day of acceptable shelf life. As shown in Table 1, the shelf life of both Lifeplus 63 and Lifeplus is greater than double at 15 days when compared to the conventional packaging bag which provides a shelf life of 7 days. Additionally, the antifog level of both Lifeplus 63 and Lifeplus are rated as very good and excellent, respectively. This offers a significant improvement over the conventional packaging which merely offers an antifog rating of poor. Moreover, the taste of the bananas packaged in the conventional shopping bag and the Lifeplus packaging were rated as Good whereas the bananas in the Lifeplus 63 and the MTEC bag were rated as acceptable. Thus, the results of the evaluation shows that the Lifeplus packaging provides superior shelf life and antifog level while maintaining the taste of the bananas packaged therein.

[0040] FIGS. **3** and **4** show the difference in appearance of the bananas wrapped in the different packaging materials during the test described above. FIG. **3** shows the bananas on the first day of the test. In each picture, it can be seen that the bananas are at substantially the same level of ripeness prior to being packaged in the respective film. FIG. **4** is a picture of the bananas on Day 12. As can be seen from the pictures, the two frames showing the bananas in the Lifeplus 63 and the Lifeplus film have ripened at a significantly slower rate and still have a greenish hue indicating that they have not ripened fully. This is in direct contrast to the frame identified as MTEC which shows nearly fully ripened bananas that are almost entirely yellowish in hue and some that include brown spots. MTEC is a competitive packaging material that protects oxygen gas and provides gas equilibrium in the packaging. The MTEC film may include Silica which is a gas barrier and includes some antifog to prevent water formation within the packaging. However, MTEC is unable to directly inhibit ethylene formation such as Lifeplus 63 and Lifeplus packaging materials.

[0041] FIG. **5** shows the visual results of a second test. This test shows the effects on ripening of the product wrapped in the Lifeplus film versus the product wrapped in a competitive protective polyolefin film identified as MTEC. The figure shows the state of the bananas at different days during the test. At Day 1, the bananas packaged show substantially the same hue and are at substantially the same ripeness level. At Day 5, the bananas in the MTEC packaging exhibited a yellowish hue as compared to those in the Lifeplus packaging which appear to have a greenish hue indicating that the bananas are still unripe. At Day 10, the bananas in the Lifeplus film retained a greenish hue due to the transition metal salt absorbing the ACC produced in the ethylene biosynthetic process whereas the bananas in the MTEC film are entirely yellow and are fully ripened. Only at Day 12 did the bananas in the Lifeplus film begin to ripen as exhibited by the partial yellowing thereof.

[0042] FIGS. **6-11** show the visual results of a test performed on different food articles. In each of FIGS. **6-11**, the tests performed were similar to those described above with respect to FIGS. **3-5**. However, FIGS. **6-11** also include visual depictions of the food article that has been left out in the atmosphere, along with a blank film packaging, the MTEC packaging and the Lifeplus packaging.

[0043] FIG. **6** shows the visual results of a test involving bananas that were un-packaged and packaged in different packaging materials. The bananas that are not in any packaging material are exposed to the atmosphere and show a significant amount of ripening as seen by the plurality of brown/black spots on the skin of the bananas which are shown within the circles labeled **610**. Bananas were packaged in a blank packaging film having no additives included therein and left for six (6) days. The result is a significant fog within the package that obscures the view of the bananas and enables water droplets to contact the surface of the banana. After 6 days, similar to the bananas exposed to the atmosphere, the bananas in the blank packaging film exhibit significant brown/black ripening spots shown in the circle labeled **620**. The M-Tec packaging, which is described above, is depicted after 10 days. However, the MTEC film also results in ripening of the bananas and a semi-fogged view of the bananas within the packaging material as can be seen in the circles labeled **630**. The bananas in the Lifeplus packaging material are more clearly visible and also show almost no ripening spots on the surface of the bananas. Thus, the lifeplus film provides a less foggy packaging material that inhibits ethylene formation due to the transition metal ion complexing with ACC produced in the ethylene biosynthetic pathway. As such, the bananas maintain a similar hue of green as compared to when they were initially packaged and do not experience much ripening, if any. Thus, the lifeplus film advantageously maintains the fruit in its pre-ripened state allowing the fruit to be transported over longer distances to reach consumers at locations further away from the harvest points.

[0044] FIG. **7** shows the visual results of a test involving mangos that were un-packaged and packaged in the blank film, M-Tec and Lifeplus packaging materials. The results shown herein are depicted at Days 1, 7 and 10. At Day 7, the Mangos that were unpackaged and that were packaged in the blank film show significant ripening exhibited by large dark brown spots (blemishes) on the skin of the mango. Specifically, as seen in circle **710**, the mango left to ripen in the atmosphere has a yellowish hue and includes a plurality of dark brown spots. Additionally, at 7 days, the mango in the blank film also has a large dark brown spot which is shown in circle **715**. This spotting is a direct result of the respiration and ripening of the mango whereby the ethylene produced during respiration ripens the mango and water droplets produced contact the fruit and further exacerbate the ripening process resulting in spoilage of the fruit. At 7 days, the mangos in the M-Tec and Lifeplus show little or no ripening. At Day 10, the Mangos in the blank film are nearly entirely rotten as shown in circle **720**. Those mangos in the M-Tec film on day 10 also exhibit significant ripening and brown spots as shown in circle **730**. However, the mangos in the Lifeplus film show no ripening has occurred. Thus, the Lifeplus film including the ethylene inhibitor and antifog have significantly reduced (or eliminated) the amount of ethylene produced by binding the ACC that is produced as part of the ethylene biosynthetic pathway. Thus, the lifeplus film advantageously maintains the mangos in an un-ripened state for a longer period of time than other known packaging materials.

[0045] FIGS. **8** and **9** show the visual results of a test involving green limes that were unpackaged and packaged in the blank film, M-Tec and Lifeplus packaging materials. The limes in the test were un-packaged and packaged in the blank film, M-Tec and Lifeplus packaging materials. Visual depictions were shown on Days 1, 5, 10 and 16. At day 5, the limes in the blank film and the M-Tec film begin to turn yellow-brown as a result of the ripening process. Additionally, these packages show a reduced clarity due to fog caused by water droplet formation. The Lifeplus packaging has substantially less fog and the limes packaged therein maintain their dark green hue. The results at day 10 are similar in that the limes in the Lifeplus packaging have not ripened whereas the limes in the blank film and the M-Tec film have continued to ripen and are approaching full rot. The results of the test on day 16 are shown in FIG. **9**. The limes that were packaged in the blank film appear significantly rotten with rot spots and mold spots growing on the rinds thereof as can be seen in the circle labeled **910**. Similarly, the limes packaged in the MTEC film also exhibit rot spots and mold growth on the rinds thereof as shown in the circles labeled **920** and **930**. Only the limes packaged in the Lifeplus packaging are viable and not rotten. On day 16, the limes in the Lifeplus packaging are not moldy or rotten because the ethylene inhibitor has complexed with ACC and prevented ethylene gas from forming in the system and accelerating the ripening process. This result is further shown in the bottom most row where the limes were halved after 16 days. The interior fruit of each of the limes that were not packaged or packaged in the Blank or MTEC packaging were rotten whereas the limes in the Lifeplus packaging are viable. Thus, the Lifeplus packaging is a superior packaging material able to prolong the shelf life of the fruit.

[0046] The results of the tests depicted in FIGS. **6-9** may be found below in Table 2.

TABLE 2

		Atmosphere	Normal bag	M-TEC	LIFEPLUS
Banana	Shelf life	5 days	6 days	10 days	15 days
	Antifog level	N/A	Poor	Good	Excellent
	Taste	Good	Good	Acceptable	Good
Mango	Shelf life	5 days	6 days	8 days	10 days
	Antifog level	N/A	Good	Good	Excellent
	Taste	Good	Good	Good	Good

TABLE 2-continued

		Atmos-phere	Normal bag	M-TEC	LIFEPLUS
Green lime	Shelf life	7 days	9 days	16 days*	16 days*
	Antifog level	N/A	Poor	Good	Excellent
	Taste	Good	Acceptable	Good	Good

[0047] FIG. **10** shows the results of a visual test involving eggplants. The eggplants in the test were an un-packaged control and packaged in the blank film, M-Tec and Lifeplus packaging materials. The results shown herein are depicted at day 10. At day 10, the unpackaged eggplant shows significant degradation with wrinkles on the skin and the eggplant is characterized by pronounced softening. The eggplants in the blank film are severely spoiled and include wrinkled skin and mold spots. The wrinkles and mold spots are a direct result of the ethylene produced during respiration and formation of water droplets on the packaging material that are allowed to contact the surface of the eggplant. Similar to the eggplants in the blank film, the eggplants in the M-Tec packaging are also severely spoiled with wrinkles on the skin as shown in the circle labeled **1010** and large mold spots as shown in the circle labeled **1020**. The deficiencies associated with the MTEC packaging are also caused by the amount of ethylene produced during respiration and water build-up that occurs over the ten day period. However the eggplant in the Lifeplus packaging shows no evidence of degradation and thus, the lifeplus packaging provides a superior packaging material for storage and transport of eggplants. Further support for this is shown when a comparison of the inside of the eggplants is made at day ten. A comparison of the inside of eggplants packaged in both the M-Tec packaging and the Lifeplus packaging is shown in frames **1040** and **1050**. At day 10, the interior of the eggplant in the MTEC packaging has turned brown (Frame **1040**) while the interior color of the eggplant packaged in Lifeplus is unchanged and is white/offwhite (Frame **1050**).

[0048] FIG. **11** shows the results of a visual test involving sweet peppers that are of the green variety. The sweet peppers in the test included an un-packaged control and peppers packaged in blank film, M-Tec and Lifeplus packaging materials. The results shown herein are depicted at day 20. Beginning at three days, the unpackaged sweet peppers show significant ripening exhibited by a color change from green to red. At day 20, the skin of the sweet peppers that were unpackaged is wrinkled and dry. The sweet peppers in the blank film and M-Tec show significant ripening with some reddening. As shown in circle **1110**, one of the sweet peppers in the blank film has advanced ripening and the color has changed from green to red. Similarly, the peppers in the MTEC film (circle **1120**) also exhibit advanced ripening and color change from green to red. Only sweet peppers that were packaged in Lifeplus are still green. The degree of ripening of a pepper may also be discerned from the appearance of the seeds of the sweet pepper. The seeds of in ripening sweet pepper will be drier and smaller in size than the seeds in a fresh sweet pepper. Additionally, the seeds in a ripening sweet pepper will exhibit a dark yellowish color as compared to the seeds in a fresh sweet pepper which have a light yellow hue. The sweet peppers that were packaged in the blank film and the MTEC packaging have a dark yellow hue, are dry and are smaller in size than the seeds of the sweet pepper that was packaged in the Lifeplus packaging material. Thus, the Lifeplus packaging material is able to maintain the freshness of the sweet pepper as exhibited by the color remaining green and having seeds that moist and have a light yellow color associated therewith. The Lifeplus packaging material inhibits the formation of ethylene by binding with ACC and depriving the ethylene biosynthetic pathway a necessary element for producing the ethylene. Thus, the Lifeplus packaging material is able to maintain the freshness of the sweet peppers until at least day 20. For the sweet peppers, an antifog agent is not necessary for extending the shelf life since this produce has a low respiration rate (12.8 ml/kg.h at 12.5° C.).

[0049] The results of the tests depicted in FIGS. **10-11** may be found below in Table 3.

TABLE 3

		Atmos-phere	Normal bag	M-TEC	LIFEPLUS
Eggplant	Shelf life	5 days	7 days	8 days	12 days
	Antifog level	N/A	Good	Good	Excellent
	Taste	Dry and tasteless	Onset of spoilage	Onset of spoilage	Good
Sweet pepper	Shelf life	3 days	12 days	15 days	20 days
	Antifog level	N/A	Good	Good	Excellent
	Taste and fragrance	Less fragrance	Tasteless and no fragrance	Tasteless and no fragrance	unchanged

[0050] Therefore, the results of the tests in FIGS. **3-11** indicate that the Lifeplus film inhibits ethylene formation by the fruit and prevents or reduces the rate of ripening. While the tests described herein apply to certain fruits and vegetables, it should be noted that the polymer composition described herein may be used to inhibit ethylene formation and extend the shelf-life for any fruit and/or vegetable that produces ethylene during respiration. This increases the shelf life of the fruit. The shelf life is increased because the packaging material includes a transition metal salt which complexes with ACC to stop the reaction driving ethylene production. Moreover, the packaging also includes a surfactant for binding moisture to prevent the formation of water droplets on the food product. The Lifeplus film effectively controls the atmosphere by using any of a multilayer and monolayer material. The polymer is a highly advantageous packaging material that improves the export and transportation of fruits and vegetables (i.e. banana, mango, limes, oranges etc) by increasing the distance these fruits and vegetables are able to travel increasing the time prior to maturation of the fruits and vegetables. Additionally, the polymer composition may be sold after market to consumers as packaging to keep products fresh that have previously been purchased.

[0051] Additional fruits and vegetables on which the packaging material described herein may be effective include but is not limited to Apples, garlic, grapes, onions, potatoes (mature), sweet potatoes Apricots, cabbages, carrots, figs (fresh), lettuce, nectarines, peaches, pears, peppers, plums, potatoes (immature), tomatoes, artichokes, brussels sprouts, cut flowers, green onions, snap beans, Asparagus, broccoli, mushrooms, peas and sweet corn. Examples of the effect of ethylene production include russet spotting of lettuce (dark brown spotting on the mid-ribs of lettuce leaves); yellowing or loss of green color (for example, in cucumber, broccoli, kale, spinach); increased toughness in turnips and asparagus spears; increase or decrease sprouting in potatoes; softening, pitting, and development of off-flavor in peppers, summer squash, and watermelons; browning and discoloration in eggplant pulp and seed; discoloration and off-flavor in sweet potatoes; increased ripening and softening of mature green tomatoes and development of bitter taste in carrots and parsnips

[0052] To the accomplishment of the above and related objects, this invention may be embodied in the form illustrated in the accompanying drawings, attention being called to the fact, however, that the drawings are illustrative only, and that changes may be made in the specific construction illustrated and described within the scope of the appended claims.

[0053] It will be understood that each of the elements described above, or two or more together may also find a useful application in other types of methods differing from the type described above.

[0054] While certain novel features of this invention have been shown and described and are pointed out in the annexed claims, it is not intended to be limited to the details above, since it will be understood that various omissions, modifications, substitutions and changes in the forms and details of the device illustrated and in its operation can be made by those skilled in the art without departing in any way from the spirit of the present invention.

1. A polyolefin composition comprising a predetermined amount of an ethylene inhibitor for binding 1-aminocyclopropane-1-carboxylic-acid (ACC) to reduce an amount of ACC available for an ethylene biosynthetic pathway.

2. The composition as recited in claim **1**, wherein said ethylene inhibitor is a transition metal salt of a fatty acid.

3. The composition as recited in claim **2**, wherein said transition metal is at least one of Manganese, Cobalt, Iron, Nickel, Silver and Copper.

4. The composition as recited in claim **2**, wherein said fatty acid salt is at least one of stearic, olleic, palmitic, myristic and behenic acid.

5. The composition of claim **1**, further comprising a predetermined amount of a fine porous inorganic material.

6. The composition of claim **5**, wherein said fine porous inorganic material includes at least one of silica, zeolite, cristobalite, Calcium carbonate, Kaolin, Talc and Limestone.

7. The composition of claim **1**, further comprising a predetermined amount of surfactant.

8. The composition of claim **5**, further comprising a predetermined amount of surfactant.

9. The composition of claim **1**, further comprising at least one of a slip agent, an antistat agent, an antioxidants and a colorants.

10. The composition of claim **1**, wherein the predetermined amount of ethylene inhibitor is provided within a range of between substantially 0.05% by weight and 3% by weight.

11. The composition of claim **5**, wherein predetermined amount of fine porous inorganic material is provided within a range of between substantially 0.05% by weight and 3% by weight.

12. The composition of claim **7**, wherein predetermined amount of surfactant is provided within a range of between substantially 0.05% by weight and 3% by weight.

13. The composition of claim **1**, wherein said composition further includes a predetermined amount of polyolefinic polymers.

14. The composition of claim **1**, wherein said composition is formed into a packaging material using at least one of an extrusion process and an injection molding process, the packaging material used for packaging at least one of fruits and vegetables for transporting the at least one packaged fruits and vegetables from one geographical location to a second different geographical location.

15. A packaging material for a food article comprising a predetermined amount of polyolefin and a predetermined amount of an ethylene inhibitor for binding 1-aminocyclopropane-1-carboxylic-acid (ACC) to reduce an amount of ACC available for an ethylene synthesis by the food article.

16. The packaging material as claimed in claim **16**, wherein said ethylene inhibitor is a transition metal salt of a fatty acid and further comprising at least one of a predetermined amount of fine porous inorganic material and a predetermined amount of surfactant.

17. The packaging material as recited in claim **16**, wherein

a. said predetermined amount of polyolefin is provided within a range of between substantially 91% by weight and 99.5% by weight, and

b. said predetermined amount of transition metal salt is provided within a range between substantially 0.05% by weight and 3% by weight.

18. The packaging material as recited in claim **17**, wherein said at least one of predetermined amount of fine porous inorganic material and predetermined amount of surfactant is provided within a range of between substantially 0.05% by weight and 3% by weight.

19. The packaging material as recited in claim **16**, wherein said packaging material is formed by at least one of an extrusion process and an injection molding process.

20. A masterbatch for use in producing a polyolefin packaging material comprising a predetermined amount of an ethylene inhibitor for binding 1-aminocyclopropane-1-carboxylic-acid (ACC) to reduce an amount of ACC available for an ethylene biosynthetic pathway.

21. The masterbatch as recited in claim **21**, wherein said ethylene inhibitor is a transition metal salt of a fatty acid and further comprising a predetermined amount of at least one fine porous inorganic material and a surfactant.

22. The masterbatch as recited in claim **21**, further comprising a predetermined amount of at least one of a slip agent, an antistat agent, an antioxidant and colorants.

23-25. (canceled)

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