Development of a Low Cost Fish Ball Incorporating Yellow Fin Tuna off Cuts and Deskinned Sword Fish

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Introduction

The contribution that fisheries resources make to human nutritional needs is significant and may represent the only readily available protein source for people in developing countries. Even small quantity of fish can play a vital role in improving the predominantly cereal based diets of the developing countries. Fish products are comparable to meat and dairy products in nutritional quality. Fish has traditionally been a popular part of the diet in some countries. Today even more people turn to fish as healthy alternative to red meat (Bender, 2005). A recent study has shown that average recovery percentage of expensive cuts of yellow fin tuna (*Thunnus albacares*) from a medium scale processing factory is approximately 50%. However every recovery percentage can be contrasted depending on the quality of the raw material and nature of the product. The remaining inexpensive off cuts has low market value. Off cuts consists with whole dark muscles, trimmings of the white muscle, tail cuts, and ventral side of the tuna. Tuna trimmings can be purchased at Rs. 200 per kg. The profit margin of food processing companies can be increased while converting these off cuts into value added products. Fish balls can be produced using any fish but the tuna varieties are preferred because meat color and flavor stands up well in finished products. Yellow fin tuna (*Thunnus albacares*), and Sword fish (*Xiphias gladius*) are the main species employed. More than two species of fish are usually blended because tuna flesh alone does not give sufficient resilience to the product (Amona, 1965).

Materials and methods

Experimental work was conducted at the Keells Food Products PLC, Ja-Ela. And the laboratory analysis was carried out at the Uva Wellassa University. Initially, a survey was carried out at the main fish market in Ja-Ela area to identify varieties of fish, usable off cuts, whole sale prices and consumer prices. Subsequent to the preliminary survey selected off-cuts and deskinned sword fish were analyzed for its nutritional quality, dry matter, ash content, crude protein content and crude fat content were analyzed via AOAC methods (AOAC, 2000). Yellow fin tuna (*Thunnus albacares*) trimmings (histamine content below 25 ppm) and deskinned Sword fish (*Xiphias gladius*) cuts were obtained from the frozen storage of the Keells Food Products PLC. Frozen fish packages were thawed for 30 minutes to bring the fish meat accessible for cutting. Fish bulk was cut in to 3 cm pieces using a vertical band saw. Then the pieces of fish were minced using a mincer and chopped with a bowl chopper for 2-3 rounds. Chopped fish, pre emulsion, flour, cereal binder, spices and Monosodium Glutamate were then mixed for 4 minutes. Fried onions, green chilies, curry leaves and fresh garlic mixture was

added to the mixture along with bread crumbs and rusks. The mixture was mixed further for 2 minutes followed by addition of water and fat. Mixture of fish mass was formed into balls using meat ball forming machine. Fish balls were then cooked in a cooking chamber for 40 minutes until the core temperature come to 72 °C (Yu, 1994). Then the fish balls were chilled in order to separate them and vacuum packed in Linear Low Density Polyethylene bags and kept in frozen conditions at -18 °C. The proportions of the ingredients of the fish balls were determined through the preliminary trials by a taste panel comprising seven panelists. Proportions of ingredients were then assessed according to the sensory and textural characteristics. Five combinations of tuna trimmings and sword fish were prepared as given in Table 1 and were tested for color, odour, flavour, spiciness, juiciness, texture and likelihood of breakage during frying and cutting.

Based on the preliminary findings, in the final trial, fish balls were formulated with 56% of fish by increasing the amount of tuna trimmings while maintaining the other ingredients constant.

Table 1: Percentages of Tuna Trimmings to Sword Fish

Treatment Number	Tuna Trimmings:Sword Fish
T1	10% : 90%
T2	30% : 70%
T3	50% : 50%
T4	70% : 30%
T5	90% : 10%

A panel of 20 untrained members of Keells Food Products PLC has participated in the sensory evaluation. A 7 point hedonic scale method with a value of 1 corresponded to lowest and a value of 7 to the highest intensity were used to evaluate appearance, colour, odour, spiciness, juiciness, texture, fish taste, after taste and overall acceptability. The samples were coded with three digit random numbers and the order of presentation was made using random permutation. The sensory evaluation was carried out at the Research and Development laboratory of Keells Food Products PLC. All necessary precautions were taken to ensure that each panelist made an independent judgment. Physical analysis was done through folding test and biting test (Lanier, 1992) and cooking loss following Murphy *et al.* (1975). Objective quality parameters of pH, Water holding capacity (Anjaneyulu, 1989), TBA value (Tarladgis, 1960) and Microbial analysis of *Staphylococcus aureus*, *Escherichia coli* and TPC were recorded thrice a week for twelve consecutive weeks. Moisture, crude protein, crude fat, crude fiber and ash content were determined in accordance with Standard AOAC methods (AOAC, 2000). The cost of each item used for the preparation of fish balls was recorded. Statistical Analysis; all measurements were carried out for the experimental design of Complete Randomized Block Design using three replications. The results were reported as the mean standard deviation and subjected to analysis of variance (ANOVA) using SAS V.9.1 statistical software. Differences between the means of fish ball qualities containing different treatments were determined using Duncan's multiple range test (DMRT). All statements of significance are based on the probability level of 0.05 ($p<0.05$).

Results and discussion

The highest estimated median value as well as highest ranks were obtained for the treatment which was having 50% of tuna trimmings and 50% of deskinned sword fish cuts for; Appearance, Colour, Odour, Texture, Fish Taste, After Taste and Overall Acceptability. However, it's highest score for juiciness was comparatively low for the seven point hedonic scale. Since the juiciness of above combination is comparatively low, 0.5% of phosphates were added to enhance the juiciness of the selected treatment. There was no significant difference between the treatments for water holding capacity, pH, TBA value.

Water Holding Capacity is basically related with the myofibrilla protein of the fish. WHC is reduced in the first six weeks and again increased possibly due to increase of pH which causes more opening to entrap water within myofibrilla proteins. This is a good sign indicates that there is no freeze denaturation with time There was no signicant difference between the first six weeks for WHC in all five treatments but there was a significant difference between first six weeks and ninth week possibly related with increased pH value.

There were no significant differences between the initial values of the storage period for pH in the all five treatments. However, a reduction of pH was observed after initial week possibly due to the presence of lactic acid which is resulted from anaerobic metabolism of carbohydrates in the product by the psychrophylic bacteria. It is illustrated that, when the pH increased, the TBA values in all five treatments decreased at the ninth week and the TBA values increased while pH decreased at the twelfth week. It has been reported that haemoglobin (Hb) can show strong pro-oxidant activity for some fish species between pH 6 and pH 7 and it can retard oxidation at pH values above 7 (Richards and Hultin, 2002; Tokur *et al.*, 2004). This may explain why the TBA value decreased when pH increased and vice versa.

Reduction in lipid content could be attributed to oxidation of poly-unsaturated fatty acids (PUFA) contained in the fish tissue to produce peroxides, aldehydes ketones and the free fatty acids. However, the rate of fat deterioration was very gradual (Figure 4.5). Fish oil has been found to be more liable to spoilage than other oils due to their greater number of unsaturated fatty acids. The greater the degree of unsaturation, the greater would be the tendency for fat oxidation (rancidity) (Akkus *et.al*, 2004). There might be risks of rancidity during prolonged storage conditions due to the inherent fatty nature of both tuna and sword fish. The TBA value is widely used as an indicator of the degree of lipid oxidation. The all treatments of developed fish balls were vacuum sealed and kept under frozen condition. Therefore oxidation cannot proceed. But the TBA value in all five treatments increased after sixth week which indicates rancidity of fish balls.

The proximate composition of the selected sample which was having 50% of tuna trimmings and 50% of deskinned sword fish was; 61.46% of moisture, 12.98% of crude fat, 15.02% of crude protein, 3.28% of ash and 7.20% of carbohydrates. Cooking yield was 93.22 %.

With comparison to the market available fish balls, newly developed fish balls showed higher scores for spiciness, odour and fish taste for its sensory attributes. Scores of folding test was fair and also it gave a fair bite for biting test.

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