

METHOD AND APPARATUS FOR PASTEURISATION OR STERILISATION
OF HERBS AND SPICES

This invention relates to a method and apparatus for pasteurising or
5 sterilising herbs, spices and other materials prone to microbial spoilage.

Attempts have been made to develop methods for pasteurising or
sterilising herbs and spices involving heat treatment. However, these
methods have been found to be impracticable as the heat treatment step
results in the mobilisation and/or destruction of the volatile substances
10 which give the herbs and spices their functionality and appeal.
Traditionally, therefore, herbs and spices have been treated by exposure to
ethylene oxide.

Unfortunately, such ethylene oxide processes have certain
disadvantages. For example, it has been found that while such processing
15 can result in a reduction in the bacterial numbers in the product, they have
the disadvantages that bacterial and fungal spores commonly have a natural
resistance to this sterilant, so its effect is concentration dependant and long
exposure times are required for penetration. Further, the exposure to
ethylene oxide of foods with high salt concentrations has been reported to
20 produce reaction products, such as epichlorhydrin, which are potentially
toxogenic.

Thus, it is one object of the present invention to provide a method
and apparatus for effectively pasteurising or sterilising herbs, spices and
other materials prone to microbial spoilage, which has little or no adverse
25 effect on their functionality.

Accordingly, in a first aspect, the present invention provides a
method for pasteurising or sterilising herbs, spices and other materials prone
to microbial spoilage comprising the steps of:

- (1) cooling said herbs, spices or other materials to a temperature
30 less than about 0°C,

- (2) rapidly heating said cooled herbs, spices or other materials to a pasteurising or sterilising temperature, and
- (3) recooling said herbs, spices or other materials to about room temperature,

5 wherein at least steps (2) and (3) are performed in an environment(s) having a pressure of greater than 1 Bar.

Performing steps (2) and (3) under pressures greater than 1 Bar, prevents loss of volatiles from the materials being treated. In addition, use of such pressure in these steps is believed to positively contribute to colour
10 fastness and the reduction of microbe numbers. Preferably, the pressures applied in steps (2) and (3) are greater than 3 Bar. Once step (3) is concluded, the environment within which the materials are contained, may be returned to atmospheric pressure.

Step (1) is preferably a rapid cooling step and may be completed in
15 0.05 to 5.0 minutes, more preferably 0.5 to 3.0 minutes. During step (1) the herbs, spices or other materials are preferably cooled to a temperature less than about -70°C, more preferably, to a temperature of about -170°C. It is also preferred that step (1) be performed in an environment(s) having a pressure greater than 1 Bar.

20 The rapid heating step (2) may be achieved by the application of heat from any source, radiative, conductive or convective, which may be generated by combustion, by induction or dielectric heating with electromagnetic radiation, microwave, by infra red irradiation, or any other means. The heat is preferably applied for 0.05 to 5.0 minutes, more
25 preferably 0.1 to 3.0 minutes or longer dependent on the material and its microbial bioburden.

The recooling step (3) is also preferably a rapid cooling step and may be completed in 0.05 to 5.0 minutes, more preferably 0.1 to 2.0 minutes.

In a second aspect, the present invention provides apparatus for
30 conducting the method of the first aspect of the invention.

The method may be performed on batches of materials or continuously. Thus, an apparatus according to the invention for batch treatments may comprise;

- a vessel comprising,
- 5 an inlet means through which a batch of herbs, spices or other materials susceptible to microbial spoilage may be introduced,
- means for cooling said batch to a temperature less than about 0°C,
- means for rapidly heating said cooled batch to a pasteurising or sterilising temperature,
- 10 means for recooling said batch to about room temperature,
- means for applying and/or regulating a pressure within the vessel during heating and recooling of greater than 1 Bar, and
- outlet means for removing the treated batch from said vessel.

Preferably, the apparatus for batch treatments comprises a pressure

15 vessel constructed to sanitary standards which feeds out through a valve to an aseptic filler sourced commercially. A batch of material for treatment is introduced through an infeed hopper equipped with a valve into the vessel where stirring is instigated by a motorised stirrer. The product is rapidly cooled to less than 0°C by the cooling effects of expanding coolant, sparged

20 through the material being treated, which may be liquefied nitrogen, liquefied carbon dioxide or a mixture of both, or other gas, either in combination or alone and may be humidified prior to application. Immediately the desired cooling step temperature (e.g. temperature of between -70°C and -170°C) and pressure (e.g. pressure greater than 1 Bar) is

25 reached, a pressure regulating valve is closed, the inflow of coolant reduced and then controlled to maintain a pressure of greater than 1 Bar, more preferably greater than 3 Bar. While this pressure is maintained, the material is exposed to heating for a treatment duration sufficient to reduce the total microbial content by the desired factor, dependant on the bacterial

30 and fungal bioburden of the infeed material.

The applied heat source is preferably arranged on the vessel so as to optimise the application and penetration of the heat, thus minimising the treatment time needed and the resultant product damage. Fast response sensitive pressure and temperature sensors may be provided to monitor
5 progression of the treatment and the outputs from these are feed to a control circuit which in turn regulates the application of heat and pressure. The control circuit typically includes a programmable logic controller and a supervising, control and data acquisition computer.

An apparatus according to the invention for continuous treatments
10 may comprise:

a first vessel comprising, an inlet means through which herbs, spices or other materials susceptible to microbial spoilage may be continuously introduced, and means for cooling said herbs, spices or other materials to a temperature less than about 0°C;

15 a second vessel comprising, means for rapidly heating said cooled herbs, spices or other materials, and means for applying and/or regulating a pressure of greater than 1 Bar; and

a third vessel comprising means for recooling the herbs, spices or other materials to about room temperature, means for applying and/or
20 regulating a pressure of greater than 1 Bar, and outlet means for removing the treated herbs, spices or other materials from said vessel,
wherein said first vessel is connected to said second vessel and said second vessel is connected to said third vessel, the arrangement being such that the herbs, spices or other materials introduced into the first vessel may be
25 continuously and progressively transferred to the second and then third vessels.

The material treated by this invention may be, in addition to herbs and spices, for which it was specifically developed, other foods, pharmaceuticals, leaf material in various forms for example tobacco or

various free flowing powdered materials which are prone to microbial spoilage.

The invention will now be further described by way of the following, non-limiting examples and accompanying figures.

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Brief Description of Accompanying Figures

Figure 1 provides a schematic elevational representation of a preferred apparatus according to the invention for batch treatments of herbs and spices.

10 Figure 2 provides a schematic elevational representation of a preferred apparatus according to the invention for continuous flow treatments of herbs and spices.

EXAMPLE 1: Batch Apparatus

15 As shown in Figure 1, the sanitary designed pressure vessel (1) has a tapered conical base, is equipped with a motorised stirrer (2), infeed hopper/valve (3) and outfeed hopper/valve (4). A safety vent (7) is also provided.

20 A preweighed batch of material to be treated is introduced through infeed hopper/valve (3) and stirring commenced with stirrer (2). Coolant is introduced through sparging ports (10) and allowed to escape through a pressure regulator valve (6) until the desired cooling step temperature is recorded by the thermocouple (9) in contact with the material being treated.

25 In the next stage, coolant gas flow is reduced and the pressure regulating valve (6) is servo driven to maintain the desired pressure (greater than 3 Bar), sensed by a pressure transducer (8). Heating is then commenced, applied from heaters (5) to a temperature of between 70-90°C for pasteurisation and between 105-150°C for sterilisation. The duration of exposure is optimised to provide the maximum reduction in bioburden
30 while maximising the flavour and other functionality of the material being

treated. Typically, heating energy/batch mass can be balanced to attain treatment times of only 0.1-3.0 minutes. This short time/high temperature processing yields at least 4 and often 6 log reductions in microbial bioburden.

5 At the end of the penetrative heat treatment stage the protective post treatment cooling is commenced. This is mandatory to protect the delicate aromatic flavour and functional components. Cooling is immediately effected while still under pressure by again controlling cooling inflow at sparging ports (10) and its release at the pressure regulator valve (6). Rapid
10 cooling reduces the temperature of the material being treated to less than 20°C and then coolant inflow is ceased and the pressure within the vessel is allowed to return to atmospheric pressure.

 Stirring is continued throughout the process and until the material is discharged directly into the aseptic filler located at (11).

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EXAMPLE 2: Continuous Flow Apparatus

 In an alternative arrangement the steps of the method according to the invention may be applied to material conveyed through three vessels similarly equipped to the batch process so that each stage of the treatment
20 can be applied in a continuous manner. Each vessel is separated by rotary locks and each vessel has a discrete conveyor mechanism. A suitable apparatus is depicted in Figure 2.

 The apparatus shown in Figure 2 employs open conveyor belts, however, it is to be understood that screw conveyor(s) could be used as an
25 alternative.

 The components (3)-(6), (9) and (10) shown in Figure 2 are as described in Example 1.

EXAMPLE 3 - Preliminary Tests**Test A****Aim:**

To assess the potential of applying heat to herbs and spices to reduce the microbial bioburden.

Method:

Target Material: Basil
Whole peppercorns
both with known high bacterial bioburden
(greater than 10^8 cfu/gram)

Equipment:

A device was constructed for these trials which consisted of a plastic pressure tank from a garden spray with a volume of approx. 3 litres. This was chosen so that it had adequate strength to allow for the pressures. The pressure entry port was modified by the installation of a car tyre valve. A screw down, O-ring sealed inlet port was present, normally for the addition of spray and water. Also present was a safety pressure release valve which was strengthened appropriately.

The device, which appeared to be made from natural high or ultrahigh density polyethylene or similar plastic, was tested at pressures greater than intended to be reached in the test and found to withstand in excess of 3 Bar, even when heated.

Heating was effected in a 750 Watt domestic microwave oven equipped with a rotating carousel. This was adapted to hold the plastic vessel which was microwave transparent and did not heat appreciably when exposed to microwave energy on its own. It was found that if it was loaded with approx. 15ml of water and exposed for 5 minutes at 2 Bar overpressure all contact surfaces were sterilised and then the vessel could be dried out with the continuation of the heating at atmospheric pressure. This process was employed before each new trial.

To overcome some initial unevenness of heating a system was devised to tilt the vessel as it was rotated by the carousel, thus mixing the target material during exposure.

Exposures:

5 100 gram samples of each target material was exposed to varying times and microwave powers and the temperatures achieved were taken with an electronic thermometer equipped with a fast response thermocouple.

10 This was repeated with 1 and 2 Bar overpressure generated with compressed air and read by an external pressure gauge to assess the effect of attained pressure on the temperatures achieved by varying the times and microwave power.

15 From this data a range of exposures were chosen so that a spectrum of attained temperatures ranging from 70 to 140 deg. C could be predicted and duplicate exposures of each target material were made with 1 and 2 Bar compressed air overpressure. This was released immediately after the exposure was completed.

Results:

20 Observations: - condensation was present but minimal.
 -a noticeable volatile aroma was present on release of the overpressure.

Target Material:

25 - loss of at least 30% of the organoleptic properties of the material was estimated. Particularly effected were the high flavour notes and after taste.

Microbiological Analyses:

30 - Reduction in microbial bioburden paralleled time and temperature with greater than 6 log reductions in Standard Plate Count achieved by the longer times and temperatures employed.

5 Test B

To develop a means of preventing the loss of volatiles during heating of the herbs and spices by the use of protective cooling and overpressure.

10	Target Material:	As for Test A.
	Equipment:	As for Test A but employing overpressure generated from bottled compressed food grade carbon dioxide controlled by a regulator. This was then used to assist with cooling, while
15		maintaining the overpressure, after the target material had been exposed to heat. Additional cooling was provided by immersing the vessel in an ice bath.

20 Results:

Target Material:

- the material was now colour fast.
- there was a considerable reduction in the organoleptic profiles.

- Not significantly different from Test A

Without losing microbial effect a definite improvement in the condition and functionality of the materials were seen following treatment.

While this was thought to be of some value, means by which the losses of volatiles could be further reduced were sought.

Test C

5 Aim:

To further enhance the reduction of volatile loss by the use of a precooling step in the process.

Method:

10 Target Material: As for Test A.
Equipment: As for Tests A and B plus either;
 - precooling with carbon dioxide sparging (-70 deg. C) in the vessel, or
 - immersion in liquid nitrogen (-170 deg. C).
Exposures: As for Tests A and B.

15 Results:

Observations: - As for Test B.
Target Material: - no discernible loss in volatiles or functionality were detectable by organoleptic evaluation for either means of precooling.
20 Microbiological Analyses:
 - reductions in microbial bioburden of greater than 7, approaching 8 log in the case of the nitrogen precooled material.

Conclusions:

25 The aim of achieving a commercially significant reduction in the loss of organoleptic functionality of herbs and spices, while maintaining reductions in the microbial bioburden was achieved.

30 It will be appreciated by persons skilled in the art that numerous variations and/or modifications may be made to the invention as shown in

the specific embodiments without departing from the spirit or scope of the invention as broadly described. The present embodiments are, therefore, to be considered in all respects as illustrative and not restrictive.

**Claims:**

1. A method for pasteurising or sterilising herbs, spices and other materials prone to microbial spoilage comprising the steps of:
 - 5 (1) cooling said herbs, spices or other materials to a temperature less than about 0°C,
 - (2) rapidly heating said cooled herbs, spices or other materials to a pasteurising or sterilising temperature, and
 - (3) recooling said herbs, spices or other materials to about room
10 temperature,wherein at least steps (2) and (3) are performed in an environment(s) having a pressure of greater than 1 Bar.
2. A method according to claim 1, wherein during step (1) the herbs,
15 spices or other material are cooled to a temperature less than about -70°C.
3. A method according to claims 1 or 2, wherein during step (1) the herbs, spices or other materials are cooled to a temperature of about -170°C.
- 20 4. A method according to any one of the preceding claims, wherein step (1) is completed in 0.05 to 5.0 minutes.
5. A method according to claim 4, wherein step (1) is completed in 0.5 to 3.0 minutes.
25
6. A method according to any one of the preceding claims, wherein step (1) is also performed in an environment(s) having a pressure greater than 1 Bar.



7. A method according to any one of the preceding claims, wherein steps (2) and (3) are performed in an environment(s) having a pressure greater than 3 Bar.
- 5 8. A method according to any one of the preceding claims, wherein step (2) is completed in 0.05 to 5.0 minutes.
9. A method according to claim 8, wherein step (2) is completed in 0.1 to 3.0 minutes.
- 10 10. A method according to any one of the preceding claims, wherein step (3) is completed in 0.05 to 5.0 minutes.
11. A method according to claim 10, wherein step (3) is completed in 0.1 to 2.0 minutes.
- 15 12. A method according to any one of the preceding claims, wherein the cooling of steps (1) and (3) is achieved by sparging of a suitable coolant gas(es).
- 20 13. A method according to any one of the preceding claims, wherein the heating of step (2) is achieved by the application of heat generated by combustion, by induction or dielectric heating with electromagnetic radiation, microwave, or by infra red irradiation.
- 25 14. An apparatus for pasteurising or sterilising a batch of herbs, spices and other materials prone to microbial spoilage comprising;
a vessel comprising,
an inlet means through which a batch of herbs, spices or other
30 materials susceptible to microbial spoilage may be introduced,



means for cooling said batch to a temperature less than about 0°C,
means for rapidly heating said cooled batch to a pasteurising or
sterilising temperature,

- 5 means for recooling said batch to about room temperature,
means for applying and/or regulating a pressure within the vessel
during at least the heating and recooling of greater than 1 Bar, and
outlet means for removing the treated batch from said vessel.

15 15. An apparatus according to claim 14, wherein the means for cooling
10 cools the batch to a temperature less than about -70°C.

16. An apparatus according to claims 14 or 15, wherein the means for
cooling cools the batch to a temperature of about -170°C.

15 17. An apparatus according to any one of claims 14 to 16, wherein the
pressure applying and/or regulating means applies or regulates a pressure
greater than 3 Bar within the vessel.

18. An apparatus according to any one of claims 14 to 17, wherein the
20 means for cooling and recooling comprise sparging ports for a suitable
coolant gas(es).

19. An apparatus according to any one of claims 14 to 18, wherein the
heating means comprises a means for applying heat generated by
25 combustion, by induction or dielectric heating with electromagnetic
radiation, microwave, or by infra red irradiation.

20. An apparatus for pasteurising or sterilising herbs, spices and other
materials prone to microbial spoilage comprising;



a first vessel comprising, an inlet means through which herbs, spices or other materials susceptible to microbial spoilage may be continuously introduced, and means for cooling said herbs, spices or other materials to a temperature less than about 0°C;

5 a second vessel comprising, means for rapidly heating said cooled herbs, spices or other materials, and means for applying and/or regulating a pressure of greater than 1 Bar; and

a third vessel comprising means for recooling the herbs, spices or other materials to about room temperature, means for applying and/or
10 regulating a pressure of greater than 1 Bar, and outlet means for removing the treated herbs, spices or other materials from said vessel,
wherein said first vessel is connected to said second vessel and said second vessel is connected to said third vessel, the arrangement being such that the herbs, spices or other materials introduced into the first vessel may be
15 continuously and progressively transferred to the second and then third vessels.

21. An apparatus according to claim 20, wherein the means for cooling cools the herbs, spices or other material to a temperature less than about
20 -70°C.

22. An apparatus according to claims 20 or 21, wherein the means for cooling cools the herbs, spices or other materials to a temperature of about
-170°C.

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23. An apparatus according to any one of claims 20 to 22, wherein the first vessel further comprises means for applying and/or regulating a pressure greater than 1 Bar.



24. An apparatus according to any one of claims 20 to 23, wherein the pressure applying and/or regulating means provided in the second and third vessel apply or regulate a pressure greater than 3 Bar.
- 5 25. An apparatus according to any one of claims 20 to 24, wherein the means for cooling and recooling provided in the first and third vessels comprise sparging ports for a suitable coolant gas(es).
26. An apparatus according to any one of claims 20 to 25, wherein the
10 heating means comprises a means for applying heat generated by combustion, by induction or dielectric heating with electromagnetic radiation, microwave, or by infra red irradiation.
27. Pasteurised or sterilised herbs and spices treated in accordance with
15 the method of any one of claims 1 to 13.