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High Pressure Processing: A Novel Food Preservation Technique

Ginsau, M.A
Department of Science Laboratory Technology, Jigawa State Polytechnic, Dutse, Nigeria.

Abstract: *Food production, processing, preservation and storage are known phenomenon in the history of mankind long before the scientific basis was understood. The general aim food preservation is to prevent spoilage and ensure safety. There are several food preservation methods that are traditionally known to be effective. With the scientific understanding of these techniques and advances in food processing coupled with the demands of consumers and food regulatory agencies; the traditional methods of food preservation and processing are now rarely used. High pressure processing (HPP) is among the novel preservation technique that addresses many of the challenges of traditional food preservation techniques.*

Key words: *Food production, food preservation, high pressure processing*

I. Introduction

Food production, processing, preservation and storage are known phenomenon in the history of mankind long before the scientific basis was understood. The general aim food preservation is to prevent spoilage and ensure safety. According to Ge at. al., (2012) the making of food and safekeeping are constantly debilitated by microbial infection and oxygenation, hence, food protection has drawn unique consideration.

High pressure processing (HPP) is among the novel preservation technique that addresses many of the challenges of traditional food preservation techniques. The likely of HPP for handling food to elongate their timeframe of realistic usability and enhance microbiological assurance was initially stated for over hundred years back and the United States was the initial nation to examine this procedure. In year 1899 Hite found that HPP could hinder microorganisms in milk and increase the timeframe of realistic usability, in this way growing the potential provisions of HPP in the food business. He tried if milk treated with different levels of pressure remained sweet for a more drawn out period than unpressurized milk did. It was appeared utilizing a pressure of over 463 Mpa for one hour normally decelerates the souring of milk for not less than twenty four hours. HPP machines are broadly utilized for the processing of meat, dairy, seafood, fruits and vegetable items, and different beverages. The turnout worth of HPP food items surpasses ten billion US dollars, with the processing amount displaying an expanding pattern every twelve-months (Huang et. al., 2014).

In the most recent decades, the advancement of novel techniques for food production, for instance HPP, has pulled in much consideration. This innovation comprises the subjection of food to high hydrostatic pressure normally around 100 and 1000 Mpa, with the motivation behind inhibition of both pathogen and damage microorganisms and of inactivating enzymes that cause undesirable alterations. The requisition of this innovation in food protection has been developing, even at industrial level, because of its impact on microorganisms and enzymes prompting great quality food items. Furthermore, this innovation is used for food and crude ingredients preparation for getting inventive sensorial and functional properties (Barcenas et. al., 2010).

During HPP of food, food are introduced to ultra high hydrostatic pressure (UHHP or UHP), normally in the reach of 100-1000 Mpa. The preparing temperature throughout pressure processing might be balanced from beneath 0°c to above 100°c with introduction times extending from a couple of seconds to over 20 minutes (Yaldagard et.al., 2008)

HPP is a non-thermal processing which has useful impact on item quality and has ability to inactivate microorganisms in different food patterns. As an elective to traditional thermal handling, HPP has potential to prepare fantastic food with 'fresh like' qualities and enhanced functionalities (Akhmazillah et. al., 2013).

As a type of non-thermal handling technique, HPP has been broadly used in the food business. It typically utilizes water based solution as a medium to transmit instantly and uniform pressure in the reach from 0 to 800 Mpa. HPP is an efficient innovation to boost food protection and outspread their time span of usability (Tao et. al., 2012).

The aim of this easy is to evaluate HPP as novel preservation technique, with the objectives of identifying the principles for its use, advantages, and disadvantages.

II. Principles Of HPP

According to Yordanov and Angellova (2010) a number of physical and chemical changes result from the use of pressure. Physical pressure throughout pressure processing brings about a volume decrease and an

increment in temperature and energy. The rationale for the use of HPP is in conformity with the three elements of physical and chemical principles.

a. Le Chatelier's principle: any phenomenon such as chemical reaction, conformational change, stage transition, that is conducted by a decline in volume is improved by pressure.

b. Principle of microscopic ordering: at consistent temperature, an expansion in pressure expands the degrees of ordering of molecules of a particular substance. In this manner pressure and temperature apply opposed forces on molecular structure and chemical reactions.

c. Isostatic principle: the food items are condensed by even pressure from each angle and after that came back to their unique shape when the pressure is discharged. The items are condensed freely of the item size and geometry in light of the fact that transmission of pressure to the center is most certainly not mass and time dependant therefore the procedure is minimized.

III. Application Of HPP

The application of HPP on food products base on the underlying principles has always been promising in food preservation against pathogenic and spoilage microorganisms. According to Hsu et. al., (2014) the damaging impacts of high pressure on microorganisms could be linked fundamentally to inactivation of enzymes, harm to DNA, RNA, and ribosomes, and the downfall of membranes and cell wall. Membrane and cell wall devastation is brought about by quick changes in cell volume and protein denaturation. The utilization of HPP has been endorsed by the Food and Drug Administration (FDA) and the U.S. Division of Agriculture (USDA) and is a dependable innovation elective to traditional high temperature pasteurization in food preparing methods. The development in HPP innovations in the most recent decade have made its provision in food handling for safeguarding quality and inactivation of pathogens in numerous seafood products, for example, shellfish, mullet, salmon, cod, squid, and shrimp cost effectively attainable

Distinctive microorganisms have distinctive degrees of resistance to HPP handling, and a wide HPP sensation extent fluctuates around microbiological species and even crosswise over strains. HPP can harm microbial membranes and in this way meddle with nutrient uptake and cell waste discarding. Other harming effect involves broad solute failure throughout pressurization, protein denaturation, and major enzyme inactivation (Huang et. al., 2014).

IV. Effectiveness Of HPP

High pressure might be use to hinder microbial development in food. On the other hand, numerous kinds of microorganisms with varying physiological attributes exist, and distinctive microorganisms may have varying pressure resistance attributes. Mainly, rise in the handling pressure create fluctuating levels of impact on microorganisms, and a lot of studies was done since that time on the reaction of microorganisms to pressure. Taking into account the literary works, 50 Mpa of pressure can restrain protein synthesis in microorganisms and diminish the amount of ribosomes. A pressure of 100 Mpa can incite halfway protein denaturation, and 200 Mpa induce harm to the cell membrane and interior cell structure. Addition of the pressure to 300 Mpa or more prompts irreversible denaturation of enzymes and proteins, which causes bursting of the cell membrane and the discharge of interior substances, bringing about bacterial fatality. Subsequently, the impacts that high pressure have on microorganisms could be classified principally as a alteration to the cell morphology, a restraint of metabolic responses fundamental for cell upkeep, and hereditary mechanism (Huang et. al., 2014).

One of the limitations of HPP is that, spore forming bacteria such as Clostridium and Bacillus spp are found to be resistant to it. According to Reineke et. al., (2013) the endospore resistance mechanism to HPP is as a result of sporulation temperature, demineralization of the core, and ability to retain dipicolinic acid (DPA). Refer to the tables below showing the effectiveness of HPP on microorganisms and the cellular structures destroyed during processing.

V. HPP Equipments

According to Yordanov and Angellova (2010) the first business establishment for HPP showed up in Japan in 1990. Despite the fact that high pressure innovation is at present very costly than conventional preparing methods, the utilization of high pressure offers new chances for food industry to react to the interest from purchasers. High pressure equipment comprises of a high pressure vessel with a closure of pressure generation structure, temperature control unit and material processing system. The pressure vessel is the most critical segment of high hydrostatic pressure system. A few viewpoints must be considered in vessel plan. It is important to plan the high pressure vessel to be measurably steady in a safely manner. Pressure conveying liquids are utilized within the vessel to communicate pressure consistently and immediately to the test items. A good number of known utilized liquids are water, glycol solutions, silicone oil, sodium benzoate solution, ethanol solution, inactive gases and castor oil. The food items are expected to be packaged in an adaptable packaging. The packages are packed into the high pressure area. The vessel is closed and the vessel loaded with

pressure passing liquid. The high pressure is normally completed with water as a pressure driven liquid to encourage the procedure and similarity with food materials. The rationale for applying high pressure to food is to condense the water within the food. At room temperature, the volume of water declines with an expansion in pressure. Since fluid condensation brings about a little volume change, high pressure vessels utilizing water do not introduce the same working dangers as vessels utilizing condense gases. Immediately the expected pressure is achieved the pump is blocked, the valves are shut and the pressure might be sustained devoid of further energy addition. Following the holding of the item for the preferred time at the specified pressure, the vessel is decompressed by discharging the pressure transmitting liquid. Generally, items are held for three to five minutes at 600 Mpa. Nearly five to six cycles for every hour are practicable, permitting time for condensation, holding, decompression, loading and emptying. At the end of the pressure processing, the prepared item is uploaded from the vessel and saved in a traditional manner. Figure 1 bellow is the schematic diagram of operation of HPP unit and a typical HPP machine.

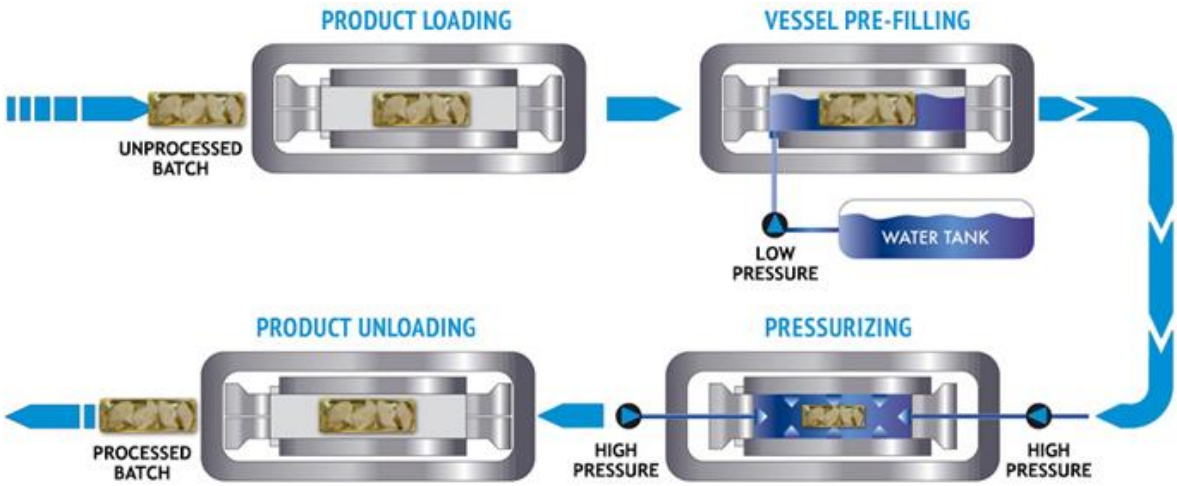

Figure 1: Diagram of operation of HHP unit.
Source: http://www.hiperbaric.com/en/hpp

Figure 2: A typical HPP machine.
Source: http://www.hiperbaric.com/en/hpp

VI. Advantages Of HPP

Yaldagard et al., (2008) enumerated the advantages of HPP as follows:
i. HPP is not reliant of size and shape of the food.
ii. HPP is not dependent of time or mass, to be precise it acts promptly; therefore decreasing the preparing time.

iii. HPP does not break covalent bonds; along these lines, the improvement of strange essence to the items is averted, sustaining the original essence of the items.
iv. HPP could be use at room temperature, therefore decreasing the measure of thermal energy required for food items throughout traditional handling.
v. In view of the fact that HPP is isostatic, that is even all around the food; the food is safeguarded uniformly all around without any particles getting away from the treatment.
vi. The procedure is environmentally accepted since it requires just electric energy and there are no waste items.

VII. Disadvantages Of HPP

Also Yaldagard et al., (2008) enumerated the disadvantages of HPP as follows:
i. Food enzymes and bacterial spores are exceptionally impervious to pressure and need elevated pressure for their inactivation.
ii. The remaining enzyme action and dissolve oxygen brings about enzymatic and oxidative debasement of certain food segments.
iii. The greater part of the pressure treated food require low temperature during safekeeping and delivery to hold their sensory and dietary qualities.

VIII. Discussion

HPP is the best novel technique that maintains food freshness, nutrition, taste, and flavor which produce greater quality products. It avoids the use of chemical preservatives that customers dislike. Since the process can be done with final packaging, it prevents the possibilities of recontamination and cross contamination. It destroys pathogenic microorganisms which guarantee safety and promote exportations. It also destroys spoilage microorganisms which gives higher quality with shelf life. HPP generally extends the shelf life of a product and enhanced customer satisfaction. It is environmentally friendly because it only needs water and electricity.

Despite all the advantages, spore inactivation is a limitation to the process. Even with the documented evidence using synergistic effect of pressure and temperature to rapidly destroys spore forming bacteria at laboratory scale, the major challenge now is to understand the exact mechanism that result to the inactivation of the bacterial spore not only for HPP but also for the well establish industrial scale processes such as canning.

IX. Conclusion

HPP being non thermal process , it is an attractive and innovative technique that allows new product development, for example product that can not be thermally treated can now be processed using HPP.

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