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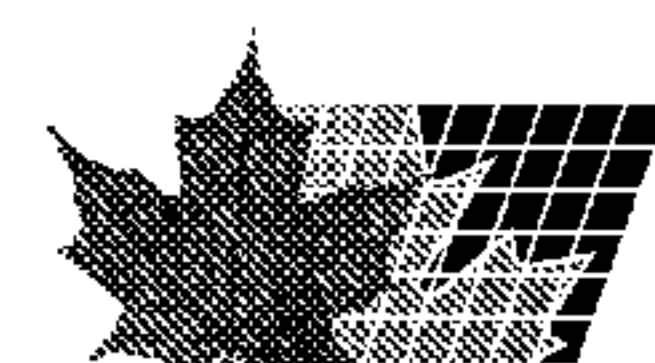
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(54) Titre : PROCEDE PERMETTANT DE TUER DES BACTERIES CONTENUES DANS LA VIANDE
(54) Title: METHOD FOR KILLING BACTERIA IN MEAT

(57) **Abrégé/Abstract:**

Bacteria on and in meat, for example hamburger, is killed by subjecting the meat to an explosive shock front pressure wave propagated through an inert liquid medium at a rate of at least 6100 meters per second.



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(21) International Application Number: PCT/US98/04512 (22) International Filing Date: 6 March 1998 (06.03.98) (30) Priority Data: 60/040,085 7 March 1997 (07.03.97) US (71) Applicant: HYDRODYNE INCORPORATED [US/US]; Suite 1602, 416 Ponce de Leon Avenue, Hato Rey, Puerto Rico 00918 (US). (72) Inventor: LONG, B., John; 988 Boulevard of the Arts, Sarasota, FL 34236 (US). (74) Agent: NEIMARK, Sheridan; Browdy and Neimark, P.L.L.C., Suite 300, 419 Seventh Street N.W., Washington, DC 20004 (US).		(81) Designated States: AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GE, GH, GM, GW, HU, ID, IL, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, UA, UG, UZ, VN, YU, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, ML, MR, NE, SN, TD, TG). Published <i>With international search report.</i>
(54) Title: METHOD FOR KILLING BACTERIA IN MEAT (57) Abstract Bacteria on and in meat, for example hamburger, is killed by subjecting the meat to an explosive shock front pressure wave propagated through an inert liquid medium at a rate of at least 6100 meters per second.		

METHOD FOR KILLING BACTERIA IN MEAT

The present invention is directed to an improved system for killing bacteria in meat.

Prior technology for killing bacteria in meat include the application of chemicals, e.g. ethyl alcohol; the application of live steam to the meat surface; and the application of radiation, especially hard gamma radiation. Chemicals such as alcohol have the disadvantage of being effective only as regards the surface bacteria, and possibly altering the taste of the meat. Live steam undesirably changes the color of the surface of the meat, turning it brownish, and has limited bacteria-killing penetration. Radiation kills bacteria on and in the meat, but some of the meat molecules are altered by radiation, with resultant fear that this alteration may produce undesirable effects, e.g. cancer.

With most forms of cooking, heat is applied to the meat surface, and through conduction is transferred throughout the meat. Experience has shown that the meat surface usually becomes hot enough to kill the bacteria, but in many cases the inside of the meat does not reach a microorganism killing temperature. With unground meat, e.g. steaks, this is normally not a problem, because the inner portion of the meat is likely to be bacteria-free. However, with ground meat the bacteria from the surface is distributed throughout the meat. Thus, there have been some recent occurrences of pathogenic E-Coli bacteria in insufficiently cooked hamburger killing persons who had eaten such hamburgers. Of the three prior methods of killing bacteria mentioned above, only radiation can kill the bacteria within the meat.

Killing microorganisms on and in meat is obviously important from a health standpoint, inasmuch as some of the bacteria can be life-threatening. However, killing all or reducing the amount of bacteria on the meat surface also greatly increases the shelf life of meat, which is economically important.

U.S. patents 5,328,403 and 5,273,766, John B. Long, are directed to the treatment of meat by exposing it to an

explosive force, in order to tenderize the meat; such an explosive force also kills microorganisms on and in the meat. Experiments conducted on meat using the system of the aforementioned U.S. patents '403 and '766 have shown that
5 about 90% of the surface bacteria on the meat samples were killed. It would be desirable to increase the percentage of bacteria killed by such a process.

It is, accordingly, an object of the present invention to overcome deficiencies in the prior art, such as
10 indicated above; and another object to provide a process which increases the percentage of bacteria killed by subjecting meat to an explosive force, and especially a process which results in killing well over 90% of the bacteria up to 100%. Briefly, this is achieved by providing a faster moving shock wave than
15 provided according to the examples of the aforementioned Long patents. The present invention is an improvement in that the application of an appropriate explosive charge can kill well over 90%, e.g. at least 92% and preferably at least 96%, more preferably 99.9% and most preferably 99.99% of the bacteria in
20 and on the meat, up to 100%.

In accordance with the present invention, a chemical explosive with high brisance is preferably used, which is more effective in rupturing the membranes of the microorganisms residing in the meat. When a detonator initiates an explosive
25 reaction in an explosive material, the speed with which the reaction traverses the explosive is referred to as the "burn rate". The faster the burn rate, the higher the brisance, and the more of the explosive energy that is expended in shattering the surrounding environment. The present invention
30 is based on the concept of using an explosive having a fast burn rate which is more effective in killing bacteria. In this instance, "fast" would be at least 6100 meters per second (m/s), and preferably at least 6300 m/s, most preferably about 7000 m/s or more.

35 Several already known explosives have burn rates in excess of 6100 meters per second, these being single molecule chemical explosives. HMX, RDX, PETN and Primasheet™ are examples of these, and are preferred. Two-part chemical

explosives can also be used; in a two-part chemical explosive, neither chemical by itself is an explosive, and the two must be mixed before an explosive is achieved. Nitromethane by itself, if it can be detonated, has a burn rate of
5 approximately 6705 meters per second. Nitromethane can be sensitized by adding a small amount, e.g. about 5%, of a sensitizer chemical like ethylene diamine, which is also a liquid, and this produces an explosive mixture which can be detonated with a standard blasting cap. Other known
10 sensitizers include urea, isopropyl nitrate, monomethylamine nitrate and hexamethylenetetramine mononitrate.

Safely usable insensitive explosives include compositions of 80-90% RDX or HMX, the explosive powders or crystals being thoroughly coated with plasticized polymer
15 (20%-10%) and wherein the HMX is usually in a bimodal crystal form (see "Explosives and Propellants (Explosives)"; Vol. 10, 4th Ed. Encyclopedia of Chemical Technology, especially pp. 55-56). Primasheet™ (Ensign-Bickford Co.) has a burn rate of 7010 m/s; the aforementioned HMX has a burn rate of 8800
20 meters per second; and PETN has a burn rate of 8260 meters per second.

Except for the use of an explosive having a fast burn rate as defined above, preferably a so-called insensitive explosive for safety purposes, the present invention in
25 certain preferred embodiments is otherwise carried out according to the method of the above-identified U.S. patents '403 and '766, the contents of which are incorporated herein. For best results, the explosive discharge should take place sufficiently below the upper level of the water in the meat
30 supporting tank so that the gas bubble created by the explosive discharge will not break through the upper surface of the liquid before the shock wave passes through the meat, is reflected from the meat supporting surface and again reaches the gas bubble from which it will be reflected again
35 so that a third shock wave will then pass through the supported meat.

Instead of using a batch system as shown in the above- identified U.S. patents '403 and '766, the process of

the present invention can be carried out using an intermittent, semi-continuous or continuously operating apparatus using various types of conveyor systems. In these types of operations, especially those which are scaled down in size whereby a smaller quantity of meat is treated with each discharge, it is desirable to replace chemical explosives with means for producing an explosion by electrical discharge. Thus, a bank of capacitors can hold a large electrical charge which can be released to under water electrodes as a method for producing an underwater shock wave. A judicious arrangement of capacitors, switches and optional reflectors can produce a shock wave having a pressure rise rate and shape with respect to pressure and time which will match those waves produced by chemical explosives.

It is therefore within the scope of the present invention to produce an explosion generated shock wave by either electric discharge or chemical explosives wherein the shock wave moves at a rate of at least 6100 meters per second, and preferably faster. In either case, however, it is important consistent with the aforementioned U.S. patents that the meat be so supported so that a reflected shock wave crosses the incoming wave to produce optimum effects.

The foregoing description of the specific embodiments will so fully reveal the general nature of the invention that others can, by applying current knowledge, readily modify and/or adapt for various applications such specific embodiments without undue experimentation and without departing from the generic concept, and, therefore, such adaptations and modifications should and are intended to be comprehended within the meaning and range of equivalents of the disclosed embodiments. It is to be understood that the phraseology or terminology employed herein is for the purpose of description and not of limitation. The means, materials, and steps for carrying out various disclosed functions may take a variety of alternative forms without departing from the invention.

Thus the expressions "means to..." and "means for...", or any method step language, as may be found in the specification above and/or in the claims below, followed by a functional statement, are intended to define and cover
5 whatever structural, physical, chemical or electrical element or structure, or whatever method step, which may now or in the future exist which carries out the recited function, whether or not precisely equivalent to the embodiment or embodiments disclosed in the specification above, i.e., other means or
10 steps for carrying out the same function can be used; and it is intended that such expressions be given their broadest interpretation.

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WHAT IS CLAIMED IS:

1. In a method of treating meat comprising supporting the meat on a shock wave reflective surface in an inert liquid, and subjecting said meat to an explosive shock wave propagated through the inert liquid, the shock wave then reflecting back from the shock wave reflective surface through the meat, the improvement wherein:

the shock wave moves through said inert liquid at a rate of at least 6100 meters per second, wherein at least 92% of the bacteria on and in the meat is killed.

2. A method according to claim 1 wherein the rate of shock wave movement through said inert liquid is at least 6300 meters per second.

3. A method according to claim 1 wherein the rate of shock wave movement through said inert liquid is at least 7000 meters per second.

4. A method according to any one of claims 1-3 wherein said shock wave is generated by explosion of a chemical explosive.

5. A method according to any one of claims 1-4 wherein said shock reflecting wall is at least partially hemispherically shaped.

6. A method according to any one of claims 1-5 wherein said meat is in the form of ground meat.

7. Meat treated by the method of any one of claims 1-6 containing no more than 8% of the bacteria originally present on and in said meat prior to said treatment.

8. Meat treated by the method of any one of claims 1-6 containing no more than 4% of the bacteria originally present on and in said meat prior to said treatment.

9. Meat treated by the method of any one of claims 1-6 containing less than 0.1% of the bacteria originally present on and in said meat prior to said treatment.

10. Meat treated by the method of claim 1 containing no more than 0.01% of the bacteria originally present on and in said meat prior to said treatment.