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REVIEW ARTICLE **OPEN ACCESS**

High Pressure Processing in Food Industry

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ABSTRACT
High pressure processing (HPP) or the cold pasteurization of foods offers a viable and practical alternative to thermal processing by allowing food to pasteurize at room temperature. When using high pressure processing, microorganisms are destroyed, but covalent bonds do not break and the effect on processed food is minimal. In addition, the positive effect consists of the avoidance of excessive thermal treatments and chemical preservatives. Food products can be HPP in a batch system or a semi-continuous process. This article provides an overview of current technology status.
Keywords: Food quality, food processing, cold pasteurization, high pressure processing

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INTRODUCTION

The demand for high quality and convenient products with natural flavor and taste has initiated a great deal of interest on minimally processed foods. Besides the focus has shifted for obtaining safe and natural products without additives such as preservatives and humectants. In order to pacify all these requirements without compromising the safety of the products, it is necessary to implement newer preservation technologies in the food industry. Developing and wielding non thermal technologies to process food has emerged to be one of the most popular methods to be in use. One such technology is that of High Pressure Processing. High pressure processing or cold pasteurization is a non thermal food processing technology that can destroy the pathogenic organisms at room temperature thus extending the shelf life of the food. HPP entails pasteurization of food in the range of 100-600 MPa which results in the reduction of microbial load. HPP obeys thermodynamic principles namely Le chateliers principle, laws of equilibrium and isostatic rule all of which account for microbial inactivation. The food material is sealed in packages and placed in an enclosed and an insulated container using a liquid typically water as a transfer medium, an ultra high pressure of 100-600 MPa is generated in commercial applications to process the food [4]. Through the isostatic principle, the pressure in the container is continuosly and evenly transferred to the food product undergoing high-pressure treatment. All parts of the food product receive identical pressure. Size of the product or its external shape does not impact high pressure processing.

Compared with traditional thermal pasteurization techniques, HPP preserves the original color, flavor, quality, and nutritional content of the food. Whereas the structure of high-molecular-weight molecules such as proteins and carbohydrates can be altered by HPP, smaller molecules such as volatile compounds, pigments, vitamins, and other compounds connected with the sensory, nutritional, and health- promoting aspects foods are less affected. Chemical changes in high-pressure processed foods are minimal, because the break of covalent bonds does not occur. Additionally, HPP technology can provide quality superiority over products obtained by conventional technologies, particularly by lowering the need for additives in food and yet still effectively extending its shelf life [14, 18, 9]. The U.S. National Advisory Committee on Microbiological Criteria for Foods has listed HPP as a non-heating pasteurization technique that can replace pasteurization. The U.S. Food and Drug Administration and the U.S. Department of Agriculture have also officially approved the use of HPP for foods [2]. Destruction of microorganisms and inactivation

of enzymes at low or moderate temperatures without changing organoleptic and nutritional properties shows that high-pressure technology has the potential to be used in the development of a new generation of value added foods. HPP is not likely to replace traditional processing methods. It may complement such methods or find niche applications. Nevertheless, their novel physico-chemical and sensory properties offer exciting opportunities for industry. The combination of HPP with other processing options such as heat, gamma-irradiation, ultrasound, carbon dioxide, and anti-microbial peptides, can lower the pressures required. The process can also be integrated to other processes such as blanching, dehydration, osmotic dehydration, rehydration, frying, extraction, gelation, freezing, and thawing. High capital expenditure may limit its application initially but this will be offset by lower operating costs since the energy used to pressurize is less than the energies used in thermal processing and other benefits with respect to product originality. With further progress of technology and its commercialization, it is expected that the cost of the equipment will come down in the near future and the high-pressure processed safe and nutritious products will be available to all consumers at an affordable cost.

INSTRUMENTATION AND PRINCIPLE

HPP is essentially a batch operation. The major components of a HPP equipment consists of a pressure vessel enclosed on both the sides. A yoke mechanism is placed to secure pressure vessel while in operation. A pressure intensifier and a pump is also placed for generating the pressure. For loading or unloading the material handling system is also present. A special PID assisted process control system is also kept in place for monitoring and recording various process variables [19].

A typical operation of HPP is carried out in a retort. The food to be processed is vacuum packaged in a flexible polymeric material and is then subsequently loaded inside a cylindrical carrier basket. The pressure is transmitted to the package on any side of the interface. The carrier basket containing the product is then placed in the pressure vessel which is then closed on all its sides. The pressure vessel is filled with pressure transmitting fluid typically water. The target pressure is obtained through compression of pressure transmitting fluid using the combined action of a pump and intensifier. During high pressure the product is held for the desired time at a target pressure. Finally the vessel is depressurised quickly and the product is unloaded. Typically cycle time for the process is about 10 minutes. There is a constant increase in temperature while compression (3/100C) and a rapid decrease in temperature while decompression which is a unique advantage of HPP for food pasteurization and sterilization [17].

The governing principle for HPP processing are based on assumption that foods under high pressure in a vessel follow the Isostatic rule regardless of their size or shape. According to this rule pressure is instantaneously and uniformly transmitted throughout a sample whether the sample is in direct contact with the pressure medium or hermetically sealed in a flexible package.This principle helps explain why nonporous foods with high-moisture content are not damaged macroscopically by pressure treatment. Because air and water differ in compressibility under pressure, the structure and shape of the foods containing air pockets (as in the case of marshmallows) may be altered upon pressure treatment, unless the food is perfectly elastic and consists of closed-cell foam from which air cannot escape [1]. The effect of HPP on food chemistry and microbiology is governed by Le chatliers principle. High pressure stimulates some phenomena (e.g. phase transition , chemical reaction and changes in molecular configuration) that are accompanied by a decrease in volume is enhanced by pressure.. The effect of pressure on protein stabilization are also governed by this principle. Breaking of concentrated bonds is also enhanced by HPP .Consequently HPP can disrupt large molecules and microbial structures such as enzymes , proteins , lipids and cell membranes and have smaller molecules such as vitamins and flavor component unaffected. [13].

APPLICATION OF HPP ON VARIOUS FOOD INDUSTRY SECTORS

APPLICATION OF HPP ON FRUITS AND VEGETABLES

High Pressure Processing is a very attractive technology for preservation of fruits and vegetable products especially high pressure treatment at room temperature is interesting for pasteurization of a range of fruits and vegetables resulting in a product with a shelf life of 4-6 weeks when stored refrigerated. Moreso over studies are available which show affirmative results for maintaining quality nutrient preservation and sensory aspect of the product. Examples are fruit juices, Jams, vegetable mixes and Ready to eat meals that are pasteurized by HPP to give them an extended shelf life of 1-2 months when stored refrigerated. Some good reviews are available that give an over view of the effect of HPP on fruits and vegetables [15, 16]. The most classic example of HPP on fruits and vegetables is guacomole or Avacado puree [3].

APPLICATION OF HPP ON DAIRY PRODUCTS

Milk was one of the first products to be subjected to HPP in 1897 but there are few applications for dairy products despite patents being developed for milk and dairy products which affirm industrial relevance of this technology. One reason for this lack of application for dairy products might be that HPP treatment effects many constituents of milk especially protein and mineral equilibrium and induce changes in the functional properties of such products [11, 12].

HHP treatment for Cheese is a potential technology in the dairy industry for the manufacture of cheese due to its positive effects on Rennet coagulation time, Cheese yield , ripening characteristics , extent of cheese shelf life , cheese functionality and development of new textures. HHP treatment reduces the number of micro organism in milk so it can be used to increase the microbiological safety and quality of milk to produce high quality cheese. Drake *et al* [8] reported a high quality cheese with HPP treated milk with no detrimental effect on cheese flavor.

APPLICATION OF HPP ON MEAT PRODUCTS

HPP facilitates the improvement of microbial safety of Meat and Meat products [6, 7, 10]. The main objective in industrial HPP is to destroy the pathogenic and spoilage micro organisms and to extend the shelf life while maintaining the characteristics and quality of meat and meat products almost intact. [1] In some cases as in dry cured meat products HPP is the only feasible pasteurization process which has minimal effects on flavor appearance , texture, and nutritional value [10].

CONCLUSION

HPP of foods was first reported by Hite in 1899 who treated milk at 670 MPa for 10 mins and detached a 5-6 log cycle reduction in total counts. Meat treated at 530 MPa for 1hr was reported to have insignificant microbial growth after three weeks. Bridgeman [5] reported egg albumin coagulation by 1 hr at 590 MPa. In last two decades HPP programmes has been established in many places in the world. Further application of this technology in various sectors have been dealt with extensively. The range of high pressure processed products available in international markets (fruits juices, rice cakes, raw squids in Japan; orange and apple juice in France and Portugal; guacamole and oysters in the United States, indicates future potential of the technology. In the coming years, HPP is likely to be used commercially before the underlying science and its full potential may be comprehensively understood. The integration of High Pressure Processing with other matured operations such as blanching, Osmotic dehydration, rehydration, frying, freezing and solid-liquid extraction has been shown to open up new processing options. The key challenges identified include heat transfer problems, resulting non-uniformity in processing, obtaining reliable and reproducible data for process validation, lack of detailed knowledge about the interaction between the high pressure and a number of food constituents, packaging and stationary issue are the areas which need to be worked upon in future.

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