(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 2 006 218 A2

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
24.12.2008 Bulletin 2008/52

(51) Int Cl.:
B65D 81/24 (2006.01) *B65D 81/26* (2006.01)
B65D 85/52 (2006.01)

(21) Application number: 08156968.3

(22) Date of filing: 27.05.2008

(84) Designated Contracting States:
AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MT NL NO PL PT RO SE SI SK TR
Designated Extension States:
AL BA MK RS

(30) Priority: 20.06.2007 IT RM20070345

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(54) Active packaging for the transportation of vegetable material

(57) The present invention regards an active packaging able to maintain alive during transportation and storage, at room temperature fruit, aromatic and ornamental plants as well as leafy branches and cut flowers also in absence of light and without being watered for a period of more than 30 days. Such packaging is able to maintain the reproductive capacity of vegetable material. The active packaging is made of an adsorbent material and a semipermeable plastic film with defined range of permeability of oxygen, carbon dioxide and water vapour.

Photo 6: I5 after 32 days

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Description

State of the art

[0001] In these years the production of fruit, aromatic and ornamental plants in pots as well as that of leafy branches and cut flowers has gained such an increase and development to favour huge investments in this field.
One of the most important problems that slows down the development of the Italian floriculture market towards international markets is closely connected to the transportation. With such a purpose it results indispensable to guarantee the maintenance of the initial quality of the plant and/or of the cut flower for all the necessary period of the delivery through the use of suitable packagings able to avoid phytosanitary risks, water and metabolic stresses assuring the correct and balanced metabolic development of the vegetable material during transportation and commercialization.

Description of the invention

[0002] It is an object of the present invention an active packaging for transportation and storage of plants on growing substratum and/or of leafy branches and/or of cut flowers and/or of vegetative material for reproduction comprising an adsorbent material made of cellulose, zeolites and starch in an amount of 0,06 - 0.5% by weight, with reference to the overall weight of the active packaging, and a semipermeable film characterized by the following characteristics.

Properties	Measure Unit Measure Unit	Interval of values
Transmission speed of the water vapour	g/24 h*m^2(38°C,100%UR)	20-30
Permeability to O_2	Cm^3/24h*m^2*bar	8.000-12.000
Permeability to CO_2	Cm^3/24h*m^2*bar	35.000-45.000

wherein said packaging encloses the plants and/or the leafy branches and/or the cut flowers so that the communication with the outside is modulated by the semipermeable film and by the adsorbent material.
[0003] Preferably the semipermeable film is thermally welded in order to improve the isolation of the plants and/or of the leafy branches, or of the cut flowers inside said packaging.

Brief description of the drawings

[0004] To the present description are attached twelve photographic reproductions that show:

photos 1 - 3 the vegetative state of plant sample (I_4) at time 0 and after 15 and 32 days;

photos 4 - 6 the vegetative state of plant sample (I_5) at time 0 and after 15 and 32 days;

photos 7 - 9 the vegetative state of plant sample (I_6) at time 0 and after 15 and 32 days and

photos 10 - 12 the vegetative state of plant sample (I_7) at time 0 and after 15 and 32 days

[0005] The active packaging is formed by an adsorbent material, that is put preferably under the vase of the plant and/or of the stem of the flower, and by a semipermeable film, advantageously sealed in hermetic way. The choice of the film and the weight of adsorbent material inside the packaging is calculated in function of the typology of the confectioned plant and in function of its respiratory rate and that of transpiration. The weight of the adsorbing material inserted into the packaging varies between 0,06 and 0.5%.
[0006] The adsorbent used in the present invention has been described in European patent application, publication N.1530998 for use in packaging for alimentary products. In particular, it contains cellulose in an amount of 40-85%, zeolites in an amount 2-30% and starch in an amount of 0,1% to the amount complementary to 100%, said amounts being expressed as amounts by weight with reference to the overall weight of the mixture. Moreover, it can also contain kaolin and/or rubber in a percentage of weight of 0,1-0,3%, with reference to the overall weight of adsorbent.
[0007] The cellulose used for the production of adsorbent according to the present invention is preferably a mixture of long fibre cellulose and microcrystalline cellulose in ratio from 70 to 30% to 50 to 50%, in particularly preferred way from 60 to 40%.
[0008] The used zeolites are preferably present as mixture of 3A and 4A zeolites, in ratio between 80 and 20% and

60 and 40%, preferably between 70 and 30%. The used starch, which must render the mixture more compact, is preferably rice starch and is used in an amount of 0,1% to the complement to 100% of the two other used compounds.

[0009] Said adsorbent is obtainable by means of a process comprising the following steps:

a. preparation of a mixture of cellulose, zeolites and starch

b. mixing of said mixture with water until obtaining of a paste

c. drying and formation of said paste

[0010] The action of the packaging explicates itself through the possibility of the semipermeable film in combination with adsorbent to create micro atmosphere in contact with the plant which is different from that normally present in the atmosphere that permits to reduce to a minimum its metabolic requirements, without irreversible alterations. The adsorbent is preferably placed under the vase and/or under the stem; in fact it is able to interact dynamically with the elements indispensable for the life of the vegetable material and, releasing 02, CO2 and water can create an equilibrium that brings to a minimum the vegetative activity of the plant.

The preferred positioning under the vase is not connected to the modality of action, that would result unchanged also in other positions, but depends on reasons connected to the operations of plant confectioning into the packaging and on reasons of image. The action of adsorbent is closely connected to that one of the semipermeable film used also for the confectioning, that specifically modulates the passage of atmospheric gases from the inside of the packaging towards the outside and vice versa. The choice of the type of film and the weight of adsorbent that is inside the packaging depends on the typology of confectioned plant that is to say its respiratory rate and transpiration.

[0011] The semipermeable films used for the active packaging of the different typologies of plants show values of permeability indicated in following table 1.

Table 1: range of permeability to O2, CO2 and water vapour of plastic films used in the active packaging.

Properties	Measure unit	Tipical values
Speed of transmission of the water vapour	g/24 h*m^2 (38°C, 100%UR)	20-30
Permeability to O_2	Cm^3/24h*m^2*bar	8.000-12.000
Permeability to CO_2	Cm^3/24h*m^2*bar	35.000-45.000

[0012] The permeabilities to oxygen and carbon dioxide have been determined at constant pressure of gases with isostatic method employing the Lyssy instrument, Model GMP 200 in agreement to what reported by Guisheng et al., 1995. Before the measure the films have been conditioned to 0% of UR. The measure of the speed of transmission of the water vapour has been determined according to what reported by Maner et al., 2000. Semipermeable films for usage in the active packaging according to the present invention include one or more compounds chosen from the class formed from Polyvinyl chloride, simple polyamide, Polystyrene, Polypropylene, Polyester, aliphatic polyesters, aromatic polyesters, ethylene/vinyl acetate copolymer, polylactates (lactic acid polymers) and polyethylene among which are particularly preferred high density polyethylene (HDPE), low density polyethylene (LDPE), polyester, and polypropylene (PP). Within the present invention, under the term compound, one or more of which will form the polymer film, also the compounds of polymer type are meant.

[0013] The active packaging according to the present invention is able to slow down the respiratory activity of the plant and its correlated metabolic phenomena allowing the normal restoration of the physiology after the packaging is opened.

Tests of conservation

[0014] A careful overhaul of the active packaging and the verification of its effectiveness have been carried out through tests of conservation of different types of plants and cut flowers characterized by different vegetative activities. In particular the plants and the cut flowers which have undergone to conservation tests were: Begonia, Cyclamen, Euphorbiaceous, Eugenia, Fern, Spathiphyllum, Euphorbia pulcherrima, Olive tree , Citruses, Rose, Gerbera, Lilium, Dianthus, Iris, Viola, Basil, Salvia, and Rosemary.

1. Effectiveness of the active packing

[0015] The preliminary part of the tests has been devoted to verification of the effectiveness of the active packaging (semipermeable film + adsorbent) in comparison with relative controls formed by plants and cut flowers without confectioning and also by plants and cut flowers only with the semipermeable film. The effectiveness of the active packaging has been following tested on the plants also without light, placing the confectioned samples with the active packaging for a period of 15 days without light and afterwards exposed to the natural cycle of light always inside the active packaging. Below are reported the different types of packaging used for the tests of plants and cut flowers

Plants:

[0016]

(I) untreated plant = plant which has not undergone confectioning and not watered for all the period of test

(I1) F + adsorbent= plant confectioned with semipermeable film + adsorbent
(I2) F = plant confectioned with only semipermeable film
(I3) F + adsorbent + darkness = plant confectioned with semipermeable film

+ adsorbent in absence of light

[0017] The tests have been conducted at room temperature varying between 22° and 28°C
Cut flowers:

(L) untreated cut flower = cut flower which has not undergone confectioning
(L1) adsorbent + F= cut flower confectioned with semipermeable film + adsorbent
(L2) F = cut flower confectioned with only semipermeable film

[0018] The tests have been conducted at temperature of refrigeration (7 ±1°C)

Plants:

[0019] The qualitative state of the plants in the various modalities of conservation has been evaluated through the normal vegetative parameters according to typology of plant used for test as withering and modification of the colour of flowers and leaves, development of vegetative buds and fungi attacks recorded by digital images. The qualitative-quantitative evaluation of the vegetative parameters of the plants submitted used for the conservation tests has been carried out by means of sensorial test using a panel constituted from 9 judges of expert of the floriculture sector.
The qualitative descriptions chosen for the sensorial valuation of the samples have been: aspect of the leaves, colour of the bracts, aspect and development of vegetative buds, fungi attacks for the plants and general turgidity, aspect of the leaves and opening of button for the cut flowers. The evaluation set applied a score variable between 1 and 4, (1 insufficient, 2 sufficient, 3 good, 4 optimal) relative to the average of the scores obtained by means of the overall judgment of the qualitative descriptors.

2. Tests of conservation on Spathiphyllum wallisii

[0020] The effectiveness of the active packaging for maintaining alive Spathiphyllum wallis plants in conditions of metabolic stress (absence of light, lack of irrigation) has been conducted by comparing different types of packaging reported below:

Typologies of packaging exposed for comparison:

(I4) untreated plant = plant not submitted to confectioning and not watered for all the period of test
(I5) F2 = plant confectioned with only semipermeable film
(I6) F2 + adsorbing material = plant confectioned with semipermeable film + adsorbing material
(I7) F2 + adsorbing material darkness = plant confectioned with semipermeable film + material adsorbing in light absence

[0021] The tests have been conducted at room temperature varying between 22°and 28°C.
[0022] In table 2 are reported the properties of the F2 film applied in the experimentation that was coupled film of LDPE and PP.

Properties	F2
Transmission Speed of the water vapour g/24 h*m^2 (38°C, 100%UR)	26
Permeability to O_2 Cm^3/24h*m^2*bar	10000
Permeability to CO_2 Cm^3/24h*m^2*bar	40000

[0023] In photos 1-3 the images of the vegetative state of the untreated plant (I4) at time zero and after 15, 32 days of conservation are reported. The images put in evidence the complete withering of the plant already after 15 days of conservation due to the lack of water; continuation of the conservation shows a phase of drying of the leaves due to the death of the vegetable tissue. The packaging with the semipermeable film (I5) improves the state of conservation of the plant to slowing down the phenomena of respiration and transpiration of the plant. This condition, however, does not result sufficient to guarantee the maintenance of the qualitative characteristics for all the days of the conservation of the plant because of the partial withering and loss of turgidity of the leaves and steles of the plant (photo 4-6).

[0024] The insertion of the adsorbent (photos 7-9) inside of the packaging (I6) can regulate all the metabolic phenomena annexed to the vegetative activity of the plant establishing the correct equilibrium between CO2, O2, and water vapour of the internal micro atmosphere of the packaging. In these conditions clear signs connected with water and respiratory stresses have not been found which in the samples (untreated plants and packed plants with semipermeable film) have damaged the structure and the initial quality of the vegetable material.

[0025] In order to evaluate the active packaging during the real conditions of transportation and storage that normally takes place inside ships or motor vehicles with lack of light,the tests of conservation of the Spathiphyllum wallis have been executed in completely dark atmospheres. The effectiveness of the active packaging (adsorbent +F2) (I7) has been verified dividing the period of conservation in two phases, during the first one (15 days) samples have been stored in atmospheres without light, during the second, (17 days), the same samples have been exposed against the light. The obtained results shown in photos 10-12 have put in evidence that the active packaging can minimize metabolic stresses of the plant connected the reduction of its photosynthetic activity which resumes without damages to carry out the biochemical phenomena connected to the photosynthesis after reexposition to the light. The results of sensorial analysis carried out on the samples I4, I5, I6 and I7 during the period of conservation are reported in table 3.

Table 3:

Results of the sensorial analysis carried out on the samples of plants (Spathiphyllum wallis) during the period of conservation.				
Time (Days)	Samples			
	I4	I5	I6	I7
0	4	4	4	4
10	1,5	3,5	4	4
15	1	3	4	4
25	1	2,5	4	4
32	1	2	4	4

3. Cut flowers

Tests of conservation on variety Texas

[0026] The effectiveness of the active packaging to the maintain alive the cut flowers (Texas rose) in conditions of metabolic stresses (absence of water) has been conducted by comparing the different types of packaging reported below:

(L3) untreated cut flower = cut flower not submitted to confectioning
(L4) adsorbent + F3 = cut flower confectioned with semipermeable film
+ adsorbing material

(L5) F3 = cut flower confectioned with only semipermeable film

[0027] In table 4 the properties of the F3 film, coupled film of LDPE and polyester, used in the experimentation are reported.

Table 4: Property of the semipermeable film F3 (coupled film of LDPE and polyester) used in the experimentation

Properties	F3
Speed of transmission of the watery vapour g/24 h*m^2(38°C,100%UR)	30
Permeability to O_2 Cm^3/24h*m^2*bar	12000
Permeability to CO_2 Cm^3/24h*m^2*bar	45000

[0028] The results obtained after the tests of the conservation on the Texas roses have confirmed the abilities of the active packaging to already prolong the state of freshness and initial quality of the cut flower. The results of the sensorial analysis, reported in table 5, show points totally insufficient for the quality of the flower L3 (untreated cut flower) after 5 days of conservation. The confectioning with the semipermeable film F3 improves the conservation making the L4 samples obtain average scores as after 10 days. The active packaging shows its capability to slow down the metabolism of the vegetable material maintaining almost unchanged the qualitative descriptors of the flower for periods longer than three weeks. In fact in this case the scores obtained from the sensorial analysis for the L5 samples have been judged always positively getting the scores not inferior than 3 for the entire period of conservation.

Table 5: Results of the sensorial analysis carried out on the samples of cut flowers (Texas Rose) during the period of conservation.

Time (Days)	Samples		
	L3	L4	L5
0	4	4	4
5	1	3	4
10	1	2	4
20	1	1	3,5
25	1	1	3

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[0029] Fan, G., Incarnato, L., Di Maio, L., Acierno, D. (1995). Discussion about the use of relative values of permeabilities between two gases for high molecular weight polymers. Polymer,36, 4345-4346

[0030] Mauer, L.J., Smith, D.E., Labuza, T.P. (2000). Water vapor permeability, mechanical, and structural properties of edible β-casein films. International Dairy Journal, 10, 353-358

Claims

1. Active packaging for the transportation and the storage of plants on growing substratum and/or of leafy branches and/or of cut flowers and/or of vegetative material for reproduction, comprising an adsorbent material made of cellulose, zeolites and starch in amount of 0,06 - 0.5% of weight, with reference to the overall weight of the active packaging, and
a semipermeable film **characterized by** following characteristics.

Properties	Measure unit	Range of values
Speed of transmission of the water vapour	g/24 h*m^2 (38°C,100%UR)	20-30
Permeability to O_2	Cm^3/24h*m^2*bar	8.000-12.000
Permeability to CO_2	Cm^3/24h*m^2*bar	35.000-45.000

wherein said packaging encloses the plants and/or the cut flowers so that the communication with the outside takes place only across said semipermeable film.

2. Packaging according to claim 1, wherein said adsorbent material contains cellulose in amount of 40 - 85%, zeolites in amount of 2 - 30% and starch in amount from 0,1% to the amount complementary to 100%, the above mentioned amounts being expressed as amounts of weight with reference to the whole weight of the material.

3. Packaging according to at least of one of the previous claims, wherein said cellulose is present as mixture of long fibres cellulose of and microcrystalline cellulose with ratio from 70 to 30% to 50 to 50%, preferably 60 to 40%.

4. Packaging according to at least one of the previous claims wherein said mentioned zeolites are present as 4A and 3 A zeolite mixture, with ratio between 80 and 20% and 60 and 40%, preferably between 70 and 30%.

5. Packaging according to at least of one of the previous claims wherein said starch comes from one or more following botanical species: potato, yam, maize, rice, cassava, Jerusalem artichoke.

6. Packaging according to at least one of the previous claims, wherein said adsorbent material contains kaolin and/or rubber in an amount of 0,1 - 0.3%, with reference to the total weight of said adsorbent material.

7. Packaging according to at least one of the previous claims, wherein said semipermeable film is sealed by welding.

8. Packaging according to at least one of the previous claims, wherein said semipermeable film is formed from one or more compounds chosen from the class formed from polyvinyl chloride, polyamide, polystyrene, polypropylene, simple polyesters, aliphatic polyesters, aromatic polyesters, ethylene/vinyl acetates, polilactates and polyethylene.

9. Packaging according to claim 8, wherein said semipermeable film is formed by one or more than one compounds preferably selected from the class formed by polyethylene of high density (HDPE), polyethylene of low density (LDPE), polyester, and polypropylene (PP).

10. Packaging according to at least one of previous claims, wherein said plants are pot plants.

11. Packaging according to the previous claims, wherein said mentioned pot plants are in particular fruit, aromatic and ornamental plants.

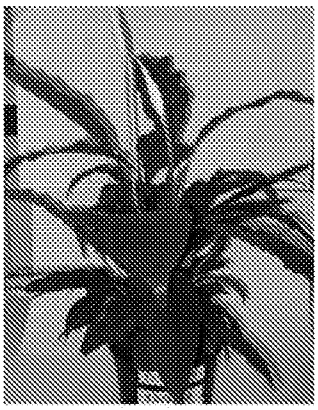

Photo 1: I4 time 0

Photo 2: I4 after 15 days

Photo 3: I4 after 32 days

Photo 4: I5 time 0

Photo 5: I5 after 15 days

Photo 6: I5 after 32 days

Photo 7: I6 time 0

Photo 8: I6 after 15 days

Photo 9: I6 after 32 days

Photo 10: I7 time 0

Photo 11: I7 after 15 days in absence of light

Photo 12: I7 after 32 days (15 days in absence of light + 17 days in the light)

REFERENCES CITED IN THE DESCRIPTION

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