

## 6. HIGH PRESSURE PROCESSING OF FISH AND FISHERY PRODUCTS

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Changes in consumer's desires in the recent past, have led to the requirement for more convenient foods having supreme qualities and freshness, minimally processed and packaged, easy to consume and nutritionally healthier. Hence, the focus of food scientists and engineers have been directed towards alternative technologies or minimal processing and preservation technologies that are environment friendly, low in cost and able to preserve fresh quality attributes of the food. Many novel non thermal technologies like high pressure processing, pulsed light, pulsed electric field, ultrasound, irradiation etc. find application in preservation of food and is in the line of commercialization.

Thermal pasteurization and thermal sterilization for the inactivation of microorganism and reduction of enzyme activity, has resulted in making safe product with extended shelf life than its raw counterparts. But despite its substantial benefits, thermal treatments end with over processed food having significant changes that can alter its sensorial attributes like flavor, colour, texture and nutrient content (Barbosa-Canovas and Bermudez-Aguirre, 2011). The introduction of non-thermal technologies in food processing opens a new era of minimally processed food with high nutritive value, retains the fresh attributes of the product without compromising the safety and quality. Among all non-thermal technologies, HPP offers promising possibilities for the processing and preservation especially in meat, poultry and seafood.

### **High pressure Processing (HPP)**

Application of very high pressures (100-900 MPa) for the preservation of food substance with or without the addition of heat, to achieve microbial inactivation or to alter the food attributes in order to achieve consumer-desired qualities. This technology is also known as high hydrostatic pressure processing or ultra-high pressure processing. HPP retains food quality, maintains natural freshness, and extends microbiological shelf life of the product. This technology is now recognized by the USFDA for RTE foods. The processing can be

conducted at ambient or refrigerated temperature eliminating thermal effects and cooked off flavors and thus highly beneficial for heat sensitive products.

The first line of HPP was demonstrated in 1899 by Bert H Hite, as a possible food preservation process at West Virginia Agricultural Experimental Station (Hoover et al., 1989; Knorr, 1999). In 1992, commercialized high pressure processed products (high acid products including apple, strawberry, and pineapple jams) were marketed in Japan and since after 1992 High pressure processed foods are available in the markets of Japan (Suzuki, 2002) and in Europe and in the United States since 1996 (Knorr, 1999). Other, commercially available high pressure processed products in Australia, Europe and the U.S. include juices, tomato salsa, smoothies, fruit & vegetable purees, and ready to eat meals.

Later there was a growing interest in the area of seafood safety that led seafood processors to explore high pressure technology in product development and extension of shelf life. This technology was utilized in the area of extending shelf life of product mainly by destroying the spoilage and pathogenic microorganisms (Toepfl et. al., 2006) and also used as an alternative thermal treatment to packaged food materials. This non thermal preservation technique could also showed many benefits like complete separation of meat from shells of clams, crabs, lobsters, and oysters providing high yield of product without any mechanical damage. HPP could open up the new eras of product development and product improvements in all segments of meat and fish industry. Another advent is pressure assisted freezing and thawing, which finds its unique application in food industry especially in product development and product quality improvement (Urrutia et.al. 2007). Since HPP has minimal detrimental impact on thermally labile bioactive compounds the technology is becoming a topic of major interest for cosmetic, nutraceutical and pharmaceutical industry.

During the time HPP has turned to be an explored technologies and today it is a commercial reality. HPP products find its place in the world food market with high quality and high value addition. Today the use of high pressure (300-700 MPa) for commercial application comes in vessels ranging 35-420L capacity which had given an annual production of >150,000 tons (Wan et. al., 2009). Regulatory agencies like FDA has approved HPP as substitute to pasteurization but in February, 2009, a combination of pressure with heat called as PATS (Pressure assisted thermal sterilization) found to be effective instead of conventional sterilization (NCFST, 2009).

The basic principles that govern the high pressure effect on the behaviour of foods are (i) Pascal's Isostatic principle and (ii) Le Chatelier's principle.

According to Pascal's isostatic principle high pressure acts uniformly and instantly throughout the sample, independently of the size and shape of the food product (Smelt,1998). A uniform pressure will be applied to the product from all direction, thereby the product will not get damage and return to its original shape on the release of pressure. The fundamental principle of physico-chemical changes occurring during HPP follow the Le Chatelier's principle, which states that 'when a system at equilibrium is disturbed, the system then respond in a way that tends to minimizes the disturbance'. So at high pressure any reactions like change in conformation, or transition of phase that is accompanied by a volume decrease will be favored, while inhibit those reactions involving an increase in volume (Lopez-Malo et. al., 2000).

### **Mechanism of Pressure Treatment**

Each processing cycle in HPP consists of an initial pressurization period where the pressure builds up and the processing operation can be done either with or without the application of heat. The packaged product should be in flexible or semi flexible pouch, that can sustain very high pressures. The product is then submerged into a pressure transmitting fluid, where water is commonly used. Other liquids like ethanol or glycol, castor oil, silicone oil etc. can also use in various combinations with water or use separately. This fluid is able to protect the inner vessel from being corroded and fluid is selected based on the manufacture's specification. During the pressure processing adiabatic heating occurs and the product gets heated up. The temperature increase due to adiabatic heating depends on the type of fluid, pressurization rate, temperature and pressure.

Once the process starts, the hydraulic fluid is pressurized with a pump and the generated pressure is transmitted into the packaged food uniformly from all sides. Since this processing is independent of size and geometry of foods, also acts instantaneously there by the total processing time can be reduced. The process is suitably applied for liquid foods and to liquid foods, having a certain amount of moisture content. The transmitted pressure is uniform and simultaneously applied from all directions so that food retained its structure even at high pressures. Once the pressure is build up to the desired level the product is held at this pressure for a few minutes and then decompression or pressure release takes place. Once

there is a fall in pressure the product temperature falls below that of the initial product temperature.

### **Major Advantages of the Technology**

1. HPP does not involve in breaking covalent bonds which prevents the development of unpleasant flavours to the product and maintains the natural freshness and quality.
2. High pressure is able to modify the palatability and functional properties by inducing denaturation and muscle protein gelation.
3. Process can be carried out at ambient temperatures, that helps in reducing the thermal energy used during conventional processing.
4. High pressure processing is isostatic in nature, equally applied to all particles of food, with no particle escapes.
5. Since high pressure is not time-mass dependent, pressure acts instantaneously thereby reducing the processing time.
6. This non thermal technology is independent of size and geometry of the food.
7. The process is ecofriendly, with no waste and requires only electric energy.

### **Application in marine Products**

- ✓ Used to extend shelf life of products
- ✓ Develop new gel based products with desired sensory attributes and mouth-feel
- ✓ Used in shell fish processing for 100% removal of meat from shells
- ✓ Reduces the microbial risks during raw sea food consumption
- ✓ Inactivates vegetative micro-organism and reduces the bacterial contamination and the pathogens
- ✓ Modify functional properties of the food material
- ✓ HPP in combination with salting and smoking helps to extend the shelf life
- ✓ Pressure assisted thermal processing used for development of shelf stable ready to eat products
- ✓ Pressure assisted freezing and thawing helps in retaining the microstructure and reduces drip loss in fish products

## High Pressure Processing Facility at ICAR-CIFT



A Research model of 2 litre capacity High Pressure machine from M/s Stansted Fluid Power Ltd, United Kingdom at Central Institute of Fisheries Technology, Cochin.

Seafood is a highly perishable commodity and technologies like high pressure processing are essential to increase the market value of some high value fishes. High pressure processing has now experiencing a growing demand in the global market. A lot of researches have been carried out on HPP from the past decade. Further studies on the effects of this technology on the textural and functional modification, biochemical characteristics and microbial kinetics of fish and shellfishes are necessary. The effectiveness of high pressure on microbial and enzyme inactivation, while maintaining optimal product quality is a crucial factor for the commercialization of this technology. HP processing offers many advantages over conventional processing methods known to seafood. This is exemplified by the success of HP-processed oysters in USA by Motivaitt Seafood, Goose Point Oysters and Joey Oysters. However, as HP processing becomes more widely available, initial capital costs may be reduced, making technology accessible to more producers. In addition, the commercialization of the technology for other foods may provide encouragement for seafood processors, by allaying apprehension regarding the use of this novel technology and demonstrating consumer acceptance of HP-processed products.