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

(11) EP 1 289 855 B1

(12) **EUROPEAN PATENT SPECIFICATION**

(45) Date of publication and mention of the grant of the patent:
12.01.2005 Bulletin 2005/02

(21) Application number: **01959756.6**

(22) Date of filing: **15.05.2001**

(51) Int Cl.[7]: **B65D 81/24**

(86) International application number:
PCT/US2001/040732

(87) International publication number:
WO 2001/092118 (06.12.2001 Gazette 2001/49)

(54) **PACKAGING OF BANANAS**

VERPACKEN VON BANANEN

EMBALLAGE DES BANANES

(84) Designated Contracting States:
AT BE CH CY DE DK ES FI FR GB GR IE IT LI LU MC NL PT SE TR

(30) Priority: **26.05.2000 US 580379**

(43) Date of publication of application:
12.03.2003 Bulletin 2003/11

(60) Divisional application:
04027190.0

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Description

[0001] This invention relates to the packaging of bananas.

[0002] Respiring biological materials consume oxygen (O_2) and produce carbon dioxide (CO_2) at rates which depend upon temperature and the stage of their development. Ideally, a respiring material should be stored in a container whose permeability to O_2 and CO_2 is correlated with (i) the atmosphere outside the package, (ii) the rates at which the material consumes O_2 and produces CO_2, and (iii) the temperature, to produce the desired atmosphere within the container. This is the principle behind the technology of controlled atmosphere packaging (CAP) and modified atmosphere packaging (MAP), as discussed, for example, in US-A-3,450,542, 3,450,544, 3,798,333, 4,734,324, 4,830,863, 4,842,875, 4,879,078, 4,910,032, 4,923,703, 5,045,331, 5,160,768, 5,254,354 and 6,013,293, WO-A-94/12040, WO-A-96/38495 and WO-A-00/04787 and EP-A-0,351,115 and 0,351,116.

[0003] Bananas are respiring biological materials whose storage and ripening present the most serious problems because

(i) bananas are grown in locations far distant from the locations at which they are consumed;
(ii) they are damaged by storage at temperatures below about 14.4 °C, with the extent of the damage depending upon the time spent below that temperature and how far the temperature is below 14.4 °C (58 °F);
(iii) they go through a climacteric when they ripen, thus producing a very large increase in respiration rate and the generation of heat;
(iv) they generate ethylene as they ripen, and they ripen at a rate which increases with the concentration of ethylene around them -- as a result, a single prematurely ripe banana can trigger premature ripening of many others; and
(iv) once they have ripened, and have been exposed to air, they rapidly become overripe.

These problems have not yet been solved. The conventional procedure is to harvest the bananas when they are hard, green and unripe; to transport the green bananas, at 13-14 °C, to the location where they will be consumed; to ripen the green bananas by exposing them to ethylene in a ripening room at that location; and to place the ripened bananas on sale. The time at which the bananas are harvested depends on the time needed to transport them to the point-of-sale. Thus bananas are typically harvested at week 11 (i.e. 11 weeks after the flower emerges from the plant) or week 12. The green bananas are shipped in bags made of polyethylene about 0.04 to 0.06 mm (1.5-2.5 mil) thick, with each bag containing about 18 kg (40 lb) of bananas and being supported by a cardboard box. In many cases, after the bananas have been placed in the bag, most of the air is exhausted from the bag, and the bag is then sealed; this is the procedure generally described in US Patent No. 3,450,542 (Badran). In other cases, the bag contains vent holes.

[0004] A serious disadvantage of the conventional procedure is the need to harvest the bananas a good while before they are fully grown. It would be desirable to harvest the bananas at a later time, when they are larger. However, the later the bananas are picked, the greater the propensity for their climacteric to be triggered by small concentrations of ethylene, and experience has shown that if the bananas are harvested later than the presently established timetables, this results in prematurely ripe bananas when the bananas are shipped in vented bags, and in so-called "green-ripe" bananas when the bananas are shipped in sealed bags. Green-ripe bananas soften, but remain green, and have an unpleasant flavor.

[0005] Another serious disadvantage of the conventional procedure is that, in order to ripen the green bananas by exposing them to ethylene, it is necessary to open each of the shipping bags if, as in most cases, the bags have been sealed during shipping.

[0006] Another serious disadvantage of the conventional procedure is that the bananas, once ripened, must be sold within a few days, or scrapped.

[0007] Another serious disadvantage of the conventional procedure is that the heat generated by the ripening of the bananas is generated over a relatively short period of time, which heats the bananas to an extent that causes dehydration of the bananas and/or increases the demand on the refrigeration equipment used to keep the bananas cool.

[0008] The present invention mitigates or overcomes one or more of these disadvantages by packaging green bananas in a sealed container having designed permeabilities to oxygen (O_2), carbon dioxide (CO_2) and ethylene. Thus, this invention provides a method of ripening green bananas which comprises

(A) providing a sealed package which comprises

(a) a sealed container, and
(b) within the sealed container, green bananas and a packaging atmosphere around the green bananas:

the sealed container

(i) including at least one atmosphere control member which provides a pathway for O_2 and CO_2, and which comprises a gas-permeable membrane comprising

(a) a microporous film, and
(b) a polymeric coating on the microporous film; and

(ii) having an O_2 permeability at 13 °C, per kg of bananas in the container (OP13/kg), of at least 700, preferably at least 1000, particularly at least 1500, ml/atm.24 hrs, an R ratio at 13 °C of at least 2, preferably at least 3, and an ethylene permeability at 13 °C, per kg of bananas in the container (EtOP13/kg) which is at least 3 times, preferably at least 4 times, the OP13/kg of the container; and

(B) placing the sealed package in an atmosphere containing ethylene.

[0009] In this specification, including the Examples and the Claims below, reference is made to particular features of the invention. It is to be understood that the disclosure of the invention in this specification includes all appropriate combinations of such particular features. For example, where a particular feature is disclosed in the context of a particular aspect or embodiment of the invention, or a particular claim, that feature can also be used, to the extent appropriate, in the context of other particular aspects and embodiments of the invention, and in the invention generally.

[0010] In describing and claiming the invention below, the following abbreviations, definitions, and methods of measurement are used. OTR is O_2 permeability. COTR is CO_2 permeability. EtTR is ethylene transmission rate. OTR, COTR and EtTR values are given in ml/m^2.atm.24 hrs; in some cases, the equivalent in cc/100 $inch^2$.atm.24 hrs is given in parentheses. OTR and COTR values referred to herein can be measured using a permeability cell (supplied by Millipore) in which a mixture of O_2, CO_2 and helium is applied to the sample, using a pressure of 0.7 kg/cm^2 (10 psi) except where otherwise noted, and the gases passing through the sample were analyzed for O_2 and CO_2 by a gas chromatograph. The cell could be placed in a water bath to control the temperature. The abbreviation P_{10} is used to denote the ratio of the oxygen permeability at a first temperature T_1°C to the oxygen permeability at a second temperature T_2, where T_2 is (T_1-10)°C, T_1 being 10°C and T_2 being 0°C unless otherwise noted. The abbreviation R or R ratio is used to denote the ratio of CO_2 permeability to O_2 permeability, both permeabilities being measured at 20°C unless otherwise noted. Pore sizes given in this specification are measured by mercury porosimetry or an equivalent procedure. Parts and percentages are by weight, except for percentages of gases, which are by volume; temperatures are in degrees Centigrade, and molecular weights are weight average molecular weights expressed in Daltons. For crystalline polymers, the abbreviation T_o is used to denote the onset of melting, the abbreviation T_p is used to denote the crystalline melting point, and the abbreviation ΔH is used to denote the heat of fusion. T_o, T_p and ΔH are measured by means of a differential scanning calorimeter (DSC) at a rate of 10°C/minute and on the second heating cycle. T_o and T_p are measured in the conventional way well known to those skilled in the art. Thus T_p is the temperature at the peak of the DSC curve, and T_o is the temperature at the intersection of the baseline of the DSC peak and the onset line, the onset line being defined as the tangent to the steepest part of the DSC curve below T_p.

[0011] Where reference is made herein to sealing bags containing bananas, it is to be understood that the sealing can be, but generally is not, hermetic sealing. Conventional methods for sealing bags of bananas can conveniently be used in this invention. Such conventional methods include, for example, the use of a cable tie to seal the neck of the bag. A seal made by conventional methods is not a hermetic seal, and has the advantage that it permits equilibration of the pressures inside and outside the bag. If the bag is sealed hermetically, it will generally be desirable to include one or more pinholes in the bag, to achieve such equilibration.

[0012] The containers used in this invention include an atmosphere control member as defined above, preferably a control member as described in one or both of WO-A- 96/38495 and WO-A-00/04787. The microporous polymeric film preferably comprises a network of interconnected pores having an average pore size of less than 0.24 micron, with at least 70% of the pores having a pore size of less than 0.24 micron. Preferably the pores in the microporous film constitute 35 to 80% by volume of the microporous film. Preferred microporous films comprise a polymeric matrix comprising (i) an essentially linear ultrahigh molecular weight polyethylene having an intrinsic viscosity of at least 18 deciliters/g, or (ii) an essentially linear ultrahigh molecular weight polypropylene having an intrinsic viscosity of at least 6 deciliters/g, or (iii) a mixture of (i) and (ii). The microporous film may contain 30 to 90% by weight, based on the weight of the film, of a finely divided particulate substantially insoluble filler which is distributed throughout the film.

[0013] The polymeric coating on the control member preferably comprises a crystalline polymer having a peak melting temperature Tp of -5 to 40 °C, e.g. 0 to 15°C, or 10 to 20 °C, an onset of melting temperature T_o such that (Tp - T_o) is less than 10 °C, and a heat of fusion of at least 5 J/g. The polymer preferably comprises a side chain crystalline polymer moiety comprising, and optionally consisting of, units derived from (i) at least one n-alkyl acrylate or methacrylate (or equivalent monomer, for example an amide) in which the n-alkyl group contains at least 12, preferably at least 14, for example 16-50, preferably 16-22, carbon atoms, for example in amount 35-100%, preferably 50-100%, often

80-100%, and (ii) one or more comonomers selected from acrylic acid, methacrylic acid, and esters of acrylic or methacrylic acid in which the esterifying group contains less than 10 carbon atoms. The polymer can be a block copolymer in which one of blocks is a crystalline polymer as defined and the other block(s) is crystalline or amorphous. Preferred block copolymers comprise polysiloxane polymeric blocks, and (ii) crystalline polymeric blocks having a T_p of -5 to 40°C. Such a polymer can be prepared by copolymerizing a mixture of reactants which comprises (i) at least one n-alkyl acrylate or methacrylate in which the n-alkyl group contains at least 12 carbon atoms and (ii) a polysiloxane having a copolymerizable group at one end thereof.

[0014] Other polymers which can be used to the coat the microporous film include cis-polybutadiene, poly (4-methylpentene), polydimethyl siloxane, and ethylene-propylene rubber.

[0015] The gas-permeable membrane preferably has one or more of the following properties

(i) a P_{10} ratio, over at least one 10°C range between -5 and 15 °C or between 10 and 20 °C, of at least 2.0 to 2.8;
(ii) an oxygen permeability at all temperatures between 20° and 25°C of 2,480,000 to 7,000,000 ml/m^2.atm.24 hr. (160,000 to 450,000 cc/100 in^2.atm.24hr); and
(iii) an R ratio of at least 2.0, preferably at least 3.0, particularly at least 3.5.

[0016] In one embodiment, the control member is as described in US-A-6,013,293.

[0017] The permeability of the container, can be influenced by perforating the container in order to make a plurality of pinholes therein.

[0018] In the method of the invention, green bananas are ripened while in a sealed container. The ripening can be carried out in a conventional ripening room containing ethylene, typically but not necessarily at a concentration of 500 to 1000 ppm. It was surprising to discover that, when using suitable containers, it was unnecessary to follow the conventional practice of opening the bags, and that the bananas would ripen satisfactorily in this way. An important advantage of this method of ripening bananas is that the ripening takes place in a more controlled fashion, resulting in lower peak temperatures in the bananas, which in turn results in reduced dehydration of the bananas and, when the ripening is carried out at temperatures below room temperature, reduced demand upon the refrigeration equipment.

[0019] The temperature at which ripening is carried out and the concentration of ethylene in the atmosphere influence the rate at which ripening takes place. In general, slower ripening results in bananas which remain in a desired range of color stage for a longer period. On the other hand, this must be balanced against delivery dates required by retail outlets and inventory constraints. Generally the ethylene-containing atmosphere will be maintained at the temperature less than 22 °C, preferably less than 20 °C, for example 16-21 °C.

[0020] The atmosphere within the bags will change substantially during the ripening process, as the bananas consume O_2 and generate CO_2. Preferably, the packaging atmosphere, for at least part of the period before the bananas reach their climacteric, contains at least 10% preferably at least 12%, particularly 14 to 19%, of O_2, and less than 10%, preferably less than 4%, of CO_2, with the total quantity of O_2 and CO_2 being less than 20 %, preferably less than 17 %. For at least part of the period after the bananas have passed their climacteric, the packaging atmosphere preferably contains at least 0.8%, preferably 1.5 to 6%, especially 1.5 to 3%, of O_2, and less than 15%, preferably less than 7%, of CO_2, with the total quantity of O_2 and CO_2 being less than 16%, preferably less than 10 %.

[0021] The invention can in principle be used for any quantity of bananas. However, it is particularly valuable when relatively large quantities are involved. Thus it is generally preferred that the sealed container contains at least 4 kg, preferably at least 15 kg, especially 16 to 22 kg of bananas.

EXAMPLES

[0022] The invention is illustrated in the following Examples, a number of which are comparative Examples, designated by the letter C before the number of the example. The bananas, bags and control members used in the Examples were as follows.

Bananas

[0023] The bananas were Cavendish bananas, from Ecuador in Examples 2A-B, C21-22, from Costa Rica in Examples 3A-C and C3, and from Colombia in the other Examples.

Bags

[0024] The large bags were about 0.96 m (38 in.) wide and about 1.2 m (50 in.) long, and were made from polyethylene film about 0.056 mm (2.2 mil) thick (available from Roplast Industries under the tradename RA 3030). The polyethylene film had an OTR at 13 °C of about 2915 (188) and at 22 °C of about 4,650 (300), and EtTR at 13 °C of about 11,400

(735) and at 22 °C of about 18,100 (1,170), an R ratio of about 4.5, and a P10 ratio (between 0 and 10 °C.) of about 1.76. The small bags were about 0.3 m (12 in.) wide and about 0.46 m (18 in.) long, and were made from the same polyethylene film.

Control Members

[0025] The Type S control members were as described in WO-A- 00/04787 and comprised a microporous polyethylene film coated with a polysiloxane/SCC block copolymer. The Type S members had an OTR at 13 °C of about 3,803,850 (245,410) and at 22 °C of about 5,000,000 (324,000), an EtTR at 13 °C of about 16,280,000 (1,050,300) and at 22 °C of about 19,500,000 (1,260,000), an R ratio of about 3.8, and a P10 ratio (between 0 and 10 °C.) of about 1.8. The microporous polyethylene film contained 50-60% silica, had a thickness of about 0.18 mm (0.007 inch), a tear strength of about 90g, a porosity of about 65%, an average pore size of about 0.1 micron and a largest pore size of 4-10 microns (available from PPG industries under the tradename Teslin SP 7). The block copolymer was prepared by the reaction of a polydimethyl siloxane terminated one end only by a methacryloxypropyl group (available from Gelest under the tradename MCR M17), 40 parts, dodecyl acrylate, 26.8 parts and tetradecyl acrylate, 33.2 parts, as described in Example A7 of WO-A- 00/04787.

[0026] The Type A control members were as described in WO-A- 96/38495, and comprised the same microporous polyethylene film coated with an SCC polymer of dodecyl acrylate, 42 parts, tetradecyl acrylate, 53 parts, and acrylic acid, 5 parts. The Type A members had an OTR at 22 °C of about 1,705,000 (110,000), an R ratio of about 4, and a P10 ratio (between 0 and 10 °C.) of about 1.4.

[0027] In each Example, the control member was secured to a portion of the bag in which one or more round holes had been cut. In Examples 1 and C11-14, the periphery of the control member was heat sealed to the interior of the bag, thus creating a control member of the kind described in US-A-6,013,293. In the other Examples, the control member was secured to the exterior of the bag by means of a layer of a pressure sensitive adhesive on the peripheral margin of the control member, and the effective area of the control member was about equal to the area of the hole or holes in the portion of the bag to which the control member is attached.

[0028] The color stages referred to in the Examples are those accepted by the industry and as shown below.

Color stage	Description
1	95% green
2	80% green, 20% slightly yellow
3	50% yellow, 50% green
4	80% yellow, 20% light green
5	95% yellow, with slight green color at stem and blossom end
6	100% yellow
7	100% yellow with brown sugar spots

Bananas are preferably at color stage 3.5 to 5 when put on retail sale.

[0029] Many of the Examples are summarized in Tables 1-5 below. In the Tables, when more than one result is given for a particular Example, this reflects the fact that more than one test was carried out under the same conditions.

Examples 1 and C11-14

[0030] Each of these Examples uses a large bag. In Examples 1 and C11-13, each bag has one S-type control member placed under one or more holes in the bag. In Example C11, the control member had an area of 967 mm^2 (1.5 in^2) and was placed under a single hole of diameter 20.6 mm (0.81 in.). In Example C12, the control member had an area of 1935 mm^2 (3 in^2) and was placed under 2 holes, each of diameter 20.6 mm (0.81 in.). In Example C13, the control member had an area of 3225 mm^2 (5 in^2) and was placed under 4 holes, each of diameter 19 mm (0.75 in.). In Example 1, the control member had an area of 12,900 mm^2 (20 in^2) and was placed under 6 holes, each of diameter 25 mm (1 in.). In Example C14, the bag did not have a control member. Each bag was packed with about 18.1 kg (40 lb) of green bananas. The bananas had been harvested at week 13, and maintained at 13-14°C for about 11 days after harvest before being packed. Except in Example C14, excess air was extracted from the bags using a vacuum pump, and then securely tied. In Example C14, the bags were left open. The sealed bags were cooled to about 13 °C and shipped to Gulfport, Mississippi, and then to San Francisco, California, maintaining the temperature at about 13°C.

In San Francisco, 36 days after packing, half the bags in each Example were opened, and the other half left intact. All the bags were then exposed to ethylene (500-1000 ppm) in a commercial ripening room for about 24 hours. The bananas in the opened bags ripened rapidly in the expected way; thus by day 43, their color was 6, by day 46 their color was greater than 7, and by day 49, they were overripe. The bags which were still sealed were opened on day 49. The results for the bags opened on day 49 are shown in Table 1 below. These Examples demonstrate that bananas harvested at 13 weeks can be transported in a suitably designed bag, and can be ripened into an excellent product by exposure to ethylene through the bag.

TABLE 1

	Example No.				
	C11	C12	C13	1	C 14
Control member	yes	yes	yes	yes	no
Total area of hole(s) in bag under control member (mm^2)	335	670	1140	3040	-
Days to change from color stage 3.5 to color stage 5	> 8	> 8	> 8	5.5	DDU
Taste and texture on day 49	SGU	SGU	SGU	Exct	DDU
% O_2 (approximate) at day 23 at day 46	8.6 2.9	9.8 0.6	12.7 1.8	15.5 2.2	
% CO_2 (approximate) at day 23 at day 46	4.45 13.8	3.65 11.4	3.3 5.0	2.85 9.0	
SGU soft, green and unpalatable DDU dehydrated, decayed and unpalatable by day 47 (day 11 after exposure to ethylene) Exct excellent taste and texture					

Examples 2A, 2B, C21 and C22

[0031] Each of these Examples uses a small bag. In Examples 2A-B, each bag has one A-type control member placed over four or five holes in the bag. In Example 2A, the control member had an area of 145 mm^2 (5.7 in^2) and was placed over four holes each of diameter 19 mm (0.75 in.). In Example 2B, the control member had an area of 4516 mm^2 (7 in^2) and was placed over 5 holes, each of diameter 19 mm (0.75 in.). In Example C21, the control member and the holes under it were as in Example 2A, except that the control member was an uncoated microporous film. In Example C22, the bag was intact except for 200 pinholes each about 0.5 mm (26 gauge) in diameter. Each bag was packed with about 1.35 kg (3 lb) of green bananas which had been maintained at 13-14 °C for about 11 days after harvest. Except in Example C22, excess air was extracted from the bags using a vacuum pump, and the bags were then securely tied. In Example C22, the bags were left open. After three days, to allow the packaging atmosphere to equilibrate, the bags were exposed to ethylene (500-1000 ppm) in a ripening room. The results are shown in Table 2 below. These Examples demonstrate that small quantities of bananas can be ripened in a suitably designed bag, and can remain in the bag in excellent condition for several days longer than bananas exposed to the air.

Table 2

	Example No.			
	2A	2B	C21	C22
Control member	yes	yes	♠	no
Total area of holes in bag over control member (mm^2)	1140	1425	1140	-
Color stage on day 10 after ethylene treatment	4.0	4.4	7.0	6.8
Weight loss (%) on day 10 after ethylene treatment	0.57	0.72	1.05	0.61
Taste & texture on day 10 after ethylene treatment	Exct	Exct	Over-ripe	Over-ripe

♠ uncoated microporous film

Exct excellent taste and texture

Examples 3A, 3B, 3C and C3

[0032] These Examples show that the bananas generate heat more evenly when ripened in a container including an atmosphere control member. In each Example, a large bag was packed with about 18.1 kg (40 lb.) of green bananas. The green bananas had been harvested 13 days previously and had been stored at 13-14 °C since harvest. A temperature sensor (available from Sensitech, Beverly, Massachusetts, under the tradename Template P) was inserted into one banana in each bag. In each of Examples 3A, 3B and 3C, the bag had two S-type control members, each having an area of 11,300 mm^2 (17.5 in^2). Each control member was placed over a single hole in the bag, the hole having an diameter of 70 mm (2.75 in.) in Example 3A, 74.4 mm (2.93 in.) in Example 3B, and 78.7 mm (3.1 in.) in Example 3C. In Example C3, the bag was perforated so that the bananas were surrounded by air. The bags were then sealed with rubber bands. The sealed bags were placed in a refrigerated room at about 13 °C. After about 84 hours, the temperature of the room was raised to about 16.7 °C and after about 12 hours, an ethylene generator was used to provide an initial ethylene concentration in the room of 500-1000 ppm. About 24 hours after the generation of ethylene had begun, the room was vented. The temperature of the bananas was monitored for about 15 days, and reached a peak at about 60 hours after the generation of ethylene had begun. At that time, the concentration of O_2 and CO_2 was measured. The results are shown in Table 3 below. It will be seen that the peak temperature was substantially lower in the bags containing control members than in the perforated bag.

Table 3

	Example No.			
	3A	3B	3C	C3
Control member	yes	yes	yes	no
Total area of holes in bag under control members (mm^2)	7700	8700	9700	-
Temperature (°C) of bananas 12 hrs after temperature of room was set to 16.7 °C	16.3	15.9	15.7	16.6
Peak Temperature °C	21.2	21.1	20.9	23.9
Difference between peak temperature and 16.6 °C	4.9	5.3	5.2	7.3
% O_2 60 hours after injection of ethylene	2.2	1.75	1.9	20.95
% CO_2 60 hours after injection of ethylene	7.95	6.1	7.4	0.03

Examples 4 and C4

[0033] Each of these Examples uses a large bag and two S-type control members, each control member having an area of 11,300 mm^2 (17.5 $in.^2$). In Example 4, there was a single hole, diameter 82.5 mm (3.25 in.), under each control member. In Example C4, there were seven holes, each hole of 25.4 mm (1 in.), under each control member. The total area of the holes was 10,700 mm^2. About 18.1 kg (40 lbs.) of green bananas were placed in each bag. In Example 4,

the bag was sealed with rubber bands. In Example C4, the bag was not sealed. The green bananas had been maintained at 13-14 °C for about 11 days after harvest. The bags were left in a cold room at 13-14 °C. Three days after packing, the bags were exposed to ethylene for 24 hours in a conventional ripening room at 16.7 °C and containing 500-1000 ppm of ethylene.

[0034] Table 4 shows the number of days taken to reach various color stages.

Table 4

Example No.	4	C4
Control member	yes	no
Days to color stage 4	6.5 6.5 7.1	4.2 4.5 4.5
Days to color stage 5.5	11.5 12 12.3	6.6 7 7.2
Days from color stage 4 to color stage 5.5	5 5.5 5.2	2.4 2.5 2.7

Table 5 below shows, for each of the bags in Examples 1, C11, C12, C13, 3A, 3B, 3C and 4 the permeability of the bag to O_2 and to ethylene ("Et" in Table 5), and the respective contributions of the control member and the remainder of the bag. For this calculation, the size of the bag, after sealing, was assumed to be 0.96 x 1.04 m (38 in. x 41 in.), i. e. to have a total area of 2 m^2 (3115 in^2).

Table 5

Example No.	Perm. of bag (mUatm.24hr) at 13°C	Perm. of bag at 13°C /kg of bananas	Hole area (m^2)	Perm. Of ACM at 13°C	Perm. of rest of bag at 13°C
C_{11}	O_2 7,200 Et 30,650	O_2 395 Et 1,695	0.000335	O_2 1,300 Et 5,500	O_2 5,900 Et 25,100
C12	O_2 8,500 Et 36,000	O_2 470 Et 2,000	0.000670	O_2 2,550 Et 10,900	O_2 5,900 Et 25,100
C_{13}	O_2 10,250 Et 43,650	O_2 565 Et 2,400	0.001140	O_2 4,350 Et 18,550	O_2 5,900 Et 25,100
1	O_2 17,450 Et 74,600	O_2 965 Et 4,120	0.003040	O_2 11,550 Et 49,500	O_2 5,900 Et 25,100
3A	O_2 35,000 Et 149,800	O_2 1,935 Et 8,280	0.007700	$0_2$29,100 Et 124,700	O_2 5,900 Et 25,100
3B	O_2 39,000 Et 166,650	O_2 2,155 Et 9,200	0.008700	O_2 33,100 Et 141,550	O_2 5,900 Et 25,100
3C	O_2 42,900 Et 183,550	O_2 2,370 Et 10,150	0.009700	O_2 37,000 Et 158,450	O_2 5,900 Et 25,100
4	O_2 46,500 Et 199,200	O_2 2,570 Et 11,000	0.010700	O_2 40,600 Et 174,100	O_2 5,900 Et 25,100

Claims

1. A method of ripening green bananas which comprises

(A) providing a seated package which comprises

(a) a sealed container, and
(b) within the sealed container, green bananas and a packaging atmosphere around the green bananas;

the sealed container

(i) including at least one atmosphere control member which provides a pathway for O_2, CO_2 and ethylene to enter or leave the packaging atmosphere and which comprises a gas-permeable membrane comprising

(a) a microporous polymeric film, and
(b) a polymeric coating on the microporous film, and

(ii) having an O_2 permeability at 13°C. per kg of bananas in the container (OP13/kg), of at least 700 ml/atm.24 hrs, an R ratio at 13°C of at least 2, and an ethylene permeability at 13°C. per kg of bananas in the container (EtOP13/kg) which is at least 3 times the OP13/kg of the container; and

(B) placing the sealed package in an atmosphere containing ethylene.

2. A method according to claim 1 wherein step (B) comprises placing the sealed package in a ripening room containing ethylene in amount 500 to 1000 ppm.

3. A method according to claim 1 or 2 wherein at least part of step (B) is carried out in an ethylene-containing atmosphere having a temperature of less than 20°C.

4. A method according to any one of the preceding claims wherein the packaging atmosphere, for at least part of the period before the bananas reach their climacteric, contains 14 to 19% of O_2 and less than 10% of CO_2, with the total quantity of O_2 and CO_2 being less than 20 %.

5. A method according to any one of the preceding claims wherein the packaging atmosphere, for at least part of the period after the bananas have passed their climacteric, contains 1.5 to 6% of O_2 and less than 15% of CO_2, with the total quantity of O_2 and CO_2 being less than 16%.

6. A method according to any one of the preceding claims wherein the sealed container contains 16 to 22 kg of bananas.

7. A method according to any one of preceding claims wherein the OP13/kg of the sealed container is at least 1500 ml/atm.24 hrs.

8. A method according to any one of the preceding claims wherein the sealed container has an R ratio at 13 °C of at least 3.

9. A method according to any one of the preceding claims wherein the EtOP13/kg of the sealed container is at least 4 times the OP13/kg of the sealed container.

10. A method according to any one of the preceding claims wherein at least 75% of the oxygen which enters the packaging atmosphere passes through said at least one atmosphere control member.

11. A method according to any one of the preceding claims wherein the gas-permeable membrane has an oxygen permeability at all temperatures between 20 and 25°C of 2,480,000 to 7,000,000 ml/m^2.atm.24 hrs.

12. A package for use in the method of any one of the preceding claims which comprises

(a) a sealed container, and

(b) within the sealed container, green bananas and a packaging atmosphere around the green bananas;

the sealed container

(i) including at least one atmosphere control member which provides a pathway for O_2, CO_2 and ethylene to enter or leave the packaging atmosphere and which comprises a gas-permeable membrane comprising

(a) a microporous polymeric film, and
(b) a polymeric coating on the microporous film, and

(ii) having an O_2 permeability at 13 °C. per kg of bananas in the container (OP13/kg), of at least 700 ml/atm. 24 hrs, an R ratio at 13°C of at least 2, and an ethylene permeability at 13 °C. per kg of bananas in the container (EtOP13/kg) which is at least 3 times the OP13/kg of the container.

13. A package according to claim 12 which is at a temperature of 13-14°C.

Patentansprüche

1. Verfahren zur Reifung von grünen Bananen, bei dem

(A) eine versiegelte Verpackung zur Verfügung gestellt wird, die

(a) einen versiegelten Behälter und
(b) in dem versiegelten Behälter grüne Bananen und eine Verpackungsatmosphäre um die grünen Bananen herum umfasst,

wobei der versiegelte Behälter

(i) mindestens ein Atmosphärekontrollelement einschließt, das einen Weg für O_2, CO_2 und Ethylen für den Eintritt oder den Austritt aus der Verpackungsatmosphäre liefert und das eine Gas durchlässige Membran umfasst, die

(a) eine mikroporöse polymere Folie und
(b) eine polymere Beschichtung auf der mikroporösen Folie umfasst, und

(ii) eine O_2-Permeabilität bei 13°C je kg Bananen in dem Behälter (OP13/kg) von mindestens 700 ml/atm. 24h, ein R-Verhältnis bei 13°C von mindestens 2 und eine Ethylenpermeabilität bei 13°C je kg Bananen in dem Container (EtOP13/kg) aufweist, die mindestens das Dreifache der OP13/kg beträgt, und

(B) die versiegelte Verpackung in einer Ethylen enthaltenden Atmosphäre angeordnet wird.

2. Verfahren nach Anspruch 1, bei dem in Stufe (B) die versiegelte Verpackung in einen Reifungsraum gestellt wird, der Ethylen in einer Menge von 500 bis 1000 ppm enthält.

3. Verfahren nach Anspruch 1 oder 2, bei dem mindestens ein Teil von Stufe (B) in einer Ethylen enthaltenden Atmosphäre mit einer Temperatur von weniger als 20°C durchgeführt wird.

4. Verfahren nach einem der vorangehenden Ansprüche, bei dem die Verpackungsatmosphäre zumindest für einen Teil der Zeit, bevor die Bananen ihr Klimakterium erreichen, 14 bis 19% O_2 und weniger als 10% CO_2 enthält, wobei die Gesamtmenge an O_2 und CO_2 weniger als 20% beträgt.

5. Verfahren nach einem der vorangehenden Ansprüche, bei dem die Verpackungsatmosphäre zumindest für einen Teil der Zeit nach dem Klimakterium der Bananen 1,5 bis 6% O_2 und weniger als 15% CO_2 enthält, wobei die Gesamtmenge an O_2 und CO_2 weniger als 16% beträgt.

6. Verfahren nach einem der vorangehenden Ansprüche, bei dem der versiegelte Behälter 16 bis 22 kg Bananen enthält.

7. Verfahren nach einem der vorangehenden Ansprüche, bei dem die OP13/kg des versiegelten Behälters mindestens 1500 ml/atm.24h beträgt.

8. Verfahren nach einem der vorangehenden Ansprüche, bei dem der versiegelte Behälter ein R-Verhältnis bei 13°C von mindestens 3 besitzt.

9. Verfahren nach einem der vorangehenden Ansprüche, bei dem die EtOP13/kg des versiegelten Behälters mindestens das Vierfache der OP13/kg des versiegelten Behälters beträgt.

10. Verfahren nach einem der vorangehenden Ansprüche, bei dem mindestens 75% des Sauerstoffs, der in die Verpackungsatmosphäre eintritt, durch das mindestens eine Atmosphärekontrollelement tritt.

11. Verfahren nach einem der vorangehenden Ansprüche, bei dem die Gas durchlässige Membran eine Sauerstoffpermeabilität bei allen Temperaturen zwischen 20 und 25°C von 2.480.000 bis 7.000.000 ml/m^2.atm.24h besitzt.

12. Verpackung zur Verwendung in dem Verfahren gemäß einem der vorangehenden Ansprüche, die

(a) einen versiegelten Behälter und
(b) in dem versiegelten Behälter grüne Bananen und eine Verpackungsatmosphäre um die grünen Bananen herum umfasst,

wobei der versiegelte Behälter

(i) mindestens ein Atmosphärekontrollelement einschließt, das einen Weg für O_2, CO_2 und Ethylen für den Eintritt oder den Austritt aus der Verpackungsatmosphäre liefert und das eine Gas durchlässige Membran umfasst, die

(a) eine mikroporöse polymere Folie und
(b) eine polymere Beschichtung auf der mikroporösen Folie umfasst, und

(ii) eine O_2-Permeabilität bei 13°C je kg Bananen in dem Behälter (OP13/kg) von mindestens 700 ml/atm.24h, ein R-Verhältnis bei 13°C von mindestens 2 und eine Ethylenpermeabilität bei 13°C je kg Bananen in dem Container (EtOP13/kg) aufweist, die mindestens das Dreifache der OP13/kg beträgt.

13. Verpackung nach Anspruch 12, die sich auf einer Temperatur von 13-14°C befindet.

Revendications

1. Procédé de maturation des bananes vertes, qui comprend :

(A) la fourniture d'un emballage scellé qui comprend:

(a) un conteneur scellé ; et
(b) à l'intérieur du conteneur scellé, des bananes vertes et une atmosphère de conditionnement autour des bananes vertes ;
le conteneur scellé

(i) incluant au moins un élément de contrôle d'atmosphère qui fournit un passage pour qu' O_2, CO_2 et l'éthylène pénètrent dans ou quittent l'atmosphère de conditionnement, et qui comprend une membrane perméable aux gaz, comprenant :

(a) un film polymère microporeux ; et
(b) un revêtement polymère sur le film microporeux ; et

(ii) ayant une perméabilité à O_2 à 13°C, par kg de bananes dans le conteneur (OP13/kg), d'au moins 700 ml/atm.24h, un rapport R à 13°C d'au moins 2, et une perméabilité à l'éthylène à 13°C, par kg de bananes dans le conteneur (EtOP13/kg), qui est d'au moins 3 fois l'OP13/kg du conteneur ; et

(B) la mise en place de l'emballage scellé dans une atmosphère contenant de l'éthylène.

2. Procédé selon la revendication 1, dans lequel l'étape (B) comprend la mise en place de l'emballage scellé dans une chambre de maturation contenant de l'éthylène dans une quantité de 500 à 1000 ppm.

3. Procédé selon l'une des revendications 1 ou 2, dans lequel au moins une partie de l'étape (B) est effectuée dans une atmosphère contenant de l'éthylène ayant une température de moins de 20°C.

4. Procédé selon l'une quelconque des revendications précédentes, dans lequel l'atmosphère de conditionnement, pendant au moins une partie de la période avant que les bananes n'atteignent leur climactérique, contient 14 à 19 % d'O_2 et moins de 10 % de CO_2, la quantité totale d'O_2 et de CO_2 étant moins de 20 %.

5. Procédé selon l'une quelconque des revendications précédentes, dans lequel l'atmosphère de conditionnement, pendant au moins une partie de la période après que les bananes aient passé leur climactérique, contient 1,5 à 6 % d'O_2 et moins de 15 % de CO_2, la quantité totale d'O_2 et de CO_2 étant moins de 16 %.

6. Procédé selon l'une quelconque des revendications précédentes, dans lequel le conteneur scellé contient de 16 à 22 kg de bananes.

7. Procédé selon l'une quelconque des revendications précédentes, dans lequel l'OP13/kg du conteneur scellé est au moins 1500 ml/atm.24h.

8. Procédé selon l'une quelconque des revendications précédentes, dans lequel le conteneur scellé a un rapport R à 13°C d'au moins 3.

9. Procédé selon l'une quelconque des revendications précédentes, dans lequel l' EtOP13/kg du conteneur scellé est au moins 4 fois l'OP13/kg du conteneur scellé.

10. Procédé selon l'une quelconque des revendications précédentes, dans lequel au moins 75 % de l'oxygène qui entre dans l'atmosphère de conditionnement passe à travers ledit ou lesdits éléments de contrôle de d'atmosphère.

11. Procédé selon l'une quelconque des revendications précédentes, dans lequel la membrane perméable aux gaz a une perméabilité à l'oxygène à toutes les températures comprises entre 20 et 25°C de 2 480 000 à 7 000 000 ml/m^2 atm.24h.

12. Emballage pour l'utilisation dans le procédé tel que défini à l'une quelconque des revendications précédentes, qui comprend :

(a) un conteneur scellé ; et
(b) à l'intérieur du conteneur scellé, des bananes vertes et une atmosphère de conditionnement autour des bananes vertes ;
le conteneur scellé :

(i) incluant au moins un élément de contrôle d'atmosphère qui fournit un passage pour qu'O_2 CO_2 et l'éthylène pénètrent dans ou quittent l'atmosphère de conditionnement, et qui comprend une membrane perméable aux gaz, comprenant :

(a) un film polymère microporeux ; et
(b) un enrobage polymère sur le film microporeux, et

(ii) ayant une perméabilité à O_2 à 13°C, par kg de bananes dans le conteneur (OP13/kg), d'au moins 700 ml/atm.24h, un rapport R à 13°C d'au moins 2, et une perméabilité à l'éthylène à 13°C, par kg de bananes dans le conteneur (EtOP13/kg), qui est au moins 3 fois l'OP13/kg du conteneur.

13. Emballage selon la revendication 12 qui est à une température de 13-14°C.