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Declaration under Rule 4.17:  
— of inventorship (Rule 4.17(iv))

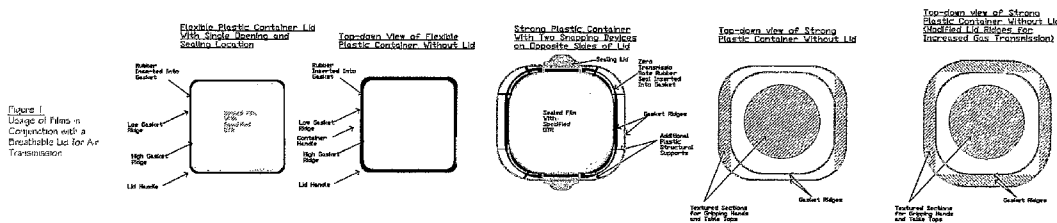
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(54) Title: A REUSABLE PLASTIC STORAGE CONTAINER AND LID WITH GAS-PERMEABLE MEMBRANES FOR MODIFIED ATMOSPHERE STORAGE OF FOOD AND PERISHABLES

Modified Atmosphere Packaging



(57) Abstract: A system and reusable plastic container for preserving the quality of a range of fruits and vegetables. The container independently maintains modified atmospheres within the range between 1% to 50% carbon dioxide and 1% to 15% oxygen at a relative humidity (RH) of 75%RH and 100%RH. For produce highly susceptible to mould, yeast and/or bacterial growth a RH of 75% to 80% will result in optimum quality retention. The container includes a plastic body, plastic lid and permeable film membrane hermetically sealed between the lid and the container. The plastic can be polyamide (nylon 6, 11, 12 or 66 and blends thereof), polycarbonate, polyethylene, polyethyleneterephthalate, polypropylene, polystyrene, polyvinylchloride, and mixtures thereof. The lid can be macro-perforated for a three piece application or micro-perforated for a two piece application. The film membrane can have different oxygen and carbon dioxide permeability rates for specific package volumes and specific produce respirations.

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# A Reusable Plastic Storage Container and Lid with Gas-Permeable Membranes for Modified Atmosphere Storage of Food and Perishables

## FIELD OF THE INVENTION

This invention relates to a novel process and reusable plastic storage container for the modified atmosphere preservation of fresh fruits and vegetables. More particularly the invention pertains to the preserving of the food integrity and food safety in a sealed container which permits the exchange of oxygen carbon dioxide and water vapour to maintain optimum internal relative humidity, high levels of carbon dioxide and low levels of oxygen for optimum preservation of foods at refrigerated temperatures for extended storage periods.

## BACKGROUND OF THE INVENTION

Fresh ripe fruits and vegetables and other foods are often purchased by consumers for intended use over a period of up to 7 days. Whole fresh fruits and vegetables are often peeled, cored, de-seeded and segmented in the home or in food service establishments prior to consumption. Often the available storage facilities are not adequate to provide proper environments to maintain the optimum quality of the food in a food safe environment for periods more than one or two days.

Reusable storage containers are often used to place prepared fruits and vegetables to maintain the quality and freshness of the product. Most of these containers serve to increase the humidity of the product to prevent desiccation of the product. While this application has a short term benefit, respiration of the product generates moisture which develops a saturated environment leading to the growth of bacteria, yeast and moulds which affect product quality and food safety. In addition, excessively high moisture levels lead to softening of the product and rapid deterioration of quality.

Most fresh fruits, vegetables maintain quality in environments that have relative humidity maintained between 84%RH and 94%RH. However, for those products highly susceptible to mould, yeast and/or bacterial growth (i. e. bell peppers, mushrooms, berries etc.) a relative humidity of 75% to 80% will result in optimum quality retention.

Modification of the gas composition in the atmosphere within a package around the food can prolong the storage life of the fruit, vegetable or other food products. Modified Atmosphere Packaging (MAP) is an application which uses the respiring food to reduce the oxygen level and accumulate the carbon dioxide levels within a package. The lower oxygen and higher carbon dioxide atmosphere slows the respiration rate and quality loss of the food and suppresses microbial vegetative growth and spore germination leading to

product quality loss (Powrie and Skura, "Modified Atmosphere Packaging of Fruits and Vegetables", Ellis Horwood, 1991, pages 169-245; Zagory. "Modified Atmosphere Packaging", A. Brody, K. Marsh Eds. The Wiley Encyclopaedia of Packaging 1023 pages).

There are many types of reusable food storage containers in use today. However, the lid and the container materials are of materials and thickness that prevent the transmission of oxygen, carbon dioxide and water vapour through the materials. For plastic container applications, the transmission of carbon dioxide, oxygen and water vapour occurs through the lid to container rim seal and is unregulated. The exchange of these gases will depend upon the tightness of the seal between the two surfaces.

Most current plastic container applications do not provide a hermetic seal at the lid to container rim surface. In these applications, oxygen and carbon dioxide diffuses freely between the interior and exterior of the container through the lid-container interface and establishes equilibrium with normal air (less than 1% carbon dioxide and 17%-20% oxygen). In these applications the fresh food does not benefit from internal modified atmospheres. However, the non-hermetic seal in the plastic container does impede the exchange of water vapour and hence provides high relative humidity within the container.

Some recent container designs use tabs or wings to secure the lid to the container. These tabs or wings which secure the lid to the container may create hermetic seals if the lid to container rim design and / or a gasket is used provide an air tight seal. The lid to container seal needs to be hermetic for the present application as gas exchange between the interior of the container and the external environment is regulated by either the type of container material or the selected films contained within the modified lid structure.

A novel functional reusable food storage container for home and institutional use can impart significant benefits in maintaining food quality, extending the usable life of foods in the home and institutions and providing greater consumer confidence in food safety.

#### SUMMARY OF THE INVENTION

This invention relates to a novel application which provides for simultaneous control and regulation of water vapour transmission and oxygen and carbon dioxide transmission for food products held at refrigerated temperatures for extended storage periods of 5 to 20 days.

The objectives of this invention, which are to be achieved from the design, composition and implementation of this system, are :

1. retention of ready-to-eat quality of prepeeled, deseeded, trimmed chunked, sliced, cubed or other prepared fruit or vegetables;
2. inhibition of mould, yeast and bacterial development on ready-to-eat food;

3. inhibition of off-flavors that develop from yeast, mould or bacteria growth and / or physiological senescent processes.

The invention consists of the novel container design and application inclusive of the following :

1. preparing the fruit or vegetable by washing, sanitizing, peeling, trimming and / or marinating the product;
2. placing the product in a custom designed container consisting of an open-box structure with a continuous inverted upper rim that represents a contact surface with two to four opposed receptacles for latch contact. The lid consists of two pieces:

i/ a micro or macro-perforated panel that engages a film with selected permeability for oxygen and carbon dioxide transmission which then form a hermetic seal with the upper rim of the container portion or alternatively;

ii/ the gas transmission film can be used either from roll stock or pre-cut film, but alternatively could be film encircled by a plastic frame which compresses and hermetically seals to the lid panel and the inverted upper rim of the container. Alternatively, the film may be selected as a high barrier film to the transmission of oxygen and carbon dioxide with a permeable rubber / plastic gasket applied to the plastic frame for optimal gas transmission. In this latter application the film may be constructed of polyamide to provide enhanced water vapour transmission properties.

The lid panel has two or four opposed latches which rotate to compress the lid and film to form a hermetic seal with the rim of the container.

3. The container body may be constituted from a range of plastic materials including but not limited to polyamide (nylon 6, 66, 11, Or 12 and blends thereof) polycarbonate, polyethylene, polyethyleneterephthalate, polypropylene, polystyrene, polyvinylchloride, and mixtures thereof.
4. The lid may be constituted from a range of plastic materials including but not limited to polyamide (nylon 6, 11, 12 or 66 and blends thereof), polycarbonate, polyethylene, polyethyleneterephthalate, polypropylene, polystyrene, polyvinylchloride, and mixtures thereof.
5. The differentially permeable film membrane hermetically sealed between the lid and the container may be constituted from a range of plastic materials including but not limited to: polyamide (high barrier to oxygen and carbon dioxide, permeable to water vapour), polyethylene, polypropylene, polyvinylchloride and mixtures and / or laminates thereof.

The container and top for holding the fresh food should have semi-rigid walls with high oxygen and carbon dioxide barrier properties. The film properties should be chosen from one of four permeability ranges specific for food type :

1. Category 1 :

High Barrier Film :

Oxygen transmission rates of : 100 to 1500 cm<sup>3</sup>per m<sup>2</sup> per 24 hours at 25°C at 1 atm

Carbon dioxide transmission rates of : 300 to 4500 cm<sup>3</sup>per m<sup>2</sup> per 24 hours at 25°C at 1 atm.

2. Category 2 :

Medium Barrier Film :

Oxygen transmission rates of : 1500 to 5000 cm<sup>3</sup>per m<sup>2</sup> per 24 hours at 25°C at 1 atm

Carbon dioxide transmission rates of : 4500 to 15,000 cm<sup>3</sup>per m<sup>2</sup> per 24 hours at 25°C at 1 atm.

3. Category 3 :

Low Barrier (High Permeability) Film :

Oxygen transmission rates of : 25,000+ over cm<sup>3</sup>per m<sup>2</sup> per 24 hours at 25°C at 1 atm

Carbon dioxide transmission rates of : 75,000+ cm<sup>3</sup>per m<sup>2</sup> per 24 hours at 25°C at 1 atm.

The films for the three categories ideally are color coded for simplicity of application to a particular food group. The color coding may be applied to the film or the plastic frame. As examples, green color coding of Category 1 would apply to green leaf salads ((low to medium respiration rates), red color coding of Category 2 would apply to fruit pieces (intermediate respiration rates), and white coding of Category 3 would apply to mushrooms (high respirations rates).

The film selections must allow carbon dioxide transmit through the film at rates 3 to 4 times the oxygen transmission rate and therefore have a carbon dioxide:oxygen diffusion ratio of 1:3 to 4. For the example which employs micro-perforations the oxygen:carbon dioxide diffusion ratio will be 1 to 1.0 to 1.5.

The container top and bottom materials can to maintain internal humidity in the range of 75%RH to 85% by the use of polyamide materials and thickness of construction. Alternatively, the gas regulation film can be constructed of polyamide for enhanced water vapour exchange and oxygen and carbon dioxide exchange provided by a single 50 to 90 micron perforation either in the lid to container gasket or the film itself.

Prior to sealing the package, air may be removed from the package by vacuum.

The sealed package of respiring fresh food can contain a ratio mass (grams) to total package volume (cm<sup>3</sup>) of between 0.3 to 0.6. The headspace gas composition of the sealed package can be between 1 and 50% carbon dioxide and 0.5% to 15% oxygen with internal relative humidity of 75%RH to 100%RH.

#### BRIEF DESCRIPTION OF THE DRAWINGS

The disclosed containers are described diagrammatically in the following drawings wherein:

FIG. 1 provides a view of the film, lid and container where the film is selected to have specific oxygen transmission properties;

FIG. 2 provides a view of the film, lid and container where the film is selected to have low oxygen and carbon dioxide transmission properties but high water vapour transmission properties and the gas exchange is regulated by a micro-perforation placed either in the film or gasket.

The drawings are not necessarily to scale and the embodiments are sometimes illustrated by graphic symbols, phantom lines, diagrammatic representations and fragmentary views. In certain instances, details which are not necessary for an understanding of the disclosed containers or which may render other details difficult to perceive may have been omitted. It should be understood, of course, that the disclosure is not necessarily limited to the particular embodiments illustrated herein.

#### DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Throughout the following description, specific details are set forth in order to provide a more thorough understanding of the invention. However, the invention may be practised without these particulars. In other instances, well known elements have not been shown or described in detail to avoid unnecessarily obscuring the invention. Accordingly, the specification is to be regarded in an illustrative, rather than a restrictive, sense.

This invention provides a novel packaging application involving the preparation of washed, sanitized, peeled, deseeded and pre-cut fruits and vegetables followed by modified atmosphere packaging of the product for ready-to-eat consumption at a later time. The fresh product continues to respire in the sealed container and consumes oxygen and releases carbon dioxide into the chamber environment and are subject to modified

atmosphere packaging (MAP). The natural processes provide reduced oxygen content with increased carbon dioxide content. This state provides for reduction of product respiration, inhibition of microbiological growth and spore germination and inhibition of senescence promoting ethylene action thereby maintaining product ripeness and retarding deterioration of the product.

The functional, reusable modified atmosphere storage container, lid and film is illustrated in Fig 1 and 2. The apparatus provides for the simultaneous or independent regulation of oxygen, carbon dioxide and water vapour transmission between the interior and exterior of the sealed package and the ambient storage atmosphere. Oxygen and carbon dioxide transmission is regulated by a range of specialized films with specific oxygen and carbon dioxide transmission rates and / or by the use of micro-perforations in the lid the container seal gasket or micro-perforations in the film itself. Generally if micro-perforations are used the total surface area would be in the range of 50 to 200 microns and can be customized for specific product categories. The lid is perforated with either micro-perforations or macro-perforations with lid perforation surface area up to 1% of the total lid surface area.

According to the invention, prepared optimum maturity fruits and vegetables are placed into the container and sealed in the plastic packages (MAP packages) with the appropriate gas transmission rates to ensure the attainment of high carbon dioxide levels (5% to 20%) and low oxygen levels (1.5% to 5%) in the headspace of the container after 7 days of storage at 5C. Films are provided for specific products and volumes to ensure that oxygen levels do not fall below 1% where anaerobic respiration can affect product quality and food safety may become an issue.

A minimum of three film or perforation options are provided for specific categories of fruit and vegetables. Each film option will be color coded for easy identification. Specifically, the film oxygen transmission ranges for ratio mass (grams) to total package volume ( $\text{cm}^3$ ) of between 0.3 to 0.6 would be applicable as :

1. Category 1 :

High Barrier Film :

Oxygen transmission rates of : 100 to 1500  $\text{cm}^3$  per  $\text{m}^2$  per 24 hours at 25°C at 1 atm

Carbon dioxide transmission rates of : 300 to 4500  $\text{cm}^3$  per  $\text{m}^2$  per 24 hours at 25°C at 1 atm.

Sample product applications : Baby carrots, beets and other root crops; fresh cut salads.

2. Category 2 :

Medium Barrier Film :

Oxygen transmission rates of : 1500 to 5000 cm<sup>3</sup>per m<sup>2</sup> per 24 hours at 25°C at 1 atm

Carbon dioxide transmission rates of : 4500 to 15,000 cm<sup>3</sup>per m<sup>2</sup> per 24 hours at 25°C at 1 atm.

Sample product applications : Fruits such as cantaloupe, honey dew, tomatoes, apple, pears, cherries, grapes, peaches, nectarines, kiwi, strawberries, tomatoes, cucumbers (in general citrus, pome and drupe fruits, berries and greenhouse crops).

4. Category 3 :

Low Barrier (High Permeability) Film :

Oxygen transmission rates of : 25,000+ over cm<sup>3</sup>per m<sup>2</sup> per 24 hours at 25°C at 1 atm

Carbon dioxide transmission rates of : 75,000+ cm<sup>3</sup>per m<sup>2</sup> per 24 hours at 25°C at 1 atm.

Sample product applications : Mushrooms, asparagus.

The novel apparatus provides additional maintenance of food product quality with options to regulate the relative humidity within the sealed package through the selection of lid, container and film materials. Fabrication of the film, container and / or lid from a range of polyamide materials (water vapor absorption / permeabilities of 1.0 to 2.5 g-mm per m<sup>2</sup>-day at 75% to 100% relative humidity) provides the ability to absorb moisture and regulate relative humidity levels within the sealed package. Maintenance of internal relative humidity levels at approximately 75%RH to 85%RH maintains product quality by removing residual surface water from the product, providing slight moisture reduction of the product, removal of water vapour generated from product respiration and maintain a relative humidity level that suppresses microbial vegetative growth and spore germination (below 80%RH). Pre-cut salads have been shown to double the effective shelf life if the product is stored without residual moisture after washing and dried to original of -1% (wt/wt) of its original weight.

Example 1 :

The process for preparation and preservation of perishable kiwi fruit using the invention, involves the following :

1. Ready-to-eat firm mature ripe kiwi fruit (firmness of 1 to 3kgf) that are free of obvious decay are selected, washed with soap and water (or 100 ppm chlorine if available) and dried with a paper towel or air;
2. Kiwi fruit are peeled with a sharp knife and sliced as halves, segments or slices of desired size;
3. Approximately 200g of prepared kiwi fruit (approximately 2 peeled kiwi fruit) are placed a 500mL container and lid constructed of polyethyleneterephthalate;
4. The kiwi fruit were sealed in the package (silicon gaskets) with a plastic film with an oxygen transmission rate of  $3000 \text{ cm}^3 \text{ per m}^2 \text{ per 24 hours}$  at  $25^\circ\text{C}$  at 1 atm and stored at  $5^\circ\text{C}$  for 15 days (MAP).

The quality of the MAP kiwi fruit compared to non-MAP controls (consisting of identical fruit in perforated clamshells) was superior after three days in storage. Control fruit were noticeably water logged, with a translucent appearance, dull grey core area, soft flesh texture and loss of characteristic kiwi flavour. Kiwi fruit placed in clamshells were rated as unacceptable for consumption after day 3 of storage by a 3 member trained sensory panel.

Kiwifruit stored in the MAP container were rated by the sensory panel as excellent on day 7 of storage and as acceptable at day 15. Fruit pieces were bright green and opaque with texture equivalent to the texture at day 0. Characteristic kiwi flavour was maintained throughout the 15 days storage period without noticeable off-flavors (ethanol and acetaldehyde) found in the control fruit.

#### Example 2 :

The process for preparation and preservation of fragile baby leaf lettuce salad using the invention, involves the following :

1. Baby leaf lettuce mixtures consisting of red romaine, green oak, red oak, green leaf, lolla rossa, red leaf, radicchio, little gem, tango and green romaine was commercially prepared and packed in a MAP bag with oxygen transmission rate  $1800 \text{ cm}^3 \text{ per m}^2 \text{ per 24 hours}$  at  $25^\circ\text{C}$  at 1 atm;
2. With six day of shelf life in the package and with 6 days remaining to code date (coded for 12 days of shelf life at  $5^\circ\text{C}$ ), the bag was opened and 100 grams of the baby lettuce blend repackaged in either in a 500 mL ventilated clamshell (ambient atmosphere) or the invention consisting of container, lid and film constructed from a polyamide blend.
3. A 60 micron perforation was inserted in the film to provide an oxygen and carbon dioxide transmission rate of approximately  $2500 \text{ cm}^3 \text{ per m}^2 \text{ per 24}$

hours at 25°C at 1 atm and the package sealed with silicon gaskets and stored at 5°C for periods of 3, 6, 9 and 12 days;

Baby leaf product stored in the ventilated clamshells demonstrated significant wilting of surface product after three days of storage and was accompanied by observable browning of some of the components, most notably the radicchio and other red components. While the product was rated as marginally acceptable at day 6, the product rated as unacceptable for consumption by day 6 of storage. At day 6 more than 60% of the leaf product was either wilted or discoloured from high oxygen levels encountered in the clamshell. By day 9, a significant off-odor was evident with product breaking down due to slime mould (*erwinia* spp., *pseudomonas* spp).

Baby leaf product stored in the MAP container after 12 days of storage was rated as 4 of a full scale of 5 (5 being excellent and 3 deemed to be marginally acceptable). Browning and wilting of the lettuce was not evident. After 12 days of storage, the MAP product was scored as 3.5 and found to be acceptable for consumption. No off odors or evidence of mould or decay were identified.

As will be apparent to those skilled in the art with respect to the forgoing disclosures, many alterations and modifications are possible in the practice of this invention without departing from the spirit or scope thereof. Accordingly, the scope of the invention is to be construed in accordance with the substance defined in the following claims.

## WHAT IS CLAIMED IS :

1. A system and reusable plastic container for preserving fresh ready-to-eat fruits and vegetables by packaging peeled, deseeded and cut pieces in a modified atmosphere package between 1% and 15% oxygen and 1% and 20%% carbon dioxide at relative humidity between 75%RH and 100%RH.
2. A reusable plastic container (Fig. 1, Fig. 2) that be designed in various shapes, including but not limited to round, square, rectangular or oval and may consist of two or three pieces including:
  - a) A container body may be constituted from a range of plastic materials including but not limited to polyamide (nylon 6, 66, 11, Or 12 and blends thereof) polycarbonate, polyethylene, polyethyleneterephthalate, polypropylene, polystyrene, polyvinylchloride, and mixtures thereof.
  - b) A lid may be constituted from a range of plastic materials including but not limited to polyamide (nylon 6, 11, 12 or 66 and blends thereof), polycarbonate, polyethylene, polyethyleneterephthalate, polypropylene, polystyrene, polyvinylchloride, and mixtures thereof. The lid may either be macro-perforated for as three piece application or micro-perforated for a two piece application.
  - c) The differentially permeable film membrane hermetically sealed between the lid and the container may be constituted from a range of plastic materials including but not limited to: polyamide (high barrier to oxygen and carbon dioxide, permeable to water vapour), polyethylene, polypropylene, polyvinylchloride and mixtures and / or laminates thereof.
3. A system for the maintenance of quality and preservation of food using modified atmospheres consisting of 1% to 50% carbon dioxide and 1% to 15% oxygen;
4. A system which provide a selection of film options with oxygen and carbon dioxide permeability designed for specific package volumes and produce respiration and may consist of:

Category 1 :

High Barrier Film :

Oxygen transmission rates of : 100 to 1500 cm<sup>3</sup>per m<sup>2</sup> per 24 hours at 25°C at 1 atm

Carbon dioxide transmission rates of : 300 to 4500 cm<sup>3</sup>per m<sup>2</sup> per 24 hours at 25°C at 1 atm.

Sample product applications : Baby carrots, beets and other root crops; fresh cut salads.

Category 2 :

Medium Barrier Film :

Oxygen transmission rates of : 1500 to 5000 cm<sup>3</sup>per m<sup>2</sup> per 24 hours at 25°C at 1 atm

Carbon dioxide transmission rates of : 4500 to 15,000 cm<sup>3</sup>per m<sup>2</sup> per 24 hours at 25°C at 1 atm.

Sample product applications : Fruits such as cantaloupe, honey dew, tomatoes, apple, pears, cherries, grapes, peaches, nectarines, kiwi, strawberries, tomatoes, cucumbers (in general citrus, pome and drupe fruits, berries and greenhouse crops).

Category 3 :

Low Barrier (High Permeability) Film :

Oxygen transmission rates of : 25,000+ over cm<sup>3</sup>per m<sup>2</sup> per 24 hours at 25°C at 1 atm

Carbon dioxide transmission rates of: 75,000+ cm<sup>3</sup>per m<sup>2</sup> per 24 hours at 25°C at 1 atm.

Sample product applications : Mushrooms, asparagus.

5. A system that can regulate relative humidity within the container within a range of 75 to 94%, preferably between 75% and 85% for some foods by removing moisture from the food and the moisture generated from respiration by constructing the lid, container or film of polyamide materials with water absorption / transmission properties within the range of 1.0 to 2.5 g-mm per m<sup>2</sup>-day at 75% to 100% relative humidity. The resulting relative humidity suppresses product decay due to micro-organisms;
6. A system which independently controls modified atmospheres and humidity within the container;
7. A system where the sealed package of respiring fresh food can contain a ratio mass (grams) to total package volume (cm<sup>3</sup>) of between 0.3 to 0.6. The headspace gas composition of the sealed package can be between 1 and 50% carbon dioxide and 1% to 15% oxygen with internal relative humidity of 75%RH to 100%RH.

Modified Atmosphere Packaging

Figure 1 Usage of Films in Conjunction with a Breachable Lid for Air Transmission:

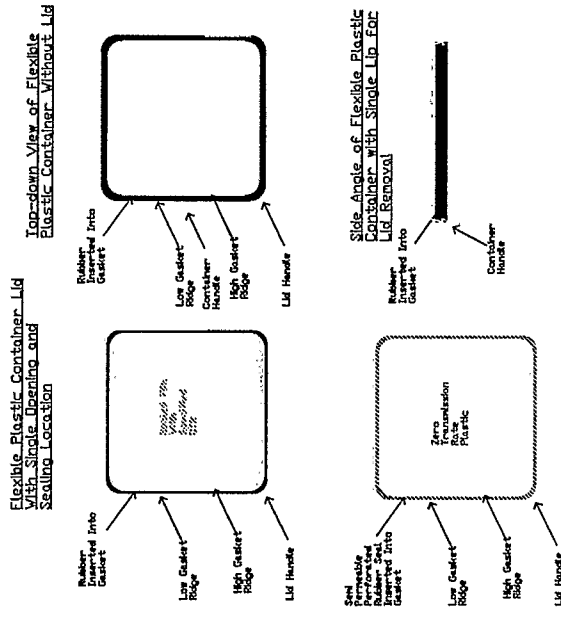
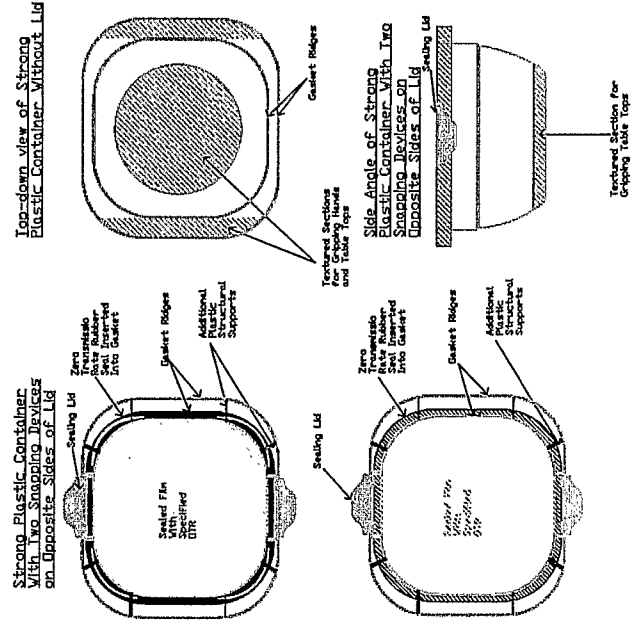
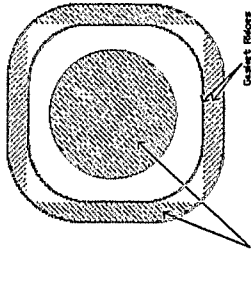


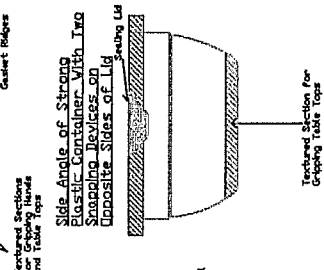
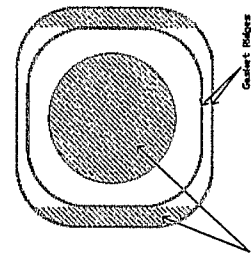
Figure 2 Usage of Perforated Rubber Insert in Conjunction with a Sealed Lid for Air Transmission on



Top-down view of Strong Plastic Container Without Lid Gasket Ridge for Increased Gas Transmission



Top-down view of Strong Plastic Container Without Lid



## INTERNATIONAL SEARCH REPORT

International application No.  
PCT/SG2006/000054**Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)**

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1.  Claims Nos.:  
because they relate to subject matter not required to be searched by this Authority, namely:
  
2.  Claims Nos.:  
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:
  
3.  Claims Nos.:  
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a)

**Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)**

This International Searching Authority found multiple inventions in this international application, as follows:

See supplemental sheet

1.  As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2.  As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.
3.  As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:
  
4.  No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

**Remark on Protest**

- The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.
- The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.
- No protest accompanied the payment of additional search fees.

**Box No. IV Text of the Abstract (Continuation of item 5 of the first sheet)**

A system and reusable plastic container for preserving the quality of a range of fruits and vegetables. The container independently maintains modified atmospheres within the range between 1% to 50% carbon dioxide and 1% to 15% oxygen at a relative humidity (RH) of 75%RH and 100%RH. For produce highly susceptible to mould, yeast and/or bacterial growth a RH of 75% to 80% will result in optimum quality retention. The container includes a plastic body, plastic lid and permeable film membrane hermetically sealed between the lid and the container. The plastic can be polyamide (nylon 6, 11, 12 or 66 and blends thereof), polycarbonate, polyethylene, polyethyleneterephthalate, polypropylene, polystyrene, polyvinylchloride, and mixtures thereof. The lid can be macro-perforated for a three piece application or micro-perforated for a two piece application. The film membrane can have different oxygen and carbon dioxide permeability rates for specific package volumes and specific produce respirations.

## INTERNATIONAL SEARCH REPORT

International application No.

PCT/SG2006/000054

## A. CLASSIFICATION OF SUBJECT MATTER

Int. Cl. **B65D 81/18** (2006.01) **B65B 25/04** (2006.01) **B65D 81/24** (2006.01)  
**A23L 3/3418** (2006.01) **B65B 31/00** (2006.01) **B65D 85/34** (2006.01)

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)  
 DWPI IPC B65D 81/-, 6/-, 8/-, 85/34, B65B 25/-, A23L 3/- and/or a combination of keywords: OXYGEN, CARBON DIOXIDE, HUMIDITY, VAPOUR, MOISTURE, PRESERVE, PERISHABLE, FRESH, QUALITY, FRUIT, VEGETABLE, CONTAINER, RECEPTACLE, CUP, PUNNET, LID, PLASTIC, POLYAMIDE, FILM, MEMBRANE, TRANSMISSION, PERMEABILITY, SEAL, HERMETIC, PERFORATION and similar terms

## C. DOCUMENTS CONSIDERED TO BE RELEVANT


Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y	WO 1997/030911 A1 (BEN-TZUR ET AL.) 28 August 1997 See whole document – eg page 1 See whole document	1, 2, 3, 5, 7 7
X Y	CA 2154388 A1 (KIMBERLY-CLARK CORPORATION) 12 February 1996 See whole document – eg page 2, lines 17 to 20; page 3, lines 26 to 36; page 5, lines 6 to 13; and page 8, line 27 to page 9, line 2. See whole document	1, 3, 7 7
X	US 4939030 A (TSUJI ET AL.) 3 July 1990 See whole document – eg column 3, line 31 to column 4, line 27	1, 3, 7

 Further documents are listed in the continuation of Box C See patent family annex

* Special categories of cited documents:	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"A" document defining the general state of the art which is not considered to be of particular relevance	"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"E" earlier application or patent but published on or after the international filing date	"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"&" document member of the same patent family
"O" document referring to an oral disclosure, use, exhibition or other means	
"P" document published prior to the international filing date but later than the priority date claimed	

Date of the actual completion of the international search  
04 July 2006Date of mailing of the international search report  
14 JUL 2006

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## INTERNATIONAL SEARCH REPORT

International application No.

PCT/SG2005/000054

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 937406 A2 (QUISQUEYA S.L.) 25 August 1999 See whole document – eg abstract, paragraphs 32, 37, 42 and claims	1, 3, 7
X	JP 2004073077 A (SUMITOMO BAKELITE CO LTD) 11 March 2004 See abstract (Derwent Abstract Accession No. 2004-350930/33, Class A92)	1, 3, 7
X	Derwent Abstract Accession No. 2005-123479/14, Class D13, CN 1539301 A (LULIN BINGLUN FRESH GARDEN STUFF TECH CO) 27 October 2004 See abstract	1, 3, 7
X	Derwent Abstract Accession No. 2005-123481/14, Class D13, CN 1539303 A (LULIN BINGLUN FRESH GARDEN STUFF TECH CO) 27 October 2004 See abstract	1, 3, 7
X	WO 2004/004474 A1 (FRESH CONCEPTS CORP. PTY LTD) 15 January 2004 See whole document – eg page 13, line 21 to page 14, line 9.	1, 3, 7
Y	WO 1990/008474 A1 (TEIJIN LIMITED) 9 August 1990 See abstract and Derwent Abstract Accession No. 90-260680/34, Class Q34 (The amount of fruit stored in container is 10-50 vol % of container.)	7
Y	US 2003/0091705 A1 (LIDSTER ET AL.) 15 May 2003 See whole document – eg paragraphs 29 to 33 (Ratio of fruit mass to total package volume of between about 0.3 to 0.5.)	7
X	WO 2003/011037 A1 (FRESHTEC PACKAGING, INC.) 13 February 2003 See whole document – eg page 5, lines 9 to 22; and page 6, lines 10 to 27	2
X	US 6042862 A (KOCHER ET AL.) 28 March 2000 See whole document – eg figures 1 to 5; and column 9, lines 14 to 57	2
X	WO 2002/051716 A1 (COLENBRANDER) 4 July 2002 See whole document – eg figures	2
X	US 5759650 A1 (RAINES ET AL.) 2 June 1998 See whole document – eg abstract and figures 1 and 2	2

## INTERNATIONAL SEARCH REPORT

International application No.

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C (Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 261930 A2 (KEYES (U.K.) LIMITED) 30 March 1988 See whole document	2
X	GB 2028082 A (POLYPLASTICS COMPANY LIMITED) 5 March 1980 See whole document – eg pages 1, lines 90 to 130	2
A	WO 2001/042010 A1 (HONEYWELL INTERNATIONAL INC.) 14 June 2001 See whole document – Food package made from plastic such as polyamide.	2
A	US 2003/0035868 A1 (COULTER ET AL.) 20 February 2003 See whole document – Modified environment packaging with perforations	2
X	Derwent Abstract Accession No. 90-120664/16, Class A92, JP 2-072074 A (TORAY IND INC) 12 March 1990 See abstract	4
X	US 5763095 A (RAMESH ET AL.) 9 June 1998 See whole document – eg column 1, lines 29 to 47; column 2, lines 6 to 29	4
X	Derwent Abstract Accession No. 21332C/12, Class A92, Q34 (A18), JP 55-020172 A (ASAHI DOW KK) 13 February 1980 See abstract	4
X	Derwent Abstract Accession No. 98423E/46, Class A92, Q34 (A13), JP 57-163661 A (ASAHI DOW KK) 7 October 1982 See abstract	4
X	EP 243965 A2 (TOYO BOSEKI KABUSHIKI KAISHA) 4 November 1987 See whole document – eg abstract	4
X	Derwent Abstract Accession No. 98312E/46, Class A92, P12 JP 57-163414 A (ASAHI DOW KK) 7 October 1982 See abstract	4
X	EP 311423 A2 (HERCULES INCORPORATED) 12 April 1989 See whole document – eg abstract	4

## INTERNATIONAL SEARCH REPORT

International application No.

PCT/SG2006/000054

C (Continuation)		DOCUMENTS CONSIDERED TO BE RELEVANT
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 6296923 B1 (ZOBEL) 2 October 2001 See whole document – eg column 2, lines 16 to 62 (Water absorption rate of 1 to 2 g-mm per m <sup>2</sup> -day for polypropylene films)	5
X	EP 1184298 A1 (FROMAGERIES BEL) 6 March 2002 See whole document – eg paragraphs 24 and 46 (& Derwent abstract accession no. 2002-282832/33, class D13) (Water vapour permeability of 1 g-mm per m <sup>2</sup> -day)	5
X	US 4001443 A (DAVE) 4 January 1977 See whole document – eg column 1, lines 22 to 59 (Water vapour permeability of about 0.3 to 45 g-mm per m <sup>2</sup> -day)	5
A	US 4711789 A (ORR ET AL.) 8 December 1987 See whole document – eg column 5, line 55 to column 6, line 9 (Water permeability/absorption rate of less than about 7.5 g-mm per m <sup>2</sup> -day)	5
X	US 5795370 A (GARRETT ET AL.) 18 August 1998 See whole document	6
X	US 5451248 A (SADKOWSKI ET AL.) 19 September 1995 See whole document	6
X	US 5872721 A (HUSTON ET AL.) 16 February 1999 See whole document – eg abstract and column 3, lines 27 to 40	6

**Supplemental Box**

(To be used when the space in any of Boxes I to VIII is not sufficient)

**Continuation of Box No III:**

This International Application does not comply with the requirements of unity of invention because it does not relate to one invention or to a group of inventions so linked as to form a single general inventive concept.

In assessing whether there is more than one invention claimed, I have given consideration to those features which can be considered to potentially distinguish the claimed combination of features from the prior art. Where different claims have different distinguishing features they define different inventions.

This International Searching Authority has found that there are different inventions as follows:

- Claims 1, 3 and 7 relate to systems wherein food is preserved in a modified atmosphere consisting of 1% to 15% oxygen and 1% to 20% carbon dioxide. It is considered that the particular composition of the atmosphere to preserve the food comprises a first distinguishing feature.
- Claim 2 relates to a reusable plastic container consisting of two or three pieces including: (a) a container body made of plastic materials, (b) a lid made of plastic materials and is either macro-perforated for as three piece application or micro-perforated for a two piece application; and (c) a permeable film membrane hermetically sealed between the lid and the container. It is considered that the construction and particular materials as defined in this claim 2 comprises a second distinguishing feature.
- Claim 4 relates to a system which provides a selection of barrier film options with different oxygen and carbon dioxide permeability or transmission rates. The claim defines three different categories for particular food products. It is considered that the different barrier film options comprise a third distinguishing feature.
- Claim 5 relates to a system that can regulate the relative humidity in a container within a range of 75% to 94%. The container, lid or film is constructed to have a water absorption / transmission property within the range of 1.0 to 2.5 g (quantity) per mm (thickness) per m<sup>2</sup> (area) per day (time) at 75% to 100% relative humidity. It is considered that system of regulating the relative humidity comprises a fourth distinguishing feature.
- Claim 6 relates to a system which independently controls modified atmospheres and humidity within the container. It is considered that the independent control of the atmosphere and humidity comprises a fifth distinguishing feature.

PCT Rule 13.2, first sentence, states that unity of invention is only fulfilled when there is a technical relationship among the claimed inventions involving one or more of the same or corresponding special technical features. PCT Rule 13.2, second sentence, defines a special technical feature as a feature which makes a contribution over the prior art.

Each of the abovementioned groups of claims has a different distinguishing feature and they do not share any feature which could satisfy the requirement for being a special technical feature. Because there is no common special technical feature it follows that there is no technical relationship between the identified inventions. Therefore the claims do not satisfy the requirement of unity of invention *a priori*.

## INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/SG2006/000054

This Annex lists the known "A" publication level patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent Document Cited in Search Report		Patent Family Member					
WO	1997/030911	AU	49284/96	BR	9612519	EP	0888237
		US	6190710				
CA	2154388						
US	4939030	EP	0356161	JP	2175140		
EP	0937406	ES	2134175				
JP	2004073077						
CN	1539301						
CN	1539303						
WO	2004/004474	AU	2003236596	US	2006093709		
WO	1990/008474	CA	2026215	JP	5131587	JP	5132515
		JP	6127570				
US	2003091705						
WO	2003/011037	US	2003031769	US	2003057217	US	2003087015
US	6042862	AU	66954/98	CA	2283254	EP	1007440
		NZ	337582	US	5779050	WO	9840287
WO	2002/051716	EP	1353860				
US	5759650						
EP	0261930	AU	78935/87	BR	8704861	CN	87106957
		DK	496887	JP	63218076	NO	873951
		US	4830863	ZA	8707119		
GB	2028082	CA	1120721	DE	2932985	FR	2433897
		JP	55085330				
WO	2001/042010	AU	19443/01	CA	2394952	EP	1250224
		FI	20021108	MX	PA02005721	US	2002071921
		US	2002071923				
US	2003035868						
JP	2072074						
US	5763095	AU	62133/96	BR	9605742	CA	2183836
		NZ	299199				
JP	55020172						
JP	57163661						

**INTERNATIONAL SEARCH REPORT**  
Information on patent family members

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EP	0243965	JP	62257840	JP	63119647	JP	63119648
		US	4876146	US	4956209		
JP	57163414						
EP	0311423	AU	23547/88	BR	8805220	IL	87974
		JP	1122429	NZ	226480	PH	25803
US	6296923	AU	38078/89	BR	8903487	EP	0351116
		GB	2221691	JP	2073831	JP	5084019
		JP	5201481	NZ	229939	ZA	8905388
EP	1184298	FR	2813279				
US	4001443	AR	209868	FR	2340687	JP	52102456
US	4711789	EP	0224713	JP	62138135	US	4753808
US	5795370	AU	56094/96	EP	0750852	JP	9105577
		SG	79199	ZA	9605534		
US	5451248	AU	81118/91	CA	2047279	EP	0467668
		IN	179347	JP	6047235	ZA	9105559
US	5872721	AU	74301/91	EP	0457431	NZ	237801
		WO	9115719	ZA	9102658		

Due to data integration issues this family listing may not include 10 digit Australian applications filed since May 2001.

END OF ANNEX