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(54) PACKAGED STABILIZED FOODSTUFF

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(57) **ABSTRACT**

A method of packaging and stabilizing a foodstuff comprising the steps of forming a package comprising a peelable seal in a region of the package and filling the package with the foodstuff; followed by treating the package at ultra high pressure to stabilize the foodstuff in the package without rupturing the peelable seal. Also provided are packaged sterilized foodstuffs obtainable by the methods of the invention.

PACKAGED STABILIZED FOODSTUFF

[0001] The present invention relates to methods for the manufacture of packaged stabilised foodstuffs, and to the stabilised foodstuffs obtainable thereby.

[0002] Conventional food sterilisation techniques rely on heating the foodstuff in a pressurised chamber (retort) at temperatures of from about 110° C. to about 130° C. for periods of from about 30 minutes to about 1 minute. Unfortunately, these methods cannot be used with containers comprising flexible films bonded by a peelable seal, that is to say a seal that can be pulled apart without rupturing the sheet material from which the package is made. Preferably, the peelably seal can be peeled apart by a force as hereinafter defined of 20N or less, which enables the package to be opened easily using only finger strength. However, it has been found that the temperature and pressure changes during the sterilisation cycle rupture or weaken peelable seals to an unacceptable degree. Therefore, conventional autoclave sterilisation requires the use of packages that have stronger seals that typically cannot be separated without tearing the material from which the package is made. Such packages usually require utensils such as scissors to open them, and can present difficulties for disabled or elderly persons.

[0003] WO97/21361 describes the preparation of stabilised foodstuffs by application of Ultra high pressure (UHP) in the range 300 MPa to 1000 MPa to foodstuffs having a pH greater than about 4.5, wherein the foodstuffs have been preheated to temperatures of at least about 75° C. The additional adiabatic heating due to the UHP raises the temperature of the foodstuffs to a temperature sufficient to achieve inactivation of bacterial spores and shelf stability.

[0004] It has now been found that UHP can be applied, even at elevated temperatures, to packages having easy-to-open, peelable seals without rupturing or weakening the seals.

[0005] In a first aspect, the present invention provides a method of packaging and stabilising a foodstuff comprising the steps of: forming a package comprising a peelable seal in at least a region of the package and filling the package with the foodstuff; followed by treating the package at ultra high pressure (UHP) to stabilise the foodstuff in the package without rupturing the peelable seal.

[0006] The package may consist essentially of the sealable sheet material. The package may for example be a sachet or pouch. Suitably, the step of forming the package comprises forming a flexible pouch substantially from said sealable sheet material. For example, the step of forming the package may comprise bonding two sealable sheets in face to face relationship to provide a flexible pouch, or the process may comprise folding-over a single sealable sheet, and bonding the margins of the sheet together to form edges of the flexible pouch.

[0007] The filling of the package with the foodstuff takes place after initial forming of the package, but before final sealing of the package.

[0008] For example, one common packaging technique is form-fill-seal packaging, including vertical form-fill-seal (VFFS) packaging. In VFFS packaging, a flat web of flexible, sealable film is unwound from a roll and formed into a continuous tube in a tube-forming section, by sealing the longitudinal edges on the film together to form a so-called lap seal or a so-called fin seal. The tube thus formed is pulled vertically downwards to a filling station. The tube is then collapsed across a transverse cross-section of the tube, the position of such cross-section being at a sealing device below the filling station. A transverse seal is made, by the sealing device, at the collapsed portion of the tube, thus making an air-tight seal across the tube. The material being packaged enters the tube above the transverse heat seal in a continuous or intermittent manner, thereby filling the tube upwardly from the transverse seal. The tube is then allowed to drop a predetermined distance usually under the influence of the weight of the material in the tube. The jaws of the sealing device are closed again, thus collapsing the tube at a second transverse section, which may be at, above or below the air/material interface in the tube, depending on the nature of the material being packaged and the mode of operation of the process. The sealing device seals and severs the tube transversely at the second transverse section. The material-filled portion of the tube is now in the form of a pillow shaped pouch. Thus, the sealing device has sealed the top of the filled pouch, sealed the bottom of the next-to-formed pouch and separated the filled pouch from the next-to-be formed pouch, all in one operation.

[0009] Variations on pouch-forming machines and in particular on this type of vertical form fill and seal apparatus are either known or conceivable. For example, the forming and sealing functions may be performed separately from severing function on separate machines. Also, the jaws of the sealing device could move to the next sealing position rather than have the film drop to the next position or there could be two sets of sealing jaws that seal both transverse ends simultaneously. Further, instead of forming a tube, two pieces of film could be fed into the machine and the pouch could be made by four seals, two longitudinal and two transverse. It will also be appreciated that form-fill-seal equipment can be operated in non-vertical mode, for example in horizontal mode, especially for packaging unitary items.

[0010] The transverse seals at the top and/or the bottom of each pouch may be the peelable seal. Suitably, the longitudinal seal (where present) has a higher peel strength and may be substantially non-peelable, that is to say the sheet material will tear before the seal will separate.

[0011] In addition to the form-fill-seal equipment described above, the method according to the present invention may comprise filling and sealing stand-up pouches. That is to say, pouches formed from flexible, sealable film having front and back panels and a bottom panel forming a gusset to allow the pouch to stand up after filling. The pouches are individually filled, and then sealed along the top edges of the front and back panels. Suitably, the seal along the top edge is a peelable seal, and the other seals are substantially non-peelable, that is to say they have a substantially greater opening force.

[0012] Generally, in the methods and packages of the invention, the bonding may be weaker in a first region of the sheet material than in other bonded regions of the sheet material, whereby the peelable seal is formed in the first region.

[0013] In certain embodiments, the step of forming the package comprises providing a formed tray or pot and sealing the sealable film across the top of the tray. The formed tray is suitably produced by thermoforming a sheet of relatively rigid (compared to the sealable sheet) thermoplastic sheet material. The formed tray typically comprises a recess for storage of the food product, and a flange around the top of the recess for attachment of the heat sealable sheet material.

[0014] Suitably, the seal strength of the peelable seal as measured by ASTM F88-00 is in the range of from about 2N to about 30N, preferably from 5N to about 20N, both before and after the UHP treatment. This seal strength range provides mechanical robustness and leak resistance to the package, while allowing easy opening of the package by peeling. In principle, the sealstrength should be as low as possible consistent with maintaining product integrity.

[0015] In principle, any of the many sealable sheet materials may be used in the practice of the present invention. Suitably, the sealable sheet material is a heat-sealable sheet material. Typically, the sealable sheet is a film laminate comprising a core layer and a sealing layer.

[0016] Suitably the sealing layer consists primarily of a polyethylene or a polypropylene. That is to say, preferably at least 50% by weight of the sealing layer is made up of a polyethylene or a polypropylene. Especially suitable polyethylenes are linear low-density polyethylenes (LLDPE) and ultralow density polyethylenes (ULDPE) made by copolymerising ethylene and C3-C8 alpha-olefins. Polymers of this type are described for example in EP-A-0351189.

[0017] The sealing temperature of the heat sealing layer should be selected to provide the desired peel strength. The heat sealing temperature is defined herein as the temperature at which the sealing step is carried out. The polymers of the sealing layer can be selected in conventional fashion to have a heat sealing temperature in the desired range. In conventional heat-sealing embodiments, the heat sealing temperature is typically from about 120° C. to about 160° C., for example from about 130° C. up to about 150° C. In other embodiments, a cold-sealing film may be used, that is to say a film having a sealing temperature of less than 100° C., typically less than about 50° C., for example about ambient (20° C.). The latter films are sealed simply by applying pressure at a temperature within the cold sealing temperature range. It is a surprising feature of the present invention that seal integrity can be maintained during the UHP treatment step even if the peak temperature reached during UHP treatment exceeds the sealing temperature at which the peelable seal was formed.

[0018] The base layers to be combined with the sealing layer in the multilayer structures for use in the present invention can be selected from among suitable film-forming polymers, regenerated cellulose, paper, paperboard, fabric and aluminium foil. The film-forming polymers include polyamide resins, e.g., nylon 6, nylon 66, nylon 11, and nylon 12; polyester resins, e.g., polyethylene terephthalate (PETP) and polybutylene terephthalate; polyolefin resins, e.g., polypropylene (PP), oriented polypropylene (OPP), poly-1-butene, poly-4 methyl-1-pentene, polyethylene, an ethylene-vinyl acetate copolymer, an ethylene-methacrylate copolymer, an ethylene-acrylate copolymer, an ethylene-methacrylic acid copolymer, and ionomers; polyvinylidene chloride; polyvinyl chloride; polystyrene; polyvinyl alcohol (EVOH); or an ethylene-vinyl alcohol copolymer. These film-forming polymers can be chosen according to the end use of a composite film taking into consideration gas barrier properties, printability, transparency, rigidity, adhesion, or the like factor. In cases of using stretchable bases, particularly those which are stretched to provide improved film characteristics, such as polyamide resins, polyester resins and polypropylene, the base may be uniaxially or biaxially stretched, if desired. Multilayer base structures are also possible.

[0019] In the sealable composite films, the sealing layer usually has a thickness of from 1 to 500 micrometers, preferably from 10 to 200 micrometers, more preferably from about 50 to about 100 micrometers. The thickness of the base layer is arbitrary and can be decided depending on the packaging application.

[0020] The composite sealing films composed of two or more layers can be produced by known processes, such as: lamination processes including dry lamination, wet lamination, sandwich lamination, and hot-melt lamination; co-extrusion such as blown film extrusion or T-die extrusion; extrusion coating (called extrusion lamination); and combinations thereof.

[0021] Suitably, the UHP processing is carried out at a pressure of from about 250 MPa to about 200 MPa, more suitably from about 400MPa to about 1200 MPa, for example from about 500 MPa to about 1000 MPA. Suitably, the total treatment time is from about 1 minute to about 30 minutes, for example from about 2 minutes to about 20 minutes. The UHP is preferably hydrostatic pressure, i.e. applied in batch fashion. The UHP may be applied in intermittent or pulsed fashion, for example as described in EP-A-1112008, the entire contents of which are incorporated herein by reference. In that case the treatment time herein is the total time spent at or above 150 MPa.

[0022] The starting temperature for the UHP treatment may be ambient temperature (15-30° C.), or the package may be preheated before application of UHP. In certain embodiments, the package is preheated to a temperature of at least about 70° C., for example at least about 80° C. or 90° C. before pressurisation.

[0023] The above temperature ranges refer to the temperature of the sauce in the uncompressed state; adiabatic heating may raise the temperature of the sauce by more than 5° C., for example by at least 10° C., typically about 10-20° C. during compression. Preferably, the pressurization is carried out under substantially adiabatic conditions. Suitably, the package is instantaneously heated by the UHP adiabatic compression to a peak temperature of at least about 110° C.

[0024] Apparatus for applying UHP are available for example from Flow International Corporation of South Kent, Wash., USA.

[0025] In a second aspect, the present invention provides a package having a peelable seal and containing a foodstuff that has been stabilised inside the package by ultrahigh pressure (UHP) treatment. Suitably, the package is obtainable by a process according to the present invention.

[0026] The package may for example be any of those described above in relation to the first aspect of the invention. The foodstuff may be any foodstuff or beverage, preferably a full-moisture foodstuff having a water activity (Aw) of at least 0.95, and preferably having a pH greater than 4.5.

[0027] The foodstuff has been stabilized by UHP treatment. UHP results in the inactivation of certain enzymes and microorganisms, but largely without the chemical and organoleptic changes characteristic of heat sterilization. Preferably, the packaged foodstuff in this aspect of the invention is storage stable, for example at a chill temperature of about 5° C., preferably at a chill temperature of about 7° C. and more preferably it is storage stable at ambient temperatures of about 20° C. That is to say, the packaged sauce can preferably be stored for at least about 7 days, more preferably at least about 30 days, and most preferably at least about 150 days. Without deterioration or microorganism growth outside regulatory limits.

[0028] It will be appreciated that any feature that is described in relation to the first aspect of the invention is likewise applicable to the second aspect of the invention.

[0029] Specific embodiments of the present invention will now be described further, by way of example.

EXAMPLE 1

[0030] Thermoformed pots, Speeko—the Netherlands, made from HDPE sheet material were filled with demineralised water. The flanged top of each pot was sealed by heat-sealing the sealable film for 5 seconds at defined sealing temperature and pressure across the top of the tray with a sheet of 12 μm metallised PETP/70 μm LLDPE film having a LLDPE sealing layer. Sealing was carried out at a range of temperatures at 5° C. intervals from 120° C. to 165° C.

[0031] The pots were then treated with UHP at 6000 bar for 100 seconds (300 seconds in the case of the sample sealed at 135° C.), using equipment and procedure substantially as described in WO97/21361. The starting temperature in each case was 23° C.

[0032] The peel strength of the seals was measured by ASTM F88-00. The measured values in Newton are given in Table 1:

TABLE 1

Seal Temperature ° C.	Non-UHP Newton	UHP Newton	UHP Newton	UHP Newton	Mean UHP Newton
120	13.63	7.06	12.30	9.36	9.57
130	11.86	16.57	13.18	12.35	14.03
135	18.73	14.70	16.18	17.21	16.03
140	33.29	38.54	33.98	43.63	38.72
145	47.21	42.36	35.84	54.52	44.24
150	46.23	44.57	42.02	47.41	44.67
155	43.29	47.61	42.31	39.61	43.18
165	42.11	41.48	52.36	46.97	46.94

[0033] It can be seen that an easy-peel seal is formed in the sealing temperature range 120-135° C., and that the peel strength is largely unchanged by the UHP treatment, especially in the sealing temperature range 130-135° C. At higher sealing temperatures, a stronger seal is formed that is not so readily peelable either before or after UHP treatment. Inspection of the packages showed that the integrity of the seals had been fully maintained during the UHP treatment. This was surprising, in view of the large forces to which the packages are subjected in the UHP treatment step.

EXAMPLE 2

[0034] Thermoformed pots PP/EVOH/PP (RPC—the Netherlands) made from polypropylene sheet material were filled with demineralised water. The flanged top of each pot was sealed by heatsealing the sealable film for 5 seconds at defined sealing temperature and pressure across the top of the tray with a sheet of 20 μm OPP/20 μm metallised OPP film having a polypropylene sealing layer. Sealing was carried out at a range of temperatures at 10° C. intervals from 110° C. to 160° C.

[0035] The pots were then treated with UHP at 6000 bar for 100 seconds, as described in Example 1. The peel strength of the seals was measured by ASTM F88-00. The measured values in Newton are given in Table 2:

TABLE 2

Seal Temperature ° C.	Non-UHP Newton	UHP Newton	UHP Newton	UHP Newton	Mean UHP Newton
110	0.00*	0.00*	0.00*	0.00*	0.00*
120	4.02	0.00**	0.93	1.52	1.23
130	2.89	14.12	6.71	4.95	8.59
140	12.16	9.56	13.33	7.99	10.29
150	7.84	9.75	9.36	9.36	9.49
160	4.75	11.08	9.02	11.32	10.47

*Pot and film were not properly sealed together before UHP treatment
**Seal was open after UHP treatment

[0036] It can be seen that an easy-peel seal is formed in the sealing temperature range 130-160° C., and that the peel strength is largely unchanged by the UHP treatment. Inspection of the packages showed that the integrity of the seals had been fully maintained during the UHP treatment.

EXAMPLE 3

[0037] A coldseal film of the type used to package TWIX (Registered Trade Mark of Mars Incorporated) confectionery, comprising Lacquer/ink/metallised OPP/coldseal layers, was sealed by pressuring the coldseal parts of the film together by hand. Only light finger pressure, sufficient to cause adherence of the coldseal surfaces, must be used in the preparation.

[0038] Measurement of peel strength according to ASTM F88-00 of a cold-sealed TWIX film was carried out before and after UHP treatment at 6000 bar and at 20° C. and 50° C. The measurements were repeated ten times, with the results shown in Table 2:

TABLE 3

Run #	Non UHP (Newton)	6000 bar, 100 sec. 20° C. (Newton)	6000 bar, 100 sec. 50° C. (Newton)
1	3.57	3.57	3.18
2	3.38	3.57	2.79
3	3.04	3.53	3.04
4	2.79	3.62	3.48
5	2.54	3.48	2.59
6	2.94	2.79	2.79
7	2.89	3.87	3.13
8	2.69	3.18	3.48
9	3.04	4.06	3.33
10	3.08	3.08	3.67
Average	3.00	3.48	3.15

[0039] It can be seen that the easy-peel properties of the film were maintained with high consistency after both of the UHP treatments. This result was extremely surprising in view of the low seating temperature of the film.

EXAMPLE 4

[0040] A coldseal film of the type used to package BOUNTY (Registered Trade Mark of Mars Incorporated) confectionery, comprising Lacquer/Ink/OPP/Coldseal layers was sealed by pressing the coldseal parts of the film together by hand. Only light finger pressure, sufficient to cause adherence of the coldseal surfaces, was used in the preparation.

[0041] Measurement of peel strength according to ASTM F88-00 of a cold-sealed BOUNTY foil was carried out before and after UHP treatment at 6000 bar and at 20° C. and 50° C. The measurements were repeated ten times, with the results shown in Table 3:

TABLE 4

Run #	Non UHP (Newton)	6000 bar, 100 sec. 20° C. (Newton)	6000 bar, 100 sec. 50° C. (Newton)
1	5.14	4.31	2.74
2	5.19	5.00	4.51
3	5.78	5.19	4.02
4	5.73	5.54	3.82
5	5.58	5.83	4.36
6	5.88	5.39	4.21
7	6.03	5.29	3.08
8	5.44	3.04	3.92
9	6.22	6.08	3.97
10	6.37	6.12	3.67
Average	5.74	5.18	3.83

[0042] It can be seen that the easy-peel properties of the film are fully maintained with high consistency after both the UHP treatments at 20° C. The seat becomes only slightly weaker following the UHP treatment at 50° C. Again, this result was surprising in view of the low sealing temperature.

EXAMPLE 5

[0043] BOUNTY film Lacquer/Ink/OPP/Coldseal was cold-sealed to a TWIX film Lacquer/ink/metallised OPP/coldseal by pressing the coldseal parts of both of the films together by hand. Only light finger pressure, sufficient to cause adherence of the coldseal surfaces, was used in the preparation.

[0044] Measurement of peel strength according to ASTM F88-00 of a BOUNTY foil cold-sealed to a TWIX film was carried out before and after UHP treatment at 6000 bar and 100 seconds at 20° C. and 50° C. The measurements were repeated ten times, with the results shown in Table 5:

TABLE 5

Run #	Non UHP (Newton)	6000 bar, 100 sec. 20° C. (Newton)	6000 bar, 100 sec. 50° C. (Newton)
1	4.41	4.21	3.53
2	5.00	4.65	3.57
3	5.09	4.41	3.87
4	4.41	3.87	3.82
5	4.41	4.06	4.02
6	4.31	4.31	4.41
7	4.46	3.87	3.62
8	4.60	3.97	3.67
9	3.87	4.80	4.06
10	4.51	4.16	3.53
Average	4.51	4.23	3.81

[0045] It can be seen that the easy-peel properties of the film were fully maintained with high consistency after the UHP treatment at 20° C. The seals becomes only very slightly weaker following the treatment at 50° C.

EXAMPLE 6

[0046] The effect of higher. UHP treatment temperatures on packages having peelable seals was studied as follows.

[0047] Thermoformed pots, Speeko—the Netherlands, made from HDPE sheet material were filled with demineralised water. The flanged top of each pot was sealed by heat sealing a LLDPE sealable film (12 μm metallised PETP/70 μm LLDPE) across the top of the tray for 5 seconds at a sealing temperature of 130° C. or 150° C.

[0048] The pots were then treated with UHP at 6000 bar for 100 seconds, using equipment and procedure substantially as described above for Example 1. However, the pots were preheated to 60° C. and 80° C. Since the UHP treatment was substantially adiabatic, the peak temperatures reached by the samples under pressure would have been 20-30° C. higher than the preheat temperature.

[0049] The peel strength of the seals was measured by ASTM F88-00. The measured values (mean of ten measurements) are given in Table 6:

TABLE 6

Sample	Non UHP (Newtons)	6000 bar, 100 sec, 60° C. (Newtons)	6000 bar, 100 sec, 80° C. (Newtons)
Sealed at 130° C.	19.2	12.5	14.7
Sealed at 150° C.	30.9	20.3	23.5

[0050] The above embodiments have been described for the purpose of illustration only. Many other embodiments falling within the scope of the accompanying claims will be apparent to the skilled reader.

1. A method of packaging and stabilising a foodstuff comprising the steps of: forming a package comprising a peelable seal in a region of the package and filling the package with the foodstuff; followed by treating the package at ultra high pressure to stabilise the foodstuff in the package without rupturing the peelable seal.

2. A method according to claim **1**, wherein the step of forming the package comprises forming a flexible pouch substantially from sealable film material.

3. A method according to claim **2**, wherein the step of forming the package comprises folding-over a single sealable sheet, and bonding the margins of the sheet together to form edges of the flexible pouch.

4. A method according to claim **3**, wherein the bonding is weaker in a first region of the margin than in the remainder of the margin, whereby the peelable seal is formed in said first region.

5. A method according to claim **1**, wherein the step of forming the package comprises providing a formed tray and sealing the sealable film across the top of the tray.

6. A method according to claim **1**, wherein the seal strength of the peelable seal as measured by ASTM F88-00 is in the range of from about 2N to about 20N both before and after the ultra high pressure treatment.

7. A method according to claim **2**, wherein the sealable film is a laminate comprising a core layer and a sealing layer, and wherein the sealing layer comprises primarily a polyethylene or a polyvinyl acetate.

8. A method according to claim **1**, wherein the peelable seal is formed by heat sealing a flexible sheet material at a temperature below the peak temperature reached in the ultra high pressure treatment step.

9. A method according to claim **2**, wherein the step of forming the package comprises bonding two sheets of sealable film material in a face to face relationship at margins of the sheets to provide a flexible pouch.

10. A method according to claim **9**, wherein the bonding is weaker in a first region of a margin than in the remainder of the margin, whereby the peelable seal is formed in the first region.

11. A package having a peelable seal and containing a foodstuff that has been stabilized inside the package by ultra high pressure treatment.

12. A package according to claim **11**, wherein the package is produced by a process according to claim **1**.

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