High pressure processing technology for smoked fish

Researchers at TEAGASC have been looking at the combination of high pressure processing (HPP) and smoking to extend the shelf life of mackerel, while also improving its quality attributes.

There is a growing demand among consumers for healthier and safer products with a longer shelf life. Fatty fish species such as mackerel, which have a high nutritional value due to their omega-3 polyunsaturated fatty acids (PUFAs) levels, constitute a valuable food resource in a healthy diet. However, these compounds can be oxidised, with a subsequent deterioration of sensorial quality, and as a consequence, the shelf life of this pelagic fish is shortened. Applying food preservation technologies that inhibit spoilage and increase the shelf life of fresh fish, while maintaining its quality and healthy attributes, is essential for the fish industry. The application of high pressure processing (HPP), a non-thermal and environmentally friendly technology, could satisfy these requirements and help the fish processing industry to meet market demands for longer life healthy products, such as pelagic fish.

HPP technology

HPP technology offers food processors a number of advantages. The energy consumption is low compared with thermal technologies. It is recognised as a minimal processing technology that maintains nutritional value and flavour compounds, as the covalent bonds, associated with an increase of volume, are not disrupted by HPP. According to the principles of HPP, pressure stimulates processes and reactions that are accompanied by a decrease in volume and inhibits those associated with increases in volume. The pressure is applied instantaneously and is uniformly transmitted, independent of the size and geometry of the food, so foods of different volumes can be processed in the same batch. The pressure transfer medium is usually water. The food is packaged and does not directly contact the processing devices, preventing the secondary contamination of food after pressurisation. This technology eliminates spoilage and pathogenic microorganisms, extending the shelf life and enhancing the microbiological safety of food. For these reasons, the application of HPP is of interest to the seafood industry.

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HPP can inactivate oxidative endogenous enzymes, involved in lipid and protein oxidation, and so can be used as a pre-treatment before storage and processing of fish products. In addition, it can reduce the contents of biogenic amine compounds (BAs), primarily produced by microbial decarboxylation of amino acids or by enzymes present in raw foodstuffs. In fish, BAs can occur quite commonly due to the fact that post-mortem changes happen very fast. The pressure applied at an industrial level is between 300 and

700MPa and its effect depends on factors such as the pressure intensity, holding time, temperature and food matrix, and also on the type of microorganisms and their physiological state, therefore necessitating optimisation of treatment conditions on an individual commodity basis.

Smoking

Smoking is a traditional method for food preservation. Smoke penetrates into the food matrix and a partial loss of moisture, often fat, and enzymatic and/or heat-induced modifications of proteins occurs. The preparation of the foodstuff, the duration of the treatment, smoke composition, temperature, humidity, handling practices and packaging of the products will determine the effects of the smoking. The smoke components affect the sensory properties of products and have antimicrobial and antioxidant activities.
Fish treated with beech tree smoke turn a goldish yellow colour (**Figure 1**).

Figure 1. Mackerel fillets treated at 500MPa/5 min (left) and treated at 500MPa/5 min combined with smoking (right).

The colour is caused primarily by oxidation and polymerisation of the deposited smoke components, mainly phenols, but is also partially due to the Maillard reaction, with the participation of carbonyl compounds from the smoke and amino groups of the food proteins and amino acids. The aroma of the smoked products comes from the molecules present in the smoke and the substances generated in biochemical and chemical reactions in the food matrix. The typical taste of smoked foods is due to the interaction of phenols, carbonyl compounds, acids and the products of their reactions with the components of the food matrix.
A study carried out by Teagasc has shown that treatments of 300MPa or 500MPa for five minutes could extend the shelf life of mackerel, as a significant reduction of Total Viable Counts (TVC) and H_2S-producing bacteria (below detection limit) was observed in mackerel fillets, immediately after treatments. However, colour changes were detected, with an increase of lightness (L^*) and a decrease of redness (a^*) of mackerel fillets (see **Figure 1**: left image). These treatments also modified the texture, with an increase of hardness in pressurised samples. In an attempt to introduce desired changes on quality attributes, the pressurisation treatments mentioned above were combined with hot smoking in mild conditions. The mackerel fillets were pressurised and after the pressurisation treatment, they were brined (200g/L NaCl) for three minutes, sprayed with tap water, dried at 15°C for one hour, heated at 47°C for 1.5 hours and smoked at 45°C for 1.5 hours. A considerable improvement in colour characteristics was achieved when HPP was combined with smoking (**Figure 1**) along with textural properties.

Conclusions

The combination of HPP and smoking has been demonstrated to enhance the quality attributes of mackerel, contributing to the maintenance of its nutritional value, and is a promising treatment to extend the shelf life of mackerel.

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