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Studies on Physical Properties of the Extruded Fish Products Employing a Single Screw Extruder

C.K. Kamalakanth[1], C.K. Abdul Asees, Leema Jose, T.K. Srinivasa Gopal, C.N. Ravishankar and A.C. Joseph
Central Institute of Fisheries Technology, Cochin - 682 029, India

The necessity and the importance of value added products are growing rapidly during the last few decades, which helped to popularize modern technologies like extrusion. In the present study less utilized pink perch (*Nemipterus japonicus*) was blended with the corn starch to produce 'Spaghetti' typed extruded product using single screw extruder. Standardization was done with increasing concentrations of fish mince. Physical properties like bulk density, linear expansion, colour etc., were found to be changed by the increase in the concentration of the fish muscle in the premix. It was found that premix with 10% fish mince had better physical properties like colour, linear expansion, shearing force etc.

Key words : ***Nemipterus japonicus*, single screw extruder, colour, shearing strength, linear expansion, water absorption index.**

In recent years there has been considerable interest in the development of extrusion processes for the production of convenient foods in developing countries. The extrusion technology has many advantages such as versatility, low cost, good quality for the products such as expanded snack foods, baby foods and ready to eat cereals. The current market studies indicate that extruded products is shifting from baby foods to the adult market which needs to improve the eating quality with respect to texture, colour, flavour and most importantly the nutritional facts (Shah, 1991). With the growing demand for convenience foods, sales of ready to cook and ready to eat packaged foods are constantly on the rise. An improved process for the manufacture of grain based extruded products including ready-to-eat cereals and snacks foods have been described (Lengerich *et al.*, 2003). There have been considerable amount of highly proteinaceous and less utilized by-catches from trawlers, which can be utilized for the production of extruded products. Market studies indicate that even though the pink perch is a common species in India, its demand among consumers is low. Processing of low value fishes like the pink perch into extruded products can enhance the nutritional quality and can be a solution for the malnutrition of common people in the developing countries. Gelatinized corn flour and cornstarch have been marketed for more than five decades for various industrial and food applications. Maize (*Zea mays*) is utilized in more diversified ways than any other cereals. Due to its high percentage of carbohydrates (Manay & Shardaksharaswamy, 2001) and high puffing characteristics of its endosperm it is a good raw material for blending with the fish muscle. It was reported that the co-extrusion of fish with cereals offers a possibility of producing shelf stable foods with good nutritional quality (Clayton & Das, 1982).

[1] Corresponding author: email : kamalakanth@rediffmail.com

Murray *et al.* (1980) reported production of co-extrudates using mixtures of soya and fish proteins by thermal extrusion process.

The present study aims to develop an extruded product using corn flour incorporating pink perch mince at different levels and to study the physical characteristics such as linear expansion, colour, shearing strength and bulk density.

Materials and Methods

Finely ground corn starch (food grade) procured from the local market was used for the study. The fish, pink perch (*Nemipterus japonicus*) obtained fresh from the landing centre was dressed, washed thoroughly with potable water and the meat was separated using meat-bone separator (Model SF-6, Safe World Enterprises (M), SDN.BDH, Malaysia). Minced meat was washed in chilled water three times, frozen at -40 ± 2°C in an air-blast freezer, packed in 250 gauge low density polythene film and stored at -18 ± 2°C in cold store. The frozen mince was thawed to room temperature and the fish mince was mixed with corn flour at ratios of 10:90, 20:80, 30:70 along with 2% salt in a Bowl chopper (Mado Garent, Type MTK 661, Maschinfabrik Dornhan, D-72175-Dornhan). Trials with different moisture levels were tried and it was observed that at 40% level, the extrusion was better. Hence the fish flour mixture was adjusted to a final moisture level of 40%. A control was also prepared (final moisture level of 40%) using cornstarch and salt without fish mince. The extrusion equipment consisted of single screw extruder (G.L Extrusion systems Pvt. Ltd., KHSRA No RZ.172/12, Durga Park, New Delhi, India) with spaghetti type die, cutting machine, conveyer, and hot air dryer. L/D ratio of the extruder barrel was 5.1 with 100-rpm screw speed. Length of the screw was 380mm with a helical angle of 42.1°. The fish-corn mixture was fed into the extruder manually at a feed rate of 240g/min, extruded at a temperature ranging from 110-120°C and the extrudate was cut and dried in a dryer maintained at 75°C for two hours. The product obtained was of spaghetti type in a ready to fry form.

Physical properties of the extruded samples were measured according to the standard methods. Bulk density of the sample was determined and expressed in g/cc by sand displacement method (Anon, 1998). Shearing strength of the sample was measured in a texture analyser (Lloyd Instruments material testing machine) by using a Warner-Bratzler shear attachment (Gogoi *et al.*, 1996). Water absorption index (Sosulusky, 1962) and percentage linear expansion (Yu *et al.*, 1981) of the samples were determined as illustated . Colour of the sample was tested using the HunterLab Miniscan XE plus spectro colorimeter (model No D/ 8-S) with geometry of Diffuse/ 8° (sphere-8mm view) and an illuminant of D65/10° (Shah, 1991). All the data were expressed as a mean of three measurements.

Results and discussion

Fig. 1 shows the linear expansion of extruded products as a function of percentage of fish mince. Extent of expansion was found to be decreasing with the increase in the concentration of fish meat in the raw mix. It was shown that expansion of extruded product was directly related to the starch content i.e., the higher the starch content the greater the expansion (Guy, 2001). An earlier study indicated that extrudate expansion of cereal-based products is largely dependent on molecular interactions and structural transformations that proteins undergo during extrusion

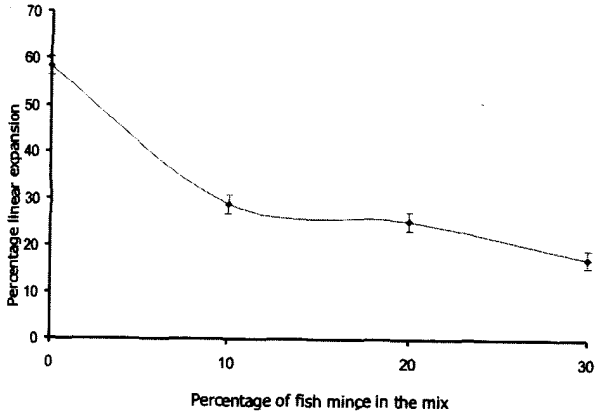

Fig. 1. Effect of incorporation of pink perch mince on linear expansion of extruded products

processing (Lambert & Kokini, 2001). This is due to the interaction between starch and the protein, which inhibits the expansion of the product. Replacing starch with protein not only reduces the amount of starch, but also increases the protein content. Similar observations were reported by Lue *et al.* (1991).

Texture is another important sensory attribute in an extruded product. Rapid flashing of water as the gelatinized starch comes out of the die gives characteristic texture to the product. Sudden drop in pressure causes the liquid water to change into vapour. These bubbles of water vapour lead the product stretch and expand, which was set upon cooling. Thus the trapped air bubbles are responsible for the puffed structure in such products. Fig. 2 indicates shearing strength of the extruded product as a function of percentage of the fish meat. The force required to break the product increased in the beginning followed by a gradual decrease with the increase in the percentage of fish mince. This may be due to the fact that as the amount of protein increases, the water holding capacity of the product increases and facilitates easy breaking of the product. This also decreases the amount of expansion. Shear strength of starch extrudate reflects its expansion volume (Owusu-Ansah *et al.*, 1984).

The characteristic colour of the extruded product is shown in terms of L*, a*, b* values in figs. 3 & 5. Analysis of the colour data of the extruded product indicated that different parameters like L*(lightness), and b*(yellowness) had significant changes with increase in the percentage of fish meat (figures 3 & 5). It is clear from the fig. 3 that L* value decreased as the fish mince was incorporated in the premix. Hunter L* values decreased initially and then increased slightly as the percentage of fish mince increased. The darkening may be due to the Maillard browning reaction between sugar from the starch and amino acid (mostly Lysine) from the fish meat. Similar observations were

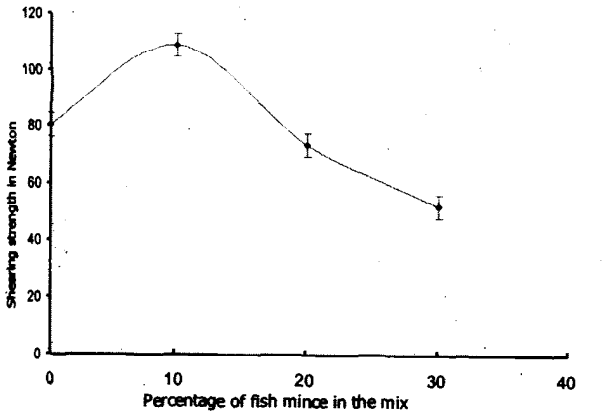

Fig. 2. Effect of incorporation of pink perch mince on the shearing strength of extruded products

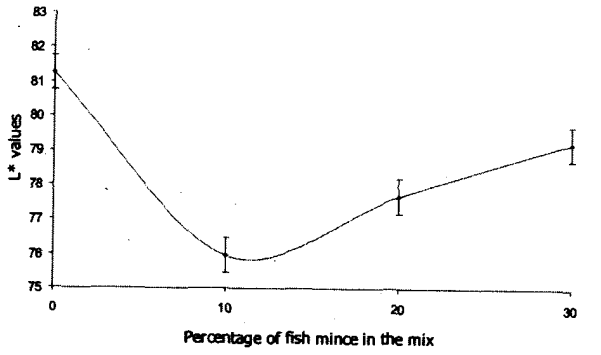

Fig. 3. Effect of incorporation of pink perch mince on the L* (lightness) of the extruded products

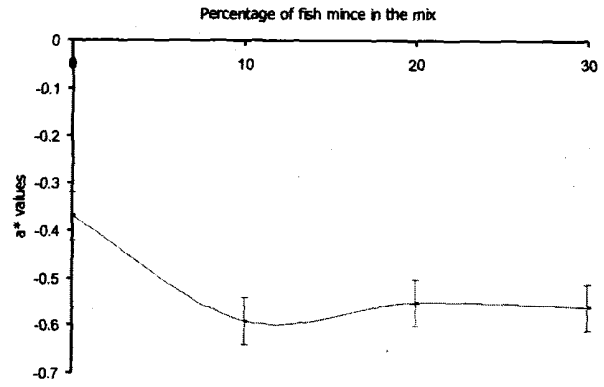

Fig. 4. Effect of incorporation of pink perch mince on the a* values of the extruded product

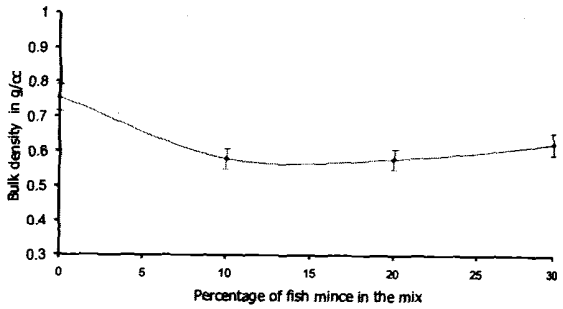

Fig. 6. Effect of incorporation of pink perch mince on the bulk density of the extruded product

made by Carrie (2003). Also the yellowness (b*values) of the product was found to increase linearly as the level of the fish mince increased. However at intermediate moisture and low extrusion temperature, there is a probability for forming dextrin. As this imparts yellowness to the product, it may cause lightening the product to some extent. However a* (redness) values remained more or less same without any significant deviation (Fig. 4).

Bulk density as a function of percentage of fish meat is shown in the fig. 6. The results indicated that bulk density decreased at 10% fish meat level in the raw mix. This may be due to the decrease in the expansion when the fish meat was incorporated in the raw mix. However there was no significant change in the value as the percentage of the pink perch meat was increased further. Bulk density is less affected by the addition of fish solids up to 30% (Gogoi *et al.*, 1996).

Fig. 7 showed a decrease in water absorption index values with increasing fish meat content. The increase in protein content decreased the rehydration. This may be attributed mainly to the reduced porosity and protein denaturation, which in turn reduced the ability to bind and hold water. This is in accordance with the study conducted by Clayton & Miscorides (1992).

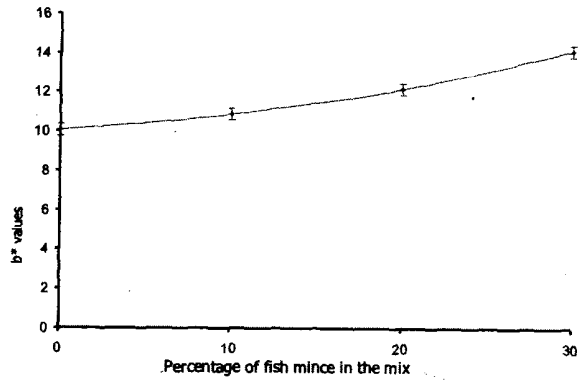

Fig. 5. Effect of incorporation of pink perch mince on the b* values of the extruded products

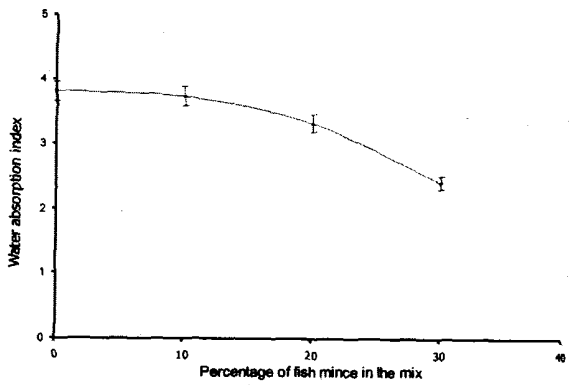

Fig. 7. Effect of incorporation of pink perch mince on the Water Absorption Index of extruded product

Extrusion Technology is nowadays a promising technology for the production of breakfast foods. This study clearly shows that the characteristic properties of extruded product like shearing strength, colour, bulk density, linear expansion etc., were affected by the amount of pink perch meat in the extruded mix. High expansion was seen in the case of extrudate having 10% pink perch meat. With this composition, most of the other properties are also desirable. However with more amounts of fish meat in the premix, the product was less acceptable. This finding provides a general guidance for the development of extruded product with the incorporation of pink perch meat at 10% level keeping moisture at 40% before extrusion. Further studies are necessary for developing different ready to cook and ready to use extruded foods.

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