

DESCRIPTION

Title of Invention:

**CONTAINER FOR COLD STORAGE OF AGRICULTURAL OR HORTICULTURAL  
CROP**

Technical Field

[0001]

The present invention relates to a container for cold storage of an agricultural or horticultural crop, the container including a sustained-release antimicrobial film, and to an agricultural or horticultural crop-containing package and a method of cold storage of an agricultural or horticultural crop.

Background Art

[0002]

As methods of long-term storage of harvested agricultural and horticultural crops such as common crops, vegetables, fruits, flowering plants, and mushrooms, a method of moderately inhibiting respiration of an agricultural or horticultural crop by enclosing an oxygen absorber or other means, a method of storing an agricultural or horticultural crop at a chilling temperature of 0°C or lower, and other methods are conventionally known (for example, PTL 1), but these methods unfortunately cannot suppress fungi development. In Japan, the use of agricultural chemicals such as fungicides in the

distribution of agricultural and horticultural crops is not approved, and their use is severely restricted also in foreign countries such as Europe. Accordingly, a technique of sterilizing a harvested agricultural or horticultural crop in advance with a hypochlorous acid-based disinfectant is known as a method of preventing fungi on an agricultural or horticultural crop, but hypochlorous acid-based disinfectants have problems in that they must be handled with extreme care and do not produce long-term effects.

[0003]

As methods for imparting antimicrobial properties to a resin film or the like used to package an agricultural or horticultural crop, a method of coating the surface of the film with a volatile antimicrobial agent (for example, PTL 2) and a method of kneading an inorganic antimicrobial agent or an organic antimicrobial agent into a resin (for example, PTLs 3 and 4) are known. In the former coating method, it is difficult to control the amount of antimicrobial agent evaporating from the antimicrobial film, and an increase in the concentration of evaporated antimicrobial agent may cause quality degradation such as odor transfer to a packed agricultural or horticultural crop or discoloration. The latter kneading method has problems in that antimicrobial activity is expressed only at portions in contact with the antimicrobial agent exposed on the surface of the

antimicrobial film, and thus the antimicrobial activity can hardly be expressed throughout the entire packed agricultural or horticultural crop, and that the antimicrobial agent present inside the resin cannot exhibit the antimicrobial activity, and thus a large amount of antimicrobial agent is necessary to provide the desired antimicrobial activity.

#### Citation List

##### Patent Literature

[0004]

PTL 1: Japanese Unexamined Patent Application  
Publication No. 06-046749

PTL 2: Japanese Unexamined Patent Application  
Publication No. 2006-199852

PTL 3: Japanese Unexamined Patent Application  
Publication No. 2016-030406

PTL 4: Japanese Unexamined Patent Application  
Publication No. 2015-189138

##### Summary of Invention

##### Technical Problem

[0005]

An object of the present invention is to provide a novel container suitable for distribution and storage that reliably suppresses a significant decrease in commercial value of an agricultural or horticultural crop due to fungi

and that does not cause quality degradation such as odor transfer or discoloration due to an antimicrobial active ingredient, a novel package, and a novel storage method.

Solution to Problem

[0006]

As a result of intensive studies to solve the above problems, the present inventors have found that when the volume of a container for storage, the area of a sustained-release antimicrobial film, and the ratio between them are in specific ranges, a significant decrease in commercial value of an agricultural or horticultural crop due to fungi can be reliably suppressed without decreasing the quality of the agricultural or horticultural crop, thereby solving the above problems.

[0007]

Specifically, the gist of the present invention is as follows.

1. A container for cold storage of an agricultural or horticultural crop, including a sustained-release antimicrobial film that includes a substrate film layer, a volatile antimicrobial active ingredient layer containing at least one selected from the group of volatile antimicrobial active compounds having boiling points in the range of 100°C to 240°C, and a volatile antimicrobial active ingredient-permeable layer formed of a vapor-deposited polymer film

that are stacked in this order, the container satisfying requirements 1 to 3 below.

[Requirement 1]; The container for storage has a volume of 25 cm<sup>3</sup> or more and 250,000 cm<sup>3</sup> or less.

[Requirement 2]; The sustained-release antimicrobial film has an area of 1 cm<sup>2</sup> or more and 5,000 cm<sup>2</sup> or less.

[Requirement 3]; The ratio of the area (cm<sup>2</sup>) of the sustained-release antimicrobial film to the volume (cm<sup>3</sup>) of the container for storage is 0.02 or more.

2. An agricultural or horticultural crop-containing package including the container for cold storage according to 1. in which an agricultural or horticultural crop is housed.

3. A method for storing an agricultural or horticultural crop, including housing an agricultural or horticultural crop using the container for storage according to 1. and performing storage at -3°C or higher and 15°C or lower.

Advantageous Effects of Invention

[0008]

The sustained-release antimicrobial film included in the container of the present invention includes a volatile antimicrobial active ingredient-permeable layer formed of a vapor-deposited polymer film and thus can stably release a specific volatile antimicrobial active compound contained in a volatile antimicrobial active ingredient layer, and since the volume of the container for storage (requirement 1) and

the area of the sustained-release antimicrobial film (requirement 2) are in specific ranges and, furthermore, the ratio of the area to the volume is greater than or equal to a specific value (requirement 3), the amount of volatilized antimicrobial active ingredient in the container for storage can be controlled to an appropriate level. According to the present invention, due to these synergistic effects, a significant decrease in commercial value of an agricultural or horticultural crop due to fungi can be reliably suppressed without degrading the quality of the agricultural or horticultural crop.

Since the volatile antimicrobial active compound having a boiling point in a specific range for use in the present invention is also a botanical fragrance ingredient used as a food additive, the present invention is useful in that agricultural and horticultural crops can be safely stored.

#### Brief Description of Drawing

[0009]

[Fig. 1] Fig. 1 is a photograph illustrating configurations 1 to 4 of a container used to perform a storage test in Test 1 for cold storage of an agricultural or horticultural crop in Examples.

#### Description of Embodiments

[0010]

Hereinafter, a container for cold storage of an

agricultural or horticultural crop according to the present invention and a method for storing an agricultural or horticultural crop using the container will be described in detail. "Cold" in the present invention means a temperature range from -3°C to 15°C.

<Agricultural or horticultural crop>

The container for cold storage of an agricultural or horticultural crop according to the present invention is a container for storing an agricultural or horticultural crop. Here, the agricultural or horticultural crop in the present invention means all kinds of cultivated crops such as common crops, vegetables, fruits, flowering plants, and mushrooms. Examples of the agricultural or horticultural crop include, but are not limited to, common crops such as rice, wheat, corn, potatoes, and beans; vegetables such as root vegetables including radish, carrot, and burdock, stem vegetables including onion, asparagus, and Udo salad plant, leaf vegetables including cabbage, lettuce, spinach, and Chinese cabbage, fruit vegetables including tomato, eggplant, and pumpkin, and flower vegetables including cauliflower, broccoli, and edible chrysanthemum; fruits such as citrus, apple, pear, grape, blueberry, strawberry, cherry, and peach; flowering plants such as cut flowers; and mushrooms such as Clam shell mushrooms, Matsutake, and Hen of the Woods.

Among them, from the viewpoint of being suitable for cold storage and effectively obtaining a fungi development inhibitory effect, the agricultural or horticultural crop in the present invention is preferably a fruit, more preferably grape, cherry, peach, or strawberry. For grape, cherry, peach, and strawberry, the more suitable storage temperature is in a temperature range from 0°C to 5°C.

[0011]

<Volatile antimicrobial active ingredient>

In the present invention, at least one selected from the group of volatile antimicrobial active compounds having boiling points in the range of 100°C to 240°C is used as a volatile antimicrobial active ingredient.

The compounds included in the group of volatile antimicrobial active compounds in the present invention are preferably compounds having 5 to 10 constituent carbon atoms, and specific examples of suitable compounds include hinokitiol (boiling point: 140°C), citronellal (boiling point: 204°C to 206°C), leaf aldehyde (trans-2-hexenal, boiling point: 146°C), citronellol (boiling point: 225°C), geraniol (boiling point: 229°C), and nerol (boiling point: 224°C to 225°C/745 mmHg). Among them, volatile antimicrobial active compounds having boiling points in the range of 100°C to 200°C are preferred, and hinokitiol and leaf aldehyde are particularly preferred.

[0012]

For the formation of a volatile antimicrobial active ingredient layer in the present invention, a technique can be appropriately selected according to, for example, the form and characteristics of a volatile antimicrobial active ingredient used. For example, in the case of a volatile antimicrobial active ingredient that is liquid at room temperature, it can be applied neat onto one surface of a substrate film layer to form a volatile antimicrobial active ingredient layer. In either case of a volatile antimicrobial active ingredient that is solid at room temperature or a volatile antimicrobial active ingredient that is liquid at room temperature, a volatile antimicrobial active ingredient layer composed substantially only of the volatile antimicrobial active ingredient can be formed by preparing a solution using a predetermined solvent such as ethanol, applying the solution onto one surface of a substrate film layer, and evaporating the solvent. Alternatively, a vapor deposition process can also be selected in which a volatile antimicrobial active ingredient is evaporated or sublimed by heating to deposit on one surface of a substrate film layer, thereby forming a volatile antimicrobial active ingredient layer composed only of the volatile antimicrobial active ingredient.

The thickness of the volatile antimicrobial active

ingredient layer in the present invention may be appropriately determined according to the type of volatile antimicrobial active ingredient selected and the desired duration of antimicrobial activity, and is typically 1  $\mu\text{m}$  or more and 5 mm or less.

[0013]

<Volatile antimicrobial active ingredient-permeable layer>

A volatile antimicrobial active ingredient-permeable layer in the present invention is formed of a vapor-deposited polymer film. Here, the vapor-deposited polymer film means a thin film obtained by a vapor deposition polymerization method.

In general, the vapor-deposited polymer film is formed by introducing two or more starting monomers vaporized by heating into a vacuum deposition chamber, depositing the starting monomers on a surface of a deposition target placed in the deposition chamber, and allowing polymerization between the starting monomers to proceed on the surface. That is, since the volatile antimicrobial active ingredient-permeable layer is formed as the film formation proceeds in conformity with microscopic irregularities on the surface of the volatile antimicrobial active ingredient layer in the present invention, high adhesion is achieved between the volatile antimicrobial active ingredient layer and the volatile antimicrobial active ingredient-permeable layer.

In addition, the vapor-deposited polymer film can also be formed so as to be very thin, and the resulting vapor-deposited polymer film has an advantage of containing very few impurities. Therefore, in a sustained-release antimicrobial film in the present invention, the occurrence of delamination due to hydrolysis, heat shock, or other factors is advantageously suppressed between the volatile antimicrobial active ingredient layer and the volatile antimicrobial active ingredient-permeable layer, so that the volatile antimicrobial active ingredient can be stably released and volatilized in an amount required for the purpose.

[0014]

As a synthetic resin constituting the volatile antimicrobial active ingredient-permeable layer in the present invention, a synthetic resin suitable for the volatile antimicrobial active ingredient can be appropriately selected from among synthetic resins capable of being formed into films according to conventionally known vapor deposition polymerization methods. Specific examples of the synthetic resin film constituting the volatile antimicrobial active ingredient-permeable layer include various synthetic resin films that can be produced according to known vapor deposition polymerization methods, such as polyurea resin films, polyamide resin films, polyimide resin

films, polyamide-imide resin films, polyester resin films, polyazomethine resin films, and polyurethane resin films. In particular, polyurea resin films can be advantageously employed because they have crosslinked structures through which the volatile antimicrobial active ingredient can effectively permeate.

The thickness of the volatile antimicrobial active ingredient-permeable layer can be appropriately determined by comprehensively considering, for example, the amount of volatile antimicrobial active ingredient released to the outside of the film per unit time and the type and amount of volatile antimicrobial active ingredient contained in the volatile antimicrobial active ingredient layer.

Specifically, the thickness of the volatile antimicrobial active ingredient-permeable layer is preferably 0.01  $\mu\text{m}$  or more and 50  $\mu\text{m}$  or less, more preferably 0.1  $\mu\text{m}$  or more and 10  $\mu\text{m}$  or less.

[0015]

<Sustained-release antimicrobial film>

A sustained-release antimicrobial film in the present invention preferably has a configuration in which a volatile antimicrobial active ingredient layer is formed on one surface of a substrate film layer and a volatile antimicrobial active ingredient-permeable layer formed of a vapor-deposited polymer film is further formed on the

surface of the volatile antimicrobial active ingredient layer, and the sizes of the substrate film layer, the volatile antimicrobial active ingredient layer, and the volatile antimicrobial active ingredient-permeable layer are preferably substantially the same.

The sustained-release antimicrobial film in the present invention is preferably disposed on an upper part of the container for cold storage of an agricultural or horticultural crop, and more preferably disposed so as to cover the surface of an agricultural or horticultural crop in the container or to be attached to the ceiling of the container. In this case, the volatile antimicrobial active ingredient-permeable layer of the sustained-release antimicrobial film is preferably disposed so as to face the agricultural or horticultural crop in the container.

The container for cold storage of an agricultural or horticultural crop of the present invention includes a sustained-release antimicrobial film of 1 cm<sup>2</sup> or more and 5,000 cm<sup>2</sup> or less as "requirement 2". The area of the sustained-release antimicrobial film is preferably 5 cm<sup>2</sup> or more and 1,000 cm<sup>2</sup> or less, more preferably 10 cm<sup>2</sup> or more and 500 cm<sup>2</sup> or less.

One or two or more multiple sustained-release antimicrobial films may be used in the container for cold storage of an agricultural or horticultural crop of the

present invention. When multiple sustained-release antimicrobial films are used, the area of the sustained-release antimicrobial film in the present invention means the sum of the areas of all the sustained-release antimicrobial films used.

[0016]

<Container for cold storage of agricultural or horticultural crop>

The container for cold storage of an agricultural or horticultural crop of the present invention may be made of any material such as resin or paper and may have any shape such as a bag shape or a box shape, and, in particular, the container preferably has a box shape. The container is preferably sealable to some extent so that the amount of volatile antimicrobial active ingredient volatilized from the sustained-release antimicrobial film in the present invention can be maintained.

The container for cold storage of an agricultural or horticultural crop of the present invention may be a container formed of the sustained-release antimicrobial film in the present invention, but it is simpler and more advantageous in terms of cost to house an agricultural or horticultural crop in a container for storage that is made of a material different from the sustained-release antimicrobial film in the present invention and that may

have a bag shape and dispose the sustained-release antimicrobial film in the present invention above the housed agricultural or horticultural crop.

The container for cold storage of an agricultural or horticultural crop of the present invention has a volume of 25 cm<sup>3</sup> or more and 250,000 cm<sup>3</sup> or less as "requirement 1". The volume of the container for storage is preferably 500 cm<sup>3</sup> or more and 100,000 cm<sup>3</sup> or less, more preferably 1000 cm<sup>3</sup> or more and 50,000 cm<sup>3</sup> or less.

[0017]

<Amount of volatile antimicrobial active ingredient>

In the container for cold storage of an agricultural or horticultural crop of the present invention, the amount of volatile antimicrobial active ingredient in the container for storage can be controlled to an appropriate level. Thus, odor transfer or discoloration due to the volatile antimicrobial active ingredient will not occur to decrease the quality of an agricultural or horticultural crop, and a significant decrease in commercial value of the agricultural or horticultural crop due to fungi can be reliably suppressed.

In general, when a sustained-release antimicrobial film is placed in an airtight container, the amount of antimicrobial ingredient in the container increases with time. If the amount of antimicrobial ingredient in the

container is small, sufficient antimicrobial activity cannot be provided, and an agricultural or horticultural crop will be rotten, whereas if the amount of antimicrobial ingredient in the container is excessively large, odor transfer or discoloration due to the volatile antimicrobial active ingredient will occur to decrease the commercial value of the agricultural or horticultural crop. That is, to reliably suppress a significant decrease in commercial value of the agricultural or horticultural crop due to fungi and also suppress quality degradation such as odor transfer and discoloration due to the volatile antimicrobial active ingredient, it is necessary to control the amount of antimicrobial ingredient in the container for storage within an appropriate range.

In the present invention, the amount of antimicrobial ingredient in the container for storage can be controlled within an appropriate range, and ranges of the area of the sustained-release antimicrobial film and the volume of the container for storage required for the control and the relationship between the sustained-release antimicrobial film and the container for storage are specified for the first time.

[0018]

The volatile antimicrobial active ingredient in the present invention is at least one selected from the group of

volatile antimicrobial active compounds having boiling points in the range of 100°C to 240°C, which is also one of the requirements for making it possible to control the amount of antimicrobial ingredient in the container for storage to an appropriate level.

As described above, by controlling the amount of volatile antimicrobial active ingredient in the container for cold storage of an agricultural or horticultural crop of the present invention to an appropriate level, the container for cold storage of an agricultural or horticultural crop can be suitable for distribution and storage so as to reliably suppress a significant decrease in commercial value of an agricultural or horticultural crop due to fungi and not to cause quality degradation such as odor transfer or discoloration due to an antimicrobial active ingredient.

[0019]

To control the amount of volatile antimicrobial active ingredient in the container for cold storage of an agricultural or horticultural crop of the present invention to an appropriate level, it is necessary to satisfy the following requirements 1 to 3.

[Requirement 1]; The container for storage has a volume of 25 cm<sup>3</sup> or more and 250,000 cm<sup>3</sup> or less.

[Requirement 2]; The sustained-release antimicrobial film has an area of 1 cm<sup>2</sup> or more and 5,000 cm<sup>2</sup> or less.

[Requirement 3]; The ratio of the area ( $\text{cm}^2$ ) of the sustained-release antimicrobial film to the volume ( $\text{cm}^3$ ) of the container for storage is 0.02 or more.

"Requirement 3" above will be described.

"Requirement 3" states that the ratio of the area ( $\text{cm}^2$ ) of the sustained-release antimicrobial film to the volume ( $\text{cm}^3$ ) of the container for storage, that is, the value obtained by dividing the area ( $\text{cm}^2$ ) of the sustained-release antimicrobial film by the volume ( $\text{cm}^3$ ) of the container for storage, is 0.02 or more.

To control the amount of volatile antimicrobial active ingredient in the container for cold storage of an agricultural or horticultural crop of the present invention to an appropriate level, it is particularly important to satisfy "requirement 3". When the ratio of "requirement 3" is smaller than 0.02, the amount of volatile antimicrobial active ingredient in the container for cold storage of an agricultural or horticultural crop is insufficient, and an antifungal effect on an agricultural or horticultural crop in the container for storage cannot be produced. When the ratio of "requirement 3" is 0.02 or more, the container for cold storage of an agricultural or horticultural crop can be suitable for distribution and storage so as to reliably suppress a significant decrease in commercial value of an agricultural or horticultural crop due to fungi and not to

cause quality degradation such as odor transfer or discoloration due to an antimicrobial active ingredient.

#### EXAMPLES

[0020]

Hereinafter, the present invention will be described with reference to Examples, but the technical scope of the present invention is not limited by these Examples.

[0021]

<Preparation of sustained-release antimicrobial film>

Using a roll-to-roll vapor deposition polymerization film-forming apparatus, hinokitiol, a volatile antimicrobial active compound, was deposited on a polyethylene terephthalate (PET) film (thickness: 12  $\mu\text{m}$ ) to form a volatile antimicrobial active ingredient layer with an active ingredient amount of 1.3 mg/cm<sup>2</sup>. Next, a vapor-deposited polymer film of polyurea resin was formed using the same vapor deposition polymerization film-forming apparatus. The vapor-deposited polymer film of polyurea resin was formed so as to have a thickness of 4  $\mu\text{m}$ .

[0022]

<Test 1 for cold storage of agricultural or horticultural crop>

As a container for storage, an airtight container 1 (volume: 1,100 cm<sup>3</sup>, bottom size: 150 mm  $\times$  134 mm (external dimension), height: 77 mm (external dimension)) with a sieve

insert was used. As shown in Fig. 1, a paper towel soaked with distilled water (20 mL) was spread on the bottom of the container for storage so as to keep humidity (1 in Fig. 1), a packing sponge was placed in the sieve insert (2 in Fig. 1), and a sustained-release antimicrobial film 1 (area: 78 cm<sup>2</sup>) prepared was attached to the inner side of the lid of the container for storage with double-sided tape (3 in Fig. 1). "Requirement 3" in the present invention of the container for storage is about 0.071.

As an agricultural or horticultural crop to be stored, grapes of Shine Muscat were used. As shown in Fig. 1, 12 grapes were put in the sieve insert in which the packing sponge was placed (4 in Fig. 1), sprayed with sterile water, and then air-dried. This sieve insert was set in 1 in Fig. 1 and covered by the lid (3 in Fig. 1). The container thus provided was subjected to a storage test as Example 1.

A container for storage different only in that the sustained-release antimicrobial film was not used was subjected to the same storage test as Comparative Example 1.

Observation was performed at 1-week intervals from the start of storage to check rotten grapes occurred in each test section, and the number thereof was counted. The rotten grapes were removed at the time of observation.

The storage test was performed three times for each Example, and the average value of accumulated rotten grape

ratios (%) was calculated. Table 1 shows the results of the tests at a storage temperature of 5°C.

[0023]

[Table 1]

|                       | "Requirement" |      |        | Accumulated rotten grape ratio (%)         |     |     |      |      |      |      |      |      |      |      |      |      |
|-----------------------|---------------|------|--------|--------------------------------------------|-----|-----|------|------|------|------|------|------|------|------|------|------|
|                       |               |      |        | Number of days elapsed after storage (day) |     |     |      |      |      |      |      |      |      |      |      |      |
|                       | 1             | 2    | 3      | 7                                          | 14  | 21  | 28   | 35   | 44   | 49   | 56   | 63   | 70   | 77   | 84   | 91   |
| Example 1             |               | 78   | ~0.071 | 0.0                                        | 0.0 | 0.0 | 0.0  | 0.0  | 0.0  | 0.0  | 0.0  | 0.0  | 0.0  | 2.8  | 5.6  | 11.1 |
| Comparative Example 1 | 1,100         | none |        | 0.0                                        | 0.0 | 8.3 | 30.6 | 44.4 | 50.0 | 50.0 | 55.6 | 58.3 | 58.3 | 61.1 | 61.1 | 69.4 |

[0024]

As shown in Table 1, in the container for cold storage of an agricultural or horticultural crop of the present invention (Example 1), there were no rotten grapes even after 70 days (2.5 months) from the start of storage, and the average of accumulated rotten grape ratios after 91 days (3 months or more) from the start of storage was 11.1%. In addition, in the grapes after 91 days from the start of storage, no quality degradation such as odor transfer or discoloration due to the volatile antimicrobial active ingredient was observed. By contrast, when a container for storage different from that of the present invention was used (Comparative Example 1), the average of accumulated rotten grape ratios was 8.3% after 21 days (3 weeks) from the start of storage and reached 69.4% after 91 days (3 months or more).

That is, it has been revealed that using the container for cold storage of an agricultural or horticultural crop of the present invention can effectively suppress mold rot of an agricultural or horticultural crop such as Shine Muscat, which is expensive and of high commercial value.

Although detailed test data are omitted, when storage was performed at 20°C falling outside the definition of cold in the present invention by using the container for cold storage of an agricultural or horticultural crop of the present invention, brown spots appeared on the surface of grapes by day 21 (week 3), and then rot of all the grapes was observed by day 49 (week 7). These results suggest that even if the container for cold storage of an agricultural or horticultural crop of the present invention is used, quality degradation such as discoloration due to an antimicrobial active ingredient occurs and then rot is promoted under conditions other than cold storage.

[0025]

<Test 2 for cold storage of agricultural or horticultural crop>

In the same manner as in "Test 1 for cold storage of agricultural or horticultural crop" above, 12 grapes and the sustained-release antimicrobial film 1 (area: 78 cm<sup>2</sup>) were set in the same airtight container 1 (volume: 1,100 cm<sup>3</sup>, bottom size: 150 mm × 134 mm (external dimension), height:

77 mm (external dimension)) with a sieve insert as used in "Test 1 for cold storage of agricultural or horticultural crop" above, and 25 grapes and a sustained-release antimicrobial film 2 (area: 312 cm<sup>2</sup>) were set in a similar container 2 (volume: 5,000 cm<sup>3</sup>, bottom size: 213 mm × 263 mm (external dimension), height: 130 mm (external dimension)).

Using Shine Muscat grapes subjected to spray-inoculation with a *Botrytis cinerea* conidia suspension (10<sup>6</sup> conidia/mL) followed by air-drying as an agricultural or horticultural crop to be stored, a storage test at a storage temperature of 5°C was performed. The container 1 (Example 2 and Comparative Example 2) was kept humid using distilled water (20 mL), and the container 2 (Example 3 and Comparative Example 3) was kept humid using distilled water (100 mL).

Observation was performed at 1-week intervals from the start of storage to check rotten grapes occurred in each test section, and the number thereof was counted. The rotten grapes were removed at the time of observation.

The storage test was performed five times in Example 2 and Comparative Example 2 and four times in Example 3 and Comparative Example 3, and the average value of accumulated rotten grape ratios (%) was calculated.

Table 2 shows the test results.

[0026]

[Table 2]

|                       | "Requirement" |      |        | Accumulated rotten grape ratio (%)         |     |      |       |
|-----------------------|---------------|------|--------|--------------------------------------------|-----|------|-------|
|                       |               |      |        | Number of days elapsed after storage (day) |     |      |       |
|                       | 1             | 2    | 3      | 7                                          | 14  | 21   | 28    |
| Example 2             | 1,100         | 78   | ~0.071 | 0.0                                        | 0.0 | 6.7  | 21.7  |
| Comparative Example 2 |               | none |        | 0.0                                        | 3.3 | 65.0 | 100.0 |
| Example 3             | 5,000         | 312  | ~0.062 | 0.0                                        | 0.0 | 1.0  | 6.0   |
| Comparative Example 3 |               | none |        | 0.0                                        | 1.0 | 17.0 | 98.0  |

[0027]

"Test 2 for cold storage of agricultural or horticultural crop" is a storage test simulating a very harsh environment in which *Botrytis cinerea* is compulsorily inoculated.

As shown in Table 2, in the container for storage of Comparative Example 2 different from the present invention, all of the test grapes were rotten on day 28 after the start of storage, and in the container for storage of Comparative Example 3 also different from the present invention, 98% of the test grapes were rotten on day 28 after the start of storage.

Even in the storage test under such very harsh conditions, in the containers for cold storage of an agricultural or horticultural crop of the present invention (Examples 2 and 3), mold rot of the agricultural or horticultural crop occurred in only about one-fifth or less

of the test grapes, and particularly in Example 3, rot occurred in only 6% of the test grapes, revealing that the containers of the present invention have very high anti-rot effects. It has also been revealed that this high anti-rot effect is exhibited regardless of the difference in the volume of the container for storage of "requirement 1".

For the grapes of Examples 2 and 3 after 28 days from the start of storage, no quality degradation such as odor transfer or discoloration due to the antimicrobial active ingredient was observed.

[0028]

<Test 3 for cold storage of agricultural or horticultural crop>

In the same manner as in "Test 1 for cold storage of agricultural or horticultural crop" above, 12 grapes and the sustained-release antimicrobial film 1 (area: 78 cm<sup>2</sup>), a sustained-release antimicrobial film 3 (area: 39 cm<sup>2</sup>), or a sustained-release antimicrobial film 4 (area: 19 cm<sup>2</sup>) were set in the same airtight container 1 (volume: 1,100 cm<sup>3</sup>, bottom size: 150 mm × 134 mm (external dimension), height: 77 mm (external dimension)) with a sieve insert as used in "Test 1 for cold storage of agricultural or horticultural crop" above, and the container was kept humid using distilled water (20 mL).

Using Shine Muscat grapes subjected to spray-

inoculation with a *Botrytis cinerea* conidia suspension ( $10^6$  conidia/mL) followed by air-drying as an agricultural or horticultural crop to be stored, a storage test at a temperature of 5°C was performed.

Observation was performed at 1-week intervals from the start of storage to check rotten grapes occurred in each test section, and the number thereof was counted. The rotten grapes were removed at the time of observation.

The storage test was performed four times for each Example, and the average value of accumulated rotten grape ratios (%) was calculated.

Table 3 shows the test results.

[0029]

[Table 3]

|                       | "Requirement" |      |        | Accumulated rotten grape ratio (%)         |     |      |      |      |      |      |      |      |      |
|-----------------------|---------------|------|--------|--------------------------------------------|-----|------|------|------|------|------|------|------|------|
|                       |               |      |        | Number of days elapsed after storage (day) |     |      |      |      |      |      |      |      |      |
|                       | 1             | 2    | 3      | 7                                          | 14  | 21   | 28   | 35   | 42   | 51   | 56   | 63   | 70   |
| Example 4             | 1,100         | 78   | ~0.071 | 0.0                                        | 2.1 | 6.3  | 6.3  | 10.4 | 16.7 | 18.8 | 25.0 | 25.0 | 29.2 |
| Example 5             |               | 39   | ~0.035 | 0.0                                        | 0.0 | 0.0  | 10.4 | 16.7 | 18.8 | 20.8 | 20.8 | 25.0 | 27.1 |
| Comparative Example 4 |               | 19   | ~0.017 | 0.0                                        | 0.0 | 0.0  | 25.0 | 39.6 | 41.7 | 45.8 | 47.9 | 56.3 | 60.4 |
| Comparative Example 5 |               | none |        | 0.0                                        | 0.0 | 93.8 | 97.9 | 97.9 | 97.9 | 97.9 | 97.9 | 97.9 | 97.9 |

[0030]

"Test 3 for cold storage of agricultural or horticultural crop" is a storage test simulating a very harsh environment in which *Botrytis cinerea* is compulsorily

inoculated.

As shown in Table 3, in the container for storage of Comparative Example 5 different from the present invention, 97.9% of the tested grapes were rotten on day 28 after the start of storage.

Even in the storage test under such very harsh conditions, in the containers for cold storage of an agricultural or horticultural crop of the present invention (Examples 4 and 5), mold rot of the agricultural or horticultural crop occurred in only about 30% or less of the tested grapes even after 70 days (2.5 months) from the start of storage, revealing that the containers of the present invention have very high anti-rot effects.

Comparative Example 4 is different from the container for storage of the present invention because "requirement 3" in the present invention, that is, the ratio of the area ( $\text{cm}^2$ ) of the sustained-release antimicrobial film to the volume ( $\text{cm}^3$ ) of the container for storage, is about 0.017. Therefore, in the storage in Comparative Example 4, the progress of mold rot of the agricultural or horticultural crop after day 28 after the start of storage was confirmed to proceed about 2.5 to 4 times faster than in Examples.

[0031]

<Test 4 for cold storage of agricultural or horticultural crop>

In an airtight container 3 (volume: 0.0030 m<sup>3</sup>, bottom size: 239 mm × 176 mm (external dimension), height: 91 mm (external dimension)) with a sieve insert, 41 grapes were placed, and using a sustained-release antimicrobial film 5 (area: 233 cm<sup>2</sup>) or the sustained-release antimicrobial film 1 (area: 78 cm<sup>2</sup>), a storage test at a storage temperature shown in Table 4 was performed on the grapes subjected to spray-inoculation with sterile water (non-inoculation) followed by air-drying in the same manner as in "Test 1 for cold storage of agricultural or horticultural crop" above. The container 3 was kept humid using distilled water (60 mL).

Observation was performed at 1-week intervals from the start of storage to check rotten grapes occurred in each test section, and the number thereof was counted. The rotten grapes were removed at the time of observation.

The storage test was performed three times for each Example, and the average value of accumulated rotten grape ratios (%) was calculated.

Table 4 shows the test results. In Comparative Examples 8 and 9, since the results on day 21 after the start of storage were greatly different from those in Examples 6 and 7, it was determined that no further follow-up was necessary, and the test was terminated. In Table 4, "-" indicates that the test observation was not performed.

[0032]

[Table 4]

|                       | Storage temperature (°C) | "Requirement" |      |        | Accumulated rotten grape ratio (%)         |      |      |     |
|-----------------------|--------------------------|---------------|------|--------|--------------------------------------------|------|------|-----|
|                       |                          |               |      |        | Number of days elapsed after storage (day) |      |      |     |
|                       |                          | 1             | 2    | 3      | 7                                          | 14   | 21   | 28  |
| Example 6             | 5                        | 3,000         | 233  | ~0.078 | 0.0                                        | 0.0  | 0.7  | 0.7 |
| Comparative Example 6 |                          |               | none |        | 0.0                                        | 0.0  | 4.8  | 9.0 |
| Example 7             | 5                        | 3,000         | 78   | ~0.026 | 0.0                                        | 0.0  | 0.0  | 0.0 |
| Comparative Example 7 |                          |               | none |        | 0.0                                        | 0.0  | 4.8  | 9.0 |
| Comparative Example 8 | 23                       | 3,000         | 233  | ~0.078 | 15.3                                       | 36.5 | 46.3 | -   |
| Comparative Example 9 |                          |               | none |        | 5.6                                        | 20.2 | 28.5 | -   |

[0033]

As shown in Table 4, it has been revealed that the containers for cold storage of an agricultural or horticultural crop of the present invention (Examples 6 and 7), as compared to the containers for storage (Comparative Examples 6 and 7) different from those of the present invention, very effectively suppress mold rot of an agricultural or horticultural crop in *Botrytis cinerea* inoculation-free storage simulating the standard state of storage. For the grapes of Examples 6 and 7 after 28 days from the start of storage, no quality degradation such as odor transfer or discoloration due to the antimicrobial active ingredient was observed.

It has also been revealed that when storage is performed at 23°C falling outside the definition of cold in the present invention (Comparative Examples 8 and 9), mold rot cannot be suppressed even if a sustained-release antimicrobial film is used (Comparative Example 8). Furthermore, in Comparative Example 8, discoloration was observed about 10 days after the start of storage. These results suggest that even if the container for cold storage of an agricultural or horticultural crop of the present invention is used, quality degradation such as discoloration due to an antimicrobial active ingredient occurs and then rot is promoted under conditions other than cold storage.

#### Industrial Applicability

[0034]

The sustained-release antimicrobial film included in the container of the present invention includes a volatile antimicrobial active ingredient-permeable layer formed of a vapor-deposited polymer film and thus can stably release a specific volatile antimicrobial active compound contained in a volatile antimicrobial active ingredient layer, and since the volume of the container for storage (requirement 1) and the area of the sustained-release antimicrobial film (requirement 2) are in specific ranges and, furthermore, the ratio of the area to the volume is greater than or equal to a specific value (requirement 3), the amount of volatilized

antimicrobial active ingredient in the container for storage can be controlled to an appropriate level. Due to these synergistic effects, a significant decrease in commercial value of an agricultural or horticultural crop due to fungi can be reliably suppressed without degrading the quality of the agricultural or horticultural crop, which is very useful.

CLAIMS

[Claim 1]

A container for cold storage of an agricultural or horticultural crop, comprising a sustained-release antimicrobial film that includes

a substrate film layer,

a volatile antimicrobial active ingredient layer containing at least one selected from the group of volatile antimicrobial active compounds having boiling points in a range of 100°C to 240°C, and

a volatile antimicrobial active ingredient-permeable layer formed of a vapor-deposited polymer film that are stacked in this order,

the container satisfying requirements 1 to 3 below:

[Requirement 1]; the container for storage has a volume of 25 cm<sup>3</sup> or more and 250,000 cm<sup>3</sup> or less,

[Requirement 2]; the sustained-release antimicrobial film has an area of 1 cm<sup>2</sup> or more and 5,000 cm<sup>2</sup> or less, and

[Requirement 3]; a ratio of the area (cm<sup>2</sup>) of the sustained-release antimicrobial film to the volume (cm<sup>3</sup>) of the container for storage is 0.02 or more.

[Claim 2]

An agricultural or horticultural crop-containing package comprising the container for cold storage according to Claim 1 in which an agricultural or horticultural crop is

housed.

[Claim 3]

A method for storing an agricultural or horticultural crop, comprising housing an agricultural or horticultural crop using the container for storage according to Claim 1 and performing storage at  $-3^{\circ}\text{C}$  or higher and  $15^{\circ}\text{C}$  or lower.