**Title:** REDUCTION OF PATHOGENS FOR FOOD IN PACKAGING

**Abstract:** A system for reducing pathogens for food in packaging comprises a bagger and pathogen reducer. The bagger is for inserting a food item into a package. The pathogen reducer is for reducing pathogens by exposing the food item and the package with the food item inside using infrared energy.

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REDUCTION OF PATHOGENS FOR FOOD IN PACKAGING

BACKGROUND OF THE INVENTION

[0001] Consumer demand for improvements in the quality and safety of processed foods has steadily driven conventional operations to change in the food industry. Currently, preservatives are added to packaged food to inhibit the growth of bacteria, yeasts, molds, and other spoilage organisms and extend shelf life without reducing quality. Packaging food in a manner free of spoilage organisms is very difficult due to their ubiquity in our environment; conducting the packaging process in a completely sterile environment would be prohibitively expensive. However, consumers desire packaged food that has fresh-like characteristics without the use of food preservatives.
BRIEF DESCRIPTION OF THE DRAWINGS

[0002] Various embodiments of the invention are disclosed in the following detailed description and the accompanying drawings.

[0003] Figure 1 is a block diagram illustrating an embodiment of a system for reduction of pathogens for food in packaging.

[0004] Figure 2 is a block diagram illustrating an embodiment of a food packaging and exposure system.

[0005] Figure 3 is a diagram illustrating an embodiment of a food exposure oven.

[0006] Figure 4 is a flow diagram illustrating an embodiment of a process for reduction of pathogens for food in packaging.

DETAILED DESCRIPTION

[0007] The invention can be implemented in numerous ways, including as a process, an apparatus, a system, a composition of matter, a computer readable medium such as a computer readable storage medium or a computer network wherein program instructions are sent over optical or communication links. In this specification, these implementations, or any other form that the invention may take, may be referred to as techniques. A component such as a processor or a memory described as being configured to perform a task includes both a general component that is temporarily configured to perform the task at a given time or a specific component that is manufactured to perform the task. In general, the order of the steps of disclosed processes may be altered within the scope of the invention. As used herein, the term 'processor' refers to one or more devices, circuits, and/or processing cores configured to process data, such as computer program instructions.
[0008] A detailed description of one or more embodiments of the invention is provided below along with accompanying figures that illustrate the principles of the invention. The invention is described in connection with such embodiments, but the invention is not limited to any embodiment. The scope of the invention is limited only by the claims and the invention encompasses numerous alternatives, modifications and equivalents. Numerous specific details are set forth in the following description in order to provide a thorough understanding of the invention. These details are provided for the purpose of example and the invention may be practiced according to the claims without some or all of these specific details. For the purpose of clarity, technical material that is known in the technical fields related to the invention has not been described in detail so that the invention is not unnecessarily obscured.

[0009] A system for reduction of pathogens for food in packaging is disclosed. The system comprises a bagger or bagging machine and a pathogen reducer (e.g., a gate opens and the product falls and the bag fills). The bagger inserts a food item into a package. The pathogen reducer reduces pathogens by exposing the food item and the package with the food item inside to infrared energy for heating of the item.

[0010] In some embodiments, a preservative free food item (e.g., a prune) is sterilized using exposure of the preservative free food item and package containing the preservative free food item. The food item and package are heated by exposure to an infrared source. The infrared source enables delivery of heat to the food item in a bag to sterilize the food item without removing an item from the bag or opening the bag.

[0011] In some embodiments, the food item is received and is preservative free. In some embodiments, the system comprises a preheater for heating the food item prior to insertion into the package, where the preheater uses steam (e.g., adding both heat and moisture). In various embodiments, the food item is put in a package where the package comprises a sealable bag, a plastic bag (e.g., a bag made of oriented polypropylene, polystyrene, or polyethylene), a plastic bag with transmission characteristics acceptable to reducing pathogens (e.g., a bag comprised of plastic with transmission over 55% for
wavelength(s) that items within the bag are exposed to for heating), a sealable bag with a seal that does not trap air within the seal itself (e.g., using heated seal bars above and below a bag zipper where the top seal is complete the seal below is not complete allowing heated air/moisture to move into the sealed bag and not blowing up the area around the zipper), a gas permeable package, or any other appropriate package. In various embodiments, the pathogen reducer reduces pathogens by pasteurization, reduces pathogens to a predetermined acceptable level (e.g., a reduction of pathogens to one part from \(10^7\)), reduces pathogens to a predetermined acceptable level for food safety, reduces pathogens to zero pathogens in the package, sterilizes the package and the food item in the package, or any other appropriate reduction of pathogens. In various embodiments, the infrared energy used to heat the package and the food item in the package has a characteristic spectrum over which the package is substantially transparent (e.g., is able to penetrate the package and cause sufficient heating for reducing pathogens without destroying the package, where the package is selected based at least in part on the characteristic spectrum or where the characteristic spectrum of the infrared energy is selected based at least in part on the package - for example, the transmissivity characteristics of the package material of about 70%), the infrared source has a filter that cuts off energy delivered to the food item and package below 650nm, or any other appropriate infrared energy or energy source. In some embodiments, the infrared source comprises a 1000W and/or a 2500W T3 Halogen Infrared Emitter. In some embodiments, the system comprises a postheater for heating the package with the food item inside after exposing the package to maintain the temperature high for reducing pathogens. In some embodiments, the system further comprises a chiller for chilling the package with the food item after exposing the package.

[0012] The infrared heating of a food item in a bag through the bag using an in-line process contrasts with batch processing by heating up a batch of bagged food items to reduce pathogens. However, to achieve the desired reduction of pathogens, this type of process requires a heat and time of heating that results in the deformation or destruction of the package.
In some embodiments, an energy depositing system for exposing food (e.g., a prune) to infrared light. The food item is preheated using a steamer. The food item is inserted into a package using a bagger. The package with the food item is then exposed to infrared, such that the temperature of the packaged food rises to the point that any spoilage organisms (e.g., pathogens heated to 200°F by exposing the item using Halogen T3 emitters for 30 seconds) present in the packaged food are destroyed. After the exposure, the package is maintained at high temperature (e.g., 3 minutes at 185°F) to ensure that the spoilage organisms are further reduced and/or ensured to be destroyed. The package is then chilled (e.g., chilled using a bath at 65-70°F for 40 minutes). A final packaging system is then used to add an external packaging (e.g., a crater or bulk packager) to the packaged and infrared exposed food.

Figure 1 is a block diagram illustrating an embodiment of a system for reduction of pathogens for food in packaging. In the example shown, food production 100 produces food to be packaged, and sends it to food warehouse 102, where it is stored before packaging. In various embodiments, the food to be packaged comprises fruit, meat, vegetable, prepared food, a pastry product, or any other appropriate food. In some embodiments, the food produced by food production 100 is preservative free. In various embodiments, food warehouse 102 stores food produced by one or more than one different food producers. In various embodiments, food from different producers stored in food warehouse 102 is sorted by producer, type of food, date produced, or by any other appropriate sorting parameter. Food is transported from food warehouse 102 to food packaging and exposure system 104. In some embodiments, food produced by food production 100 is transported directly to food packaging and exposure system 104 and is not stored between production and packaging and exposure. Food is then packaged (e.g., using a bagger) and exposed by packaging and exposure system 104. In some embodiments, food is packaged and exposed by packaging and exposure system 104 in such a way that the food can be distributed and sold safely without the use of preservative additives to the food. Food is then transported to food vendor 106 and sold.
Figure 2 is a block diagram illustrating an embodiment of a food packaging and exposure system. In some embodiments, the food packaging and exposure system of Figure 2 comprises food packaging and exposure system 104 of Figure 1. In the example shown, food enters the food packaging and exposure system and proceeds to food pre-heater 200. Food pre-heater 200 heats the food in order to reduce the amount of infrared exposure necessary in food exposure oven 204 in order to raise the food temperature to a desired peak food temperature. In various embodiments, food pre-heater 200 heats the food using a steamer, using an infrared light, using an electric heating element, using burning gas, or using any other appropriate heating method or combination of heating methods. In various embodiments, food pre-heater 200 heats the food for a specific period of time, until the food reaches a specific temperature, or until any other appropriate condition has been met. After heating, the food proceeds to food bagger 202. In some embodiments, food pre-heater 200 is not used, and food proceeds directly to food bagger 202 upon entering the food packaging and exposure system.

Upon receiving a food item, food packager 200 inserts the food item into a package, and delivers the packaged food item to food exposure oven 204. In various embodiments, the package comprises a sealable bag, a plastic bag, a package made from a gas permeable material, a package selected for its composition material with a high degree of transparency to the exposure source used by food exposure oven 204, or any other appropriate packaging criterion. In various embodiments, the package is sealed after the food item is inserted into it and before the packaged food is delivered to food exposure oven 204, the package is sealed in such a way so air is not trapped within the seal, the package is sealed after the food has been processed by food exposure oven 204.

In some embodiments, food packager 200 additionally comprises a scale for weighing the desired content into the package. In various embodiments, food packager 200 comprises a packaging checker that checks that the package has been filled appropriately by measuring package weight, by measuring package volume, by optically examining the package, or using any other appropriate method. In some embodiments, a package checker confirms the proper fill weight and is located further downstream in the
packaging process. In various embodiments, the scale is enclosed to retain heat, the packaging checker comprises a scale that is enclosed to retain heat, the packaging checker and/or scale associated with the packaging checker adds heat so that the food item is not so cold before entering the infrared exposure system, or any other appropriate configuration of a packaging checker and/or a scale. In some embodiments, food packager 200 additionally comprises a package seal checker for checking that the package has been sealed properly.

[0018] Food exposure oven 204 exposes the packaged food received from food bagger 202. The exposure process is conducted in order to reduce pathogens. In various embodiments, food exposure oven 204 exposes the packaged food with infrared exposure, exposes the packaged food with infrared energy chosen at a characteristic spectrum to which the package used by food bagger 202 has a high degree of transparency, exposes the food for a specific period of time, exposes the food until the food reaches a specific temperature, or any other manner of exposing. In some embodiments, the food package is sealed after the food has been exposed by food exposure oven 204. In various embodiments, reducing pathogens comprises sterilization, pasteurization, reducing pathogens to acceptable levels, reducing pathogens to acceptable levels for food safety, reducing pathogens to zero, or any other appropriate pathogen reduction condition. In various embodiments, pathogens comprise bacteria, yeasts, molds, or any other appropriate pathogens.

[0019] After the food has been exposed by food exposure oven 204, it is transported to food post-heater 206. Food post-heater 206 heats the packaged food after exposure by food exposure oven 204. Food post-heater 206 heats the food in order to maintain its temperature above a specific point for at least a specific amount of time and/or in order to improve the uniformity of the temperature of the food. In various embodiments, food post-heater heats the packaged food using a steamer, using an infrared light, using an electric heating element, using burning gas, or using any other appropriate heating method or combination of heating methods. In some embodiments,
food post-heater 206 heats the food while it is in motion. In some embodiments, food post-heater 206 comprises a spiral heater.

[0020] After the food has been heated by food post-heater 206, it is transported to food chiller 208.

[0021] In some embodiments, food post-heater 206 is not used, and the food proceeds directly from food exposure oven 204 to food chiller 208. In some embodiments, food post-heater 206 and food chiller 208 are both not used, and food proceeds directly from food exposure oven 204 to food final packaging 210.

[0022] Food chiller 208 comprises a chiller for lowering the temperature of the packaged food after heating and prior to final packaging. In some embodiments, it is used to lower the temperature to a point that will not damage the final packaging. In some embodiments, food chiller 208 chills the food while it is in motion. In some embodiments, food chiller 208 comprises a spiral chiller.

[0023] After the food has been chilled by food chiller 208, it is transported to food final packaging 210. Food final packaging 210 comprises placing the packaged food into a final package suitable for sale to consumers. Food final packaging 210 comprises a final packaging step for the food. In various embodiments, the final package comprises a box, a bag, a can, or any other appropriate final package. In some embodiments, food final packaging 210 seals the package the food was placed in by food bagger 202 prior to placing the packaged food in the final package. In some embodiments, food chiller 208 is not used, and food proceeds directly from food post-heater 206 to food final packaging 210. After final packaging, the packaged food is delivered to the food vendor (e.g., food vendor 106 of Figure 1).

[0024] Figure 3 is a diagram illustrating an embodiment of a food exposure oven. In some embodiments, the food exposure system of Figure 3 comprises food exposure oven 204 of Figure 2. In the example shown, packaged food 302 sits on conveyor 304 and is moved along the length of exposure oven 300 as conveyor 304 moves. Exposure
elements 306 are located at the top and bottom of exposure oven 300, and emit energy that is delivered to packaged food 302 as it travels through the length of exposure oven 300. The temperature achieved in the package and/or for the food item in the package is monitored using a monitor (e.g., a thermocouple). In some embodiments, the energy emitted by exposure elements 306 is infrared energy. In some embodiments, exposure elements 306 are T3 infrared lamps. In various embodiments, there are one, two, three, four, or any other appropriate number of exposure elements 306 along the width of exposure oven 300 (e.g., in the direction into the page in Figure 3), and/or there are two, six, fourteen, twenty-four, or any other appropriate number of exposure elements 306 along the length of exposure oven 300 (e.g., left to right in Figure 3). In some embodiments, one or more of exposure elements 306 can be shut off in the event that the food temperature crosses a food temperature limit. In some embodiments, exposure elements 306 include reflectors for increasing the fraction of the emitted infrared energy that is directed at packaged food 302.

[0025] In various embodiments, when conveyor 304 carries packaged food 302 to the end of exposure oven 300, packaged food 302 exits exposure oven 300 and is transported to the food post-heater (e.g., food post-heater 206 of Figure 2), the food chiller (e.g., food chiller 208 of Figure 2), food final packaging (e.g., food final packaging 210 of Figure 2), or any other appropriate next processing step.

[0026] Figure 4 is a flow diagram illustrating an embodiment of a process for reduction of pathogens for food in packaging. In some embodiments, the process of Figure 4 is used by a food packaging and exposure system (e.g., food packaging and exposure system 104 of Figure 1) for packaging and exposing food. In the example shown, in 400, the food item is inserted into a package (e.g., using a bagger or bagging machine). In 402, the packaged food item is exposed. For example, pathogens are reduced by exposing the food item and the package with the food item inside using infrared source.
Although the foregoing embodiments have been described in some detail for purposes of clarity of understanding, the invention is not limited to the details provided. There are many alternative ways of implementing the invention. The disclosed embodiments are illustrative and not restrictive.

WHAT IS CLAIMED IS:
CLAIMS

1. A system for reducing pathogens for food in packaging, comprising:
   a bagger for inserting a food item into a package; and
   a pathogen reducer for reducing pathogens by exposing the food item and the
   package with the food item inside using infrared energy.

2. A system as in claim 1, further comprising receiving the food item.

3. A system as in claim 2, wherein the food item is preservative free.

4. A system as in claim 1, further comprising a preheater for heating the food item
   prior to insertion into the package.

5. A system as in claim 4, wherein the preheater uses steam for heating the food
   item.

6. A system as in claim 1, wherein the package comprises a sealable bag.

7. A system as in claim 6, wherein the sealable bag comprises a plastic bag.

8. A system as in claim 6, wherein the sealable bag is sealed so as to not trap air
   within the seal.

9. A system as in claim 1, wherein the package comprises a gas permeable package.

10. A system as in claim 1, wherein the pathogen reducer reduces pathogens by
    sterilization.

11. A system as in claim 1, wherein the pathogen reducer reduces pathogens by
    pasteurization.

12. A system as in claim 1, wherein the pathogen reducer reduces pathogens to a
    predetermined acceptable level.

13. A system as in claim 1, wherein the pathogen reducer reduces pathogens to a
    predetermined acceptable level for food safety.
14. A system as in claim 1, wherein the pathogen reducer reduces pathogens by reducing pathogens in the package to zero pathogens.

15. A system as in claim 1, wherein the infrared energy comprises infrared energy with a characteristic spectrum, wherein the package is substantially transparent for the majority of the energy in the characteristic spectrum.

16. A system as in claim 15, wherein the package is selected based at least in part on the characteristic spectrum of the infrared energy.

17. A system as in claim 15, wherein the characteristic spectrum of the infrared energy is selected based at least in part on the package.

18. A system as in claim 1, further comprising a postheater for heating the package with the food item inside after exposing the package.

19. A method as in claim 1, further comprising a chiller for chilling the package with the food item inside after exposing the package.

20. A method for reducing pathogens for food in packaging, comprising:

   inserting a food item into a package; and

   reducing pathogens by exposing the food item and the package with the food item inside using infrared energy.
Fig. 1
Food

Food Pre-Heater

Food Bagger

Food Exposure Oven

Food Post-Heater

Food Chiller

Food Final Packaging

Packaged and Exposed Food

Fig. 2
Start

400: Insert Food Item Into Package

402: Expose Packaged Food Item

End

Fig. 4
INTERNATIONAL SEARCH REPORT

A. CLASSIFICATION OF SUBJECT MATTER
IPC(8) - A23L 3/96 (2011.01)
USPC - 426/326

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

B. FIELD SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
USPC - 426/326

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
USPC - 426/326, 426/124, 426/392, 426/324

Electronic data base consulted during the international search (name of data base and where practicable, search terms used)
- "Databases: WEST (PGPB, USPT, USOC, EPAB, JPAB); Google, Google Scholar " Search Terms Used: Sunsweet, Pierce, Ramsey, Lance, Dodson, Dugan, food, packaged, packaging, bagged, bagging, bag, infrared, steam, preheated, preheating, system, apparatus, sterilization, sterilizing, sterilized characteristic spectrum, pathogen

C. DOCUMENTS CONSIDERED TO BE RELEVANT

<table>
<thead>
<tr>
<th>Category</th>
<th>Citation of document, with indication, where appropriate, of the relevant passages</th>
<th>Relevant to claim No.</th>
</tr>
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<tbody>
<tr>
<td>Y</td>
<td>US 7,682,641 B1 (Vasilenko) 23 March 2010 (23.03.2010), especially col 2, in 24-28; col 3, in 41-43; col 5, in 23-28; col 5, in 66-68 to col 6, in 4; col 9, in 9-11</td>
<td>3, 11-17</td>
</tr>
<tr>
<td>Y</td>
<td>US 5,617,781 A (Nakatani et al.) 08 April 1997 (08.04.1997), especially col 5, in 49-63; col 6, in 53-55</td>
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<td>Y</td>
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<td>6-8, 15-19</td>
</tr>
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</table>

Further documents are listed in the continuation of Box C.

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  - "A" document defining the general state of the art which is not considered to be of particular relevance
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- Later document published after the international filing date or priority date and not in conflict with the application but cited to understand the invention
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- 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
- Document member of the same patent family

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