Impact of Different Processing Methods on Proximate Chemical Compositions and Nutritional Contents of Skipjack Tuna (*Katsuwonus pelamis* Linnaeus, 1758)-Balaya Fish

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Abstract- *Millions of people eat fish around the globe, which is high in omega -3 fatty acids and a rich source of protein. Fish is typically processed with a variety of processing techniques. Processing can have an impact on the nutritional value of fish. The effects of processing on proximate composition and sensory quality parameters were investigated. According to the results obtained, the mean moisture, fat, and ash contents of raw fish were found to be 71.36±0.30 %, 0.96±0.02 %, and 1.95±0.05 % respectively. The moisture, ash, and fat contents were found to differ significantly ($p<0.05$) depending on the processing. The highest and the lowest moisture contents were found to be recorded in raw (71.36±0.30 %) and fried samples (41.01±1.77 %). The highest (4.79±0.24 %) and the lowest (1.77±0.06 %) ash contents were found to be recorded in fried and grilled samples. The highest (8.78±0.96 %) and the lowest (0.96±0.02 %) fat contents were found to be recorded in fried and raw samples. Evaluation of sensory quality parameters was performed with nine hedonic scales on both samples. It showed that frying and boiling achieved the highest ratings, while steaming was the least. For nutritional value, boiling was found to be the best. Frying obtained the highest while steaming obtained the least score. Out of the total population, a greater portion consumes tuna fish without the knowledge of the impact of processing on nutritional composition. The findings of this present study will help to explore the best processing method with minimal nutrient loss and to secure maximum palatability.*

Keywords: Katsuwonus pelamis, cooking methods, nutritional value, sensory qualities

I. INTRODUCTION

Fish are one of the most important vertebrate groups, and are a major source of food for humans (Mahaliyana *et al.*, 2015), which is a good source chemical components (Abraha *et al.*, 2018), where moisture, protein, and fat are the primary components of fish, with trace amounts of vitamins and minerals (Aberoumand, 2014). Many people like fish since it is the cheapest source of animal protein and other key elements for human health (Mahaliyana *et al.*, 2015). In 2018, the world fisheries and aquaculture production were 178.5 million tons (FAO, 2020). Meanwhile the total fish production of Sri Lanka in 2019 was 505,830 MT. Furthermore, marine fish production totaled 415,49 MT, while freshwater fish production totaled 90,340 MT. Out of 439,370 MT of marine fish harvested, the production of *Katsuwonus pelamis* only in 2018 was 47,230 MT (Fisheries Statistics, 2020). In 2016, the average per capita consumption of fish in Sri Lanka was 11.8 Kg (Fisheries Statistics, 2020).

Katsuwonus pelamis is a member of the Scombridae family and belongs to the genus *Thunnus* as per the authors Karunarathna and Attygalle, (2009), and it is a popular food and a good source of protein. It is low in fat, with omega-3 fatty acids making up the majority of its fatty acid composition, which have higher health benefits (Mahaliyana *et al*., 2015). Furthermore, it contains a high concentration of Fe, Cu, and Zn, all of which are essential minerals in the human body (Mahaliyana *et al*., 2015). Fresh *Katsuwonus pelamis* had a chemical composition of 71.76 % moisture, 25.29 % protein, 0.60 % fat, 1.49 % ash, and 0.87 % carbohydrates (Nurjanah *et al.*, 2015). Fish is normally not consumed raw; instead, it is prepared using a variety of cooking methods (Aberoumand, 2014). These methods include frying, grilling, baking, steaming and boiling. These cooking methods have a wide range of uses, techniques, and effects on the nutritional and proximate composition of processed fish (Abraha *et al.*, 2018). Proper cooking methods are essential for retaining maximum nutritional value, including proximate composition, vitamins, minerals, and fatty acid composition (Golgolipour *et al*., 2019).

II. LITERATURE REVIEW

A fish is an aquatic vertebrate with a scaled body that moves with fins and tails and breathes through its gills. (Gonzales, 2016). Fish lipids are high in Poly Unsaturated Fatty Acids (PUFAs), which are divided into two groups: omega-3-fatty acids and omega-6-fatty acids (Abraha *et al*., 2018). Both are categorized as essential fatty acids since humans cannot synthesis them and must get them through food or supplements (Chandravanshi *et al*., 2019). Skipjack tuna also have little fat and the majority of its fatty acid composition is made up of omega-3 fatty acids, as well as it contains a high protein content and high concentration of Iron, Copper, and Zinc (24.05, 5.04, and 6.89 mg kg^{-1}), which have more health benefits for human (Mahaliyana *et al*., 2015). ASkipjack tuna's body is fusiform, elongate, and rounded. Gill rakers are abundant, with 53 to 63 on the first-gill arch. Teeth are small and conical, with a single series; gill rakers are small and conical, with a single series. It's a dark purplish-blue with silvery lower sides and belly, as well as four to six prominent longitudinal dark bands (Florida Museum of Natural History, 2017).

Fish processing improves flavor and taste while inactivating pathogenic microorganisms. Furthermore, because of their sensitivity to heat, oxygen, light, pH, or a combination of these, it causes macro and micronutrient distortion (Karimian-Khosroshahi *et al.*, 2016). By generating fragrance compounds, appealing color, crust, and texture, increases the sensory quality of food. In addition, food processing improves hygienic quality by inactivating harmful bacteria and increasing nutrient digestion and bioavailability in the digestive tract (Bognár, 1998). Cooking with steam heat generated by boiling water is the basis of steaming (Sobral *et al*., 2018). According to the same author, boiling is a simple meat and fish cooking method that involves heating the meat or fish in 100 °C water. The heat used during baking can be dry heat, which helps to sterilize the food by killing harmful bacteria, control unwanted enzymatic reactions, and improve nutrient availability (Munir, 2009). Grilling, as opposed to broiling, is a form of cooking that uses radiant heat from below rather than above (El-lahamy *et al.*, 2019).

III. PROBLEM STATEMENT

Fish is one of the invaluable and healthiest food on the planet due to its excellent nutritional value. Fish is rarely consumed as raw and different cooking processes are used to prepare it for eating. Skipjack tuna can be cooked in many ways for consumption such as frying, grilling, baking, steaming and boiling. These cooking methods can impact the nutritional and proximate compositions and sensory qualities of Skipjack tuna fish.

IV. MATERIALS AND METHODS

Four fresh, individual *Katsuwonus pelamis* fish were collected from the fish landing site, Oluvil. They were kept in polystyrene box with ice cubes and taken to laboratory immediately. Upon the arrival at the laboratory, the biometric data of each fish (length, weight, perimeter, etc.) were recorded and the morphological characters of each fish were studied then finally the species was confirmed. Then, the fish were thoroughly washed with water, descaled, de-headed, gutted, and filleted. The fillets were then wrapped with aluminum foil sheet and immediately transferred to frozen storage at -21 ºC until further use. The samples were then removed from the frozen storage and thawed for about 20 minutes at 10 ºC before processing. The thawed fishes were cut into ideal size range from 2.5 cm to 4.5 cm in length, 60-80g weight, 2-4 cm height and immersed in pure coconut oil in a frying pan and deep-fried for 5 minutes at 180 ºC. During the frying process, the fillets were turned upside down occasionally to ensure the evenness of frying of fillets. The steaming of fish fillets was performed by way of placing the fillets in a steamer above steel pot containing 500 ml of boiling water at (100 ºC) and cooked for 15 minutes with the lid on. Baking of fish fillets was performed in a preheating electric oven for 20 minutes with the temperature set at 200 °C. The boiling of fish fillets was performed by way of placing in a stainless-steel cooking pot containing 500 ml of boiling water at (100 ºC) and cooked with the lid off for 15 minutes. The grilling of fish samples was performed by way of being wrapped in a foil sheet and grilled by wood charcoal grilling for 20 minutes.

A. Determination of Proximate Chemical Compositions

Determination of the proximate chemical composition of cooked and raw fish fillets were performed in triplicate for moisture, ash and fat contents. Moisture content was determined by oven drying using oven (Memmert UF110, Germany) at 105 °C to constant weight as described by (AOAC, 2000). The fat content was extracted by using the Soxhlet system (FAT-06A) as described by (AOAC, 2000). Ash content was

determined with muffle furnace (MF 1400-30) by maintaining the temperature at 550 °C to constant weight as described by (AOAC, 2000).

B. Determination of Sensory qualities

25 Panelists indicated their degree of liking for each sample by choosing the appropriate category. The sensory evaluation was carried out based on texture, color, flavor, mouth-feel, and overall acceptability of fried, steamed, boiled, baked and grilled samples.

C. Statistical analysis

The results obtained by proximate analysis and sensory evaluation were submitted to analysis of variance (ANOVA) and means were compared by the test of Tukey's HSD at p= 0.05 using SPSS.25 windows, 2017.

V. RESULTS AND DISCUSSION

A. Determination of proximate chemical composition

The mean weight and length of Skipjack tuna fillets were 2.31±0.03 kg and 54.25±0.47 cm respectively and thickness of the fillets ranged from 2.5 to 4.5 cm on average. The Skipjack tuna fillets were processed as fried, baked, grilled, boiled, and steamed as shown in Figure _1 and compared with raw fillets. The average proximate values were determined by analyzing three samples each.

1) Moisture Content:

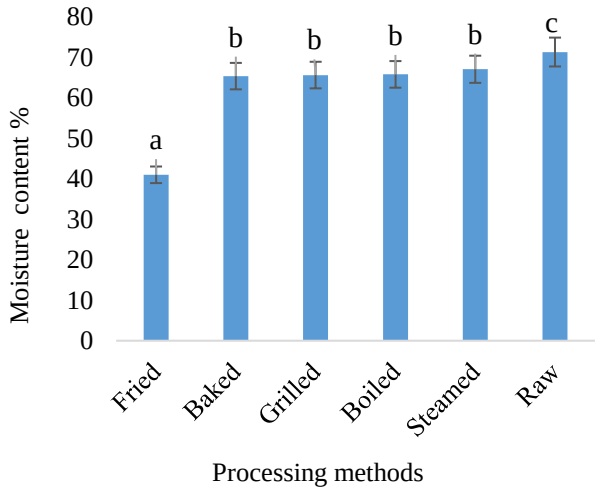

Figure 1: The moisture content of the raw and cooked samples. The bar with different superscripts varies significantly (p<0.05)

When fish filets were subjected to various processing methods, the moisture contents of the samples varied significantly (Oluwaniyi *et al.*, 2010). There was significant difference in moisture content between raw and fried samples, as shown in Figure 1. The moisture content of the raw fish fillets was found to be the highest (71.36 %), while the moisture content of the fried samples was found to be the lowest 41.01 % (Figure 1). Since the water in the fish forms an aqueous/oil mixture during frying and is expelled before the frying is completed since the boiling point of the oil is much higher than that of water, the moisture content of the fried fish samples is the lowest (Oluwaniyi and Dosumu, 2009). According to the results of the present study, there was no significant difference (p>0.05) observed in moisture content among the baked, grilled, boiled and steamed fish sample as shown in Figure 1. According to Aberoumand and Ziaei-Nejad, (2015) due to decreased moisture loss, baked and boiled fish fillets exhibited higher nutritional values than fried fish fillets. The high humidity maintained during boiling and steaming may cause minor water loss during cooking (Sobral *et al.*, 2018).

2) Ash Content:

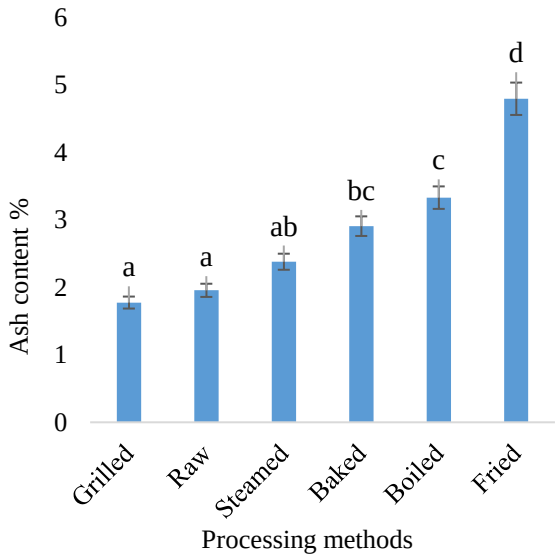

Figure 2: The Ash content of the raw and processed fillets samples. The bar with different superscripts varies significantly (p<0.05)

The ash content of raw and processed fillets is shown in Figure 2. The mineral content of a food sample is defined as ash content of food (Ismail, 2017). In this study, the ash content of processed *Katsuwonus pelamis* fillets ranged from 1.77 % (grilled) to 4.79 % (fried) as shown in Figure 2 above but the authors Nurjanah *et al.*, (2015) report that the ash content was found to be 1.49 % in their study. The highest ash content as per the

present study was found to be in fish samples processed by frying (4.79 %) whereas the lowest (1.77 %) was found to be in fish samples processed by grilling, and significant differences (p<0.05) were observed between the cooking methods in this present study. The ash content of fried sample (4.79 %) was found to be increased significantly (p<0.05) owing to water loss during the frying process (Kocatepe *et al.*, 2011). The ash content of fresh *K. pelamis* fillets was found to be (1.95 %) in wet weight basis, which could increase after cooking, while others have suggested that it could decrease due to lixiviation losses of these components, which are lost with water and diffused when the muscle comes into contact with steam (Bastías *et al.*, 2017). Increased ash content was noticed in steamed, baked, boiled and fried samples when compared to raw fish fillets. No significant differences were observed between the raw sample and processed samples by grilling, steaming and baking. But significant difference was observed in boiled and fried sample as shown in Figure 2. Similar to the present study, the authors Hoffman *et al*. (1994) reported that the ash content was the highest in deep-fried samples (1.42 %) in African sharp tooth catfish (*Clarias gariepinus*) which is in agreement with the present study.

3) Fat Content

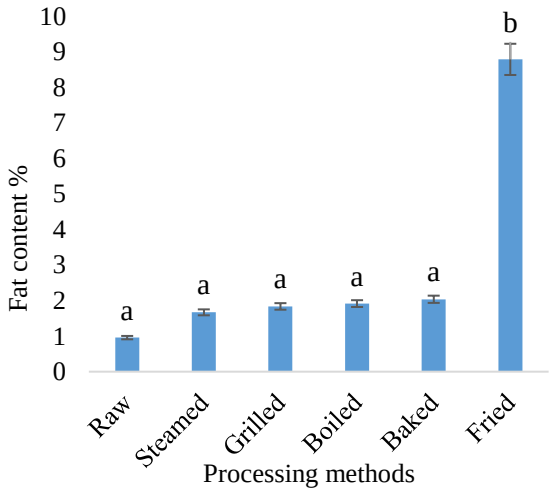

Figure 3: The fat content of the raw and processed fillets. The bar with different superscripts varies significantly (p<0.05)

According to the present study as given in Figure 3, significantly higher fat content (8.78 %) was found to be observed in fried sample whereas the lowest fat content (0.96 %) was observed in raw sample. Similar results were reported for Black sea anchovy (*Engraulis encrasicolus*, Linnaeus 1758) which was cooked by frying (Kocatepe *et al.*, 2011). Further no significant differences in fat at content found between raw, steamed, grilled, boiled and baked samples as shown in Figure 3, but there was a highly significant difference was found in the fried sample when compared with raw and other processed samples as shown in Figure 3. Mature fish has more fat content because it requires substantial energy savings from fat to breed (Nurjanah *et al.*, 2015). Oil absorption during the cooking process is linked to the rise in fat content of fried fish fillets. Furthermore, the increase in fat content can be due to oil penetration on the food after evaporation has lost some of the water (Aberoumand and Ziaei-Nejad, 2015). Apart from that, the fat content of raw fish can affect fat exchanges and interactions between culinary fat and fish fat during processing (Oluwaniyi and Dosumu, 2009). Furthermore, according to the author Bognár, (1998), the act of frying is linked to fat absorption (2 – 14 g per 100 g of raw food)

B. Determination of Sensory qualities

Table 1 shows the results of the sensory evaluation of the processed Skipjack tuna. Since fish is rarely eaten fresh, various processing methods are used to prepare it for consumption. Some of these processes, which may have varying effects on color, texture, and flavor and other sensory parameters (Aberoumand and Ziaei-Nejad, 2015). Texture is essential in the acceptance of many foods, like meat tenderness and bread softness. (Sharif *et al.*, 2017). Due to denaturation and aggregation during cooking, both filament lattice and collagen of proteins shrink, resulting in a loss of water-holding ability and, as a result, a shift in texture of the fish to become hard or firm (Abraha *et al.*, 2018). Color is one of the first features that the human senses pick up on, and it plays an important role in food recognition and final selection (Sharif *et al.*, 2017). Aromatic compounds that are conceived by a mixture of taste and odor and perceived by the mouth and nose are known as flavoring substances (Sharif *et al.*, 2017). The tactile sensations sensed at the lining of the mouth, including the tongue, gums, and teeth, are referred to as mouthfeel (Caracciolo *et al.*, 2020).

Based on this study, the highest scores of the texture, color, flavor and mouthfeel were obtained

Table 1: Evaluation of Sensory qualities of processed *Katsuwonus pelamis* fillets

Processing methods	Texture	Color	Flavor	Mouth-feel	Overall acceptability
Frying	7.40±0.27[b]	7.20±0.36[b]	6.88±0.33	6.92±0.30	7.44±0.23[b]
Steaming	6.44±0.20[a]	5.96±0.35[a]	5.64±0.31	6.52±0.25	6.04±0.30[a]
Boiling	6.36±0.19[a]	6.00±0.27[a]	6.52±0.30	6.92±0.30	6.60±0.24[ab]
Baking	6.40±0.27[a]	6.72±0.26[ab]	6.00±0.31	5.76±0.42	6.64±0.25[a]
Grilling	6.04±0.25[a]	6.16±0.21[ab]	6.08±0.38	5.96±0.26	6.35±0.12[a]

The values are means of the triplicates ± standard error mean (SEM); within a column, means followed by the same letter are not significantly different by the Tukey's HSD at p=0.05

by the frying method. In contrast, the sensory features of color and flavor obtained least scores by steaming method whereas texture obtained by grilling and mouth feel obtained by baking. Eventually, frying and baking methods obtained the highest rate of overall acceptability. However, there were significant differences observed between texture, color and mouth-feel except for the flavor of processed fish by different processing methods.

VI. CONCLUSION

The present study consisted of an evaluation of the impact of different processing methods on proximate chemical compositions and nutritional contents of *Katsuwonus pelamis* fish. It is concluded that all the processing methods analyzed have an impact on the nutritional value of *Katsuwonus pelamis.* Based on the results of nutritional value, the boiling processing method of fish sample was found to be the best among all processing methods. Finally, based on the sensory quality parameters, frying processing of *Katsuwonus pelamis* fish fillets was the best among all processing methods because it turned light brown and had denser texture and had delicious smell.

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