The invention relates to a package (1) for preserving respiring produce (2), in particular vegetables, fruit, and herbs, comprising a packaging material, in particular a polymer film (1A), provided with at least one opening (3) enabling gas exchange with the atmosphere surrounding the package (1). The package (1) contains a scavenger (4).
Fig. 1

Fig. 2

Fig. 3
The invention relates to a package for preserving respiring produce contained in the package, in particular vegetables, fruit, and herbs, comprising a packaging material, in particular a polymer film, provided with at least one opening enabling gas exchange, in particular the exchange of oxygen and carbon dioxide, with the outside atmosphere surrounding the package. The invention further relates to an apparatus for making such a package.

As explained in U.S. Pat. No. 7,083,837, the quality and shelf life of many food products is enhanced by enclosing them in packaging that modifies or controls the atmosphere surrounding the product. Increased quality and longer shelf life result in fresher products for the consumer, less waste from spoiled produce, better inventory control, and appreciable overall savings for the food industry at both the retail and wholesale levels.

Modified and controlled atmosphere packaging (MAP/CAP) preserves produce quality by reducing the aerobic respiration rate but avoiding anaerobic processes that lead to adverse changes in texture, flavor, and aroma, as well as an increased public health concern. It is mentioned in U.S. Pat. No. 7,083,837 that sometimes the package is gas-flushed with N₂ or a combination of CO₂ and N₂ or O₂, CO₂, and N₂ before sealing to rapidly establish the desired gas composition inside the package.

Flushing packages with a gas slows down the packaging process significantly, e.g. by 50% when compared to a process without flushing, and thus raises the costs of the packages obtained.

It is an object of the present invention to provide a modified atmosphere package which reaches the desired gas composition inside the package relatively quickly, e.g. within one day, substantially without slowing down the packaging process.

To this end, the package according to the invention is characterized in that it comprises, preferably contains a scavenger. In an embodiment, the package comprises one or more scavengers for oxygen, carbon dioxide and/or ethylene. In a further embodiment, the scavenger is or includes a scavenger for oxygen and the amount of the scavenger for oxygen is selected to remove only part of the oxygen contained in the package after sealing the package during production, i.e. the scavenger is depleted before all oxygen is removed. In other words, the amount of the scavenger is adjusted to the desired composition of the atmosphere inside the package. E.g., the amount of the scavenger for oxygen is selected to reduce, preferably within 24 hours, the concentration of oxygen to within a range of from 0.2 to 10%, preferably from 0.5 to 7%.

It is observed that to date the purpose of scavengers is to remove specific gases from the contents of hermetic packages and to permanently keep the contents free of these gases. Combining a scavenger with an opening, e.g. a microperforation, for gas exchange is counter-intuitive and yet provides an effective solution to the problem underlying the present invention.

The scavenger can be included prior to packaging, e.g. be integrated in or adhered to the packaging material in the form of a sachet, strip or label, or during packaging, e.g. be inserted in the package while it is formed in a flow pack process, avoiding or at least reducing slowing down the packaging process.

In an embodiment, the at least one opening is a microperforation, e.g. having a diameter in a range from 25 to 250 μm for packages containing average amounts, e.g. two to four portions, of produce.

In an alternative embodiment, the at least one opening is larger, e.g. in a range from 0.5 to 3 cm, and covered by a membrane that is permeable to oxygen and/or carbon dioxide.

The invention further relates to an apparatus for making a package according to the present invention comprising a supply reel and a take-up reel for a packaging material, a beam generator, such as a laser device, for making perforations in the packaging material, in particular a polymer film, and characterised by a supply reel for tape comprising adhesive elements containing a scavenger, which elements are to be applied to the packaging material.

In an embodiment, the elements include sachets, strips or labels to be adhered to the inner wall of the package.

For the sake of completeness, attention is drawn to U.S. Pat. No. 7,387,205, which relates to a active packaging wherein reactive chemicals, including scavengers, are “sequestered” outside the main body of the food storage bag or container. It allows the free exchange of gasses and moisture between the bag contents and the sequestered chemical. This eliminates the two major concerns with the use of sachets in active packaging: that sachets may be accidentally eaten by the consumer or their contents may spill into the package. In the embodiment shown in the drawings of U.S. Pat. No. 7,387,205, an exterior patch (2) is attached to the exterior of a thermoplastic re-closable bag (1) and perforations (6) in the bag between the exterior patch and the interior of the bag. It allows the free flow of gasses and moisture between the contents of the exterior patch and the headspace of the bag.

WO 01/66436 relates to a packaging system which is comprised of a tray (12), a permeable (non-respiring) good or goods (15), e.g., red meat (veal, beef, pork, etc.). pasta, cooked food, and the like, disposed within the tray. A gas permeable film material (18), which may include slits or perforations (20), covers the permeable goods. A barrier bag (22) surrounds the tray (12) and film (18) and is preferably made of a substantially impermeable material. This barrier bag is provided with a one-way (pressure relief) valve (24). In the embodiment shown in FIGS. 6 and 7, an oxygen absorber is present between the tray and the bag.

Within the framework of the present invention the term “scavenger” is synonymous to “gas scrubber” and refers to any substance that reacts with specific gaseous components, in particular oxygen, carbon dioxide and/or ethylene, of the atmosphere inside the package. Oxygen scavenging technologies are generally based on one of the following concepts: iron powder oxidation, ascorbic acid oxidation, photosensitive dye oxidation, and enzymatic oxidation. Carbon dioxide scavengers include calcium oxide. Ethylene scavengers are also known in the art and include potassium permanganate-imregnated alumina pellets, potassium permanganate, activated carbon, activated carbon-Pd-catalyst, activated carbon and bromine type inorganic compounds, and zeolites.

The invention will now be explained in more detail with reference to the drawings, which show a preferred embodiment of the present invention.
FIG. 1 is a graph showing how the concentration of oxygen and carbon dioxide changes with time in a prior art package and in a package according to the present invention.

FIG. 2 shows a cross-section through package according to the present invention.

FIG. 3 apparatus for making a package according to the present invention.

In the packaging of vegetables, fruit, and herbs, MAP/CAP is used to preserve produce quality by reducing the aerobic respiration rate but avoiding anaerobic processes that lead to adverse changes in texture, flavor, and aroma, as well as an increased public health concern. Aerobic respiration can be defined by the following equation:

\[
\text{CH}_4 + 4\text{O}_2 \rightarrow 2\text{CO}_2 + 2\text{H}_2\text{O} + \text{heat}
\]

where oxygen from the air is used to metabolize carbohydrate reserves and in the process, carbon dioxide, and water are produced and heat is generated. For each respiration item, there is an optimum oxygen and carbon dioxide level that will reduce its respiration rate and thereby, slow aging and degenerative processes.

Different fresh produce items have different respiration rates and different optimum atmospheres for extending quality and shelf life. E.g., iceberg lettuce is considered a low respiration vegetable and is best stored at 0, 5 to 1% oxygen, whereas broccoli florets are best stored at 5 to 7% oxygen.

FIG. 1 is a graph showing inter alia how the concentrations of oxygen and carbon dioxide change with time in a modified atmosphere package comprising one or more microperforations. The size and number of the perforations have been selected, in a manner known in itself, to obtain after a few days (indicated on the horizontal line) an optimum or near optimum concentration of carbon dioxide (indicated by the solid and falling line) and oxygen (dashed and falling line).

FIG. 2 shows a package 1 according to the present invention made from a packaging material, in this example a polymer film 1A. Suitable polymers include polyethylene, polypropylene, polyester, polyamide, and cellulose, in monolayers and laminates. In this example, the package was obtained by means of flow pack wrapping.

The package 1 contains produce 2, e.g. cabbage, lettuce, or broccoli, and is provided with a single microperforation 3 adjusted in size to the specific produce, in particular having a diameter enabling a gas exchange that results in suitable concentrations of oxygen and carbon dioxide within a few days. The package 1 further contains a label 4 adhered to the inner wall of the package 1. On the side adhered to the inner wall, the label is provided with information, such as a brand or information relating to the produce or its origin. The other side of the label comprises, in a compartment or dispersed in the material of the label, a scavenger for oxygen, e.g. iron powder, and a scavenger for carbon dioxide, e.g. calcium oxide.

The amount of the scavenger for oxygen was selected to remove only part of the oxygen contained inside the package, i.e. the scavenger is depleted before all oxygen is removed. This is illustrated in FIG. 1 (solid and falling line), which shows how the concentration of oxygen falls, in less than a day, from about 20% to about 1%, appropriate for low respiring produce, such as iceberg lettuce. By that time, the scavenger for oxygen has been depleted and is no longer efficacious. A concentration of about 1% is subsequently maintained by means of the micro-perforation.

The amount of the scavenger depends on the amount of air contained in the package and can be calculated in a straightforward manner. E.g., for a package containing 200 ml air, the scavenger should have a capacity of 38 ml O₂ to reduce the concentration of oxygen to 1%.

As a comparison, FIG. 1 also illustrates (dotted line) the reduction of the concentration of oxygen if only the scavenger and no micro-perforation is present. In that case, oxygen is depleted after approximately one day and decay resulting from anaerobic processes ensues.

The amount of the scavenger for carbon dioxide is selected to remain efficacious beyond the shelf life of the produce. For most produce, to avoid anaerobic defects such as off smell and tissue breakdown, it is preferred that the concentration of carbon dioxide does not exceed 15-20%.

FIG. 3 schematically shows an apparatus 5 for making a package as described above. The apparatus 5 comprises a supply reel 6 and a take-up reel 7 for a packaging film 1A, and a beam generator 9, such as a laser device 8, for making openings, in particular micro-perforations, in the packaging material. The apparatus 5 further comprises a supply reel 9 for tape 10 comprising adhesive elements containing a scavenger to be applied to the packaging material. To prevent the tape from closing off the perforations, the supply reel 9 for the tape 10 is offset relative to the beam generator 8. The apparatus can comprise yet a further supply reel for a strip-like membrane that is permeable to oxygen and/or carbon dioxide to cover the openings, in particular bigger openings.

From the example above, it will be clear that the invention provides a modified atmosphere package which reaches the desired gas composition inside the package relatively quickly, e.g. within one day, without having to flush the package with the desired gas composition and thus without substantially slowing down the packaging process.

The invention is not restricted to the above-described embodiments which can be varied in a number of ways within the scope of the claims.

1. Package for preserving respiring produce contained in the package, in particular vegetables, fruit, and herbs, the package comprising:

   a packaging material provided with at least one opening enabling gas exchange with the atmosphere surrounding the package, and

   one or more scavengers.

2. Package according to claim 1, wherein the one or more scavengers are scavengers for oxygen, carbon dioxide and/or ethylene.

3. Package according to claim 2, wherein the one or more scavengers are or include a scavenger for oxygen and wherein the amount of the scavenger for oxygen is selected to remove only part of the oxygen contained in the package.

4. Package according to claim 3, wherein the amount of the scavenger for oxygen is selected to reduce the concentration of oxygen to within a range of from 0, 2 to 10%.

5. Package according to claim 1, wherein the scavenger is integrated in the packaging material or contained in a sachet, strip or label adhered to the packaging material.

6. Package according to claim 1, wherein the at least one opening is a micro-perforation.

7. Package according to claim 1, wherein the at least one opening is covered by a membrane that is permeable to oxygen and/or carbon dioxide.
8. Package according to claim 1 containing produce.

9. Package according to claim 1, wherein the scavenger is contained inside the package.

10. Apparatus for making a package for preserving respiring produce contained in the package, the package comprising a packaging material provided with at least one opening enabling gas exchange with the atmosphere surrounding the package, and a scavenger, the apparatus comprising:

   a supply reel for the packaging material,
   a take-up reel for the packaging material,
   a beam generator for making openings in the packaging material, and
   a supply reel for tape comprising adhesive elements containing the scavenger to be applied to the packaging material.

11. Apparatus according to claim 10, wherein the elements include sachets, strips or labels to be adhered to the inner wall of the package.

12. Apparatus according to claim 10, wherein the supply reel for tape is offset relative to the beam generator.

13. Package according to claim 1, wherein the packaging material comprises a polymer film.

14. Package according to claim 1, wherein the produce comprises vegetables, fruits, and herbs.

15. Package according to claim 4, wherein the amount of the scavenger for oxygen is selected to reduce the concentration of oxygen to within a range of from 0.5 to 7%.

16. Package according to claim 8, wherein the produce comprises vegetables, fruits, and herbs.

17. Apparatus according to claim 10, wherein the openings are micro-perforations.

18. Apparatus according to claim 10, wherein the packaging material comprises a polymer film.

* * * * *