

EFFECTS OF PROCESSING METHODS ON NUTRITIONAL COMPOSITION OF FISH *PAMPUS ARGENTEUS* (WHITE POMFRET) IN IRAN

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ABSTRACT

The effects of different processing methods (Frying cooking, brining and boiling) on the proximate composition of fish species (*Pampus argenteus*) were investigated. The objective of this work is to know the best processing methods, the effect of processing on nutritional values of fish products. The result of the proximate composition of the fish species showed that the highest protein content (38.17%) was in *P. argenteus* processed with the frying process. The result of moisture content indicated that boiled samples were consistently the least (25.20%) while for fried sample had the highest moisture percentage. The lipid was reduced to the least value of 9.94% in the brined fish. In cooking, the important factors for consideration are moisture, lipids, and protein, though low moisture would ensure a fish product with extended shelf life. To have a longer shelf life, high protein is desirable, a low lipid is equally desirable as to reduce oxidation and rancidity in the samples which causes off-flavor and bad taste in fish products. In conclusion, all the processing methods are good and could extend the shelf life of the products with an exception of boiling method; they could keep the fish fillet free from spoilage and microorganisms attack for some period. This study showed that the proximate values obtained could be of help in choosing fish based on nutritional values.

Keywords: frying; brining; boiling; processing; *Pampus argenteus*

INTRODUCTION

Fish and seafood are a source of good quality protein which is essential for health (Kim and Lall, 2000). Fish is usually cooked in different ways such as boiling, smoking, baking, frying, and grilling. These cooking methods result in enhancing flavor, taste, and improve the digestibility and inactivate the pathogenic microorganisms and enzymes (Kocatepe et al., 2011).

During cooking of fish, some chemical and physical reactions take place such as protein denaturation that increases its digestibility and improves the nutritional value. However, the contents of fat-soluble vitamins or polyunsaturated fatty acids are often reduced (Alizade et al., 2009).

Deep Fat Frying (DFF) is a major cooking method and is considered to be one of the oldest methods of food preparation. It is a cooking method of immersing foods in hot oil at a temperature above the boiling point of water. The oil temperature usually varies from 130 to 200 °C. During frying, there are many chemical reactions such as browning, gelatinization, and denaturation due to the elevated temperature of the product (Tangduangdee, Bhumiratana, and Tia, 2003).

Pampus argenteus (White pomfret) is one of the most preferred indigenous aquaculture species in Iran due to

better growth. Nutritional information is only available for fresh fish (Figure 1). The study was carried out to determine nutritional composition (protein, fat, ash, moisture, and energetic values) of brined, boiled, and fried *Pampus argenteus*.

These cooking methods result in enhancing organoleptic properties and improve the digestibility and inactivate the pathogenic microorganisms (Kocatepe et al., 2011). Method cooking of fish, lead to some chemical and physical reactions take place such as protein denaturation that increases its digestibility and improves the nutritional value. Meanwhile, the contents of fat-soluble vitamins or polyunsaturated fatty acids are often reduced (Alizade et al., 2009). Deep fat frying is a major cooking method and is mentioned as one of the old methods of food preparation. It is a cooking method of immersing foods in plant hot oil at a temperature above the boiling point of water. The oil temperature usually is around 180°C. During frying, there are many chemical reactions that take place such as browning, gelatinization, and denaturation due to the elevated temperature of the product (Tangduangdee, et al. 2003).

Salting is the oldest, applied, and commonly used processing technique for fish preservation all over the world because of the simplicity of the process and low production cost (Martínez-Alvarez and Gómez-Guillén, 2013). Salt is effective as a preservative compound because it reduces the



Figure 1 Fish *Pampus argenteus* (White pomfret).

water activity of fish fillets, consequently, microorganism growth and enzymatic spoilage are inhibited. Also, the aim of salted fish is to improve sensory properties more than preservation (Mujaffar and Sankat, 2005).

Scientific hypothesis

The different processing methods will affect the composition and energetic values of the *Pampus argenteus* fish fillets.

MATERIAL AND METHODOLOGY

Raw materials

This study was carried out in the Department of Fisheries, Behbahan Khatam Alanbia University of Technology in November 2019. *Pampus argenteus* (White pomfret) fresh fish, similar sizes (54 – 66 cm) and weights (3.456 – 3.234 kg), were purchased from the fish market of the city of Behbahan, Iran, they were immediately stored in containers with ice and transported to the fish analysis laboratory of the Behbahan Khatam Alanbia University of Technology for processing and analysis.

Sample preparation and cooking methods

White pomfret fish were caught from the southern waters of Iran during September 2019. A homogeneous lot of fish was kept in a cold iced box and transported to the laboratory within 20 min. Samples were then filleted and then fish fillets were divided into 3 groups. The first group was uncooked (raw samples); the other 2 groups were cooked by different heat treatments (boiling and frying) and the third group was brine salted treated.

Boiling

The fillets were uniformly placed forming a thin layer on a stainless steel steamer above a stainless steel pot of boiling water and cooked with the lid on for 20 min.

Frying

The fillets were uniformly placed forming a thin layer in a wire mesh basket and immersed in Sunflower oil in a deep fryer for 10 min at 180 °C.

Brine salting

In the brine salting method, the cleaned fish were placed inside plastic jars of 5 liters, and brine was added until the fish was completely covered and brined in 30% salt solution, fish fillet to salt solution ratio is 1:1. were placed for 15 min in a special container (Binici and Kaya, 2018). The producer and purity of chemicals used for experiments were according to a standard method by Binici and Kaya (2018).

Analytical procedures

The heat treatment methods were performed in triplicate. After all heat treatments, the samples were cooled to 25 °C temperature. Each sample of raw or cooked fish fillets was crushed using a kitchen blender (made in Iran) and the fish powder was used to determine proximate chemical composition.

Proximate chemical composition

The moisture content of cooked and uncooked fish fillets was dehydrated by an oven at 115 °C until a constant weight was obtained (AOAC, 2005). Crude protein content was calculated by converting the nitrogen content determined by Kjeldahl's method ($6.25 \times N$). Fat content was determined according to the Soxhlet method (AOAC, 2005) by using chloroform as an extraction solvent. Ash content was determined by incineration in a muffle furnace (Made in Iran) at 600 °C for 2.5 h (AOAC, 2005). The total caloric value was calculated from the corresponding caloric coefficients for proteins, lipids, and carbohydrates, respectively 4, 9, and 4 kcal.g⁻¹ (USDA, 2015).

Statistical analysis

Statistical analysis was performed using SPSS for Windows version 16.0. Software for Difference in the means between the groups was analyzed using the T-test. Duncan's multiple range tests were applied to do multiple means comparison. Statistical significance was set at $p < 0.05$.

Table 1 Proximate composition (g.100g⁻¹) and caloric value of fresh, brined, fried and boiled fish *Pampus argenteus*, on a dry basis.

	Moisture	Protein	Lipids	Ash	Calories (Kcal.100g ⁻¹)
Fresh	24.60 ±0.28 ^a	13.60 ±0.38 ^a	55.80 ±0.23 ^a	6.00 ±0.07 ^a	556.60 ±1.9 ^a
Boiled	25.20 ±0.4 ^b	29.40 ±0.97 ^b	38.40 ±0.55 ^b	7.00 ±0.12 ^b	463.2 ±1.61 ^b
Brined	38.80	33.56	9.94	17.70	223.6
Fried	40.40	38.17	12.23	9.20	262.75

Note: Mean of samples analyzed in duplicate. The same letters in the column do not differ from each other at the 5% level of significance.

RESULTS AND DISCUSSION

Results for proximate composition analysis (protein, fat, moisture, and ash) for fresh, boiled, fried, and brined fish *Pampus argenteus* are presented in Table 1.

Determined protein content for *P. argenteus* was 13.60%, 29.40%, 38.17%, and 33.56% for fresh, boiled, fried, and brined fish respectively (Table 1). Protein content was significantly increased ($p < 0.05$) is processed (boiled, fried, and brined) fish. Lowest protein levels were nevertheless observed in boiled fish. The highest and lowest levels of fat were recorded in brined (9.94%) fish and were significantly different from unprocessed (fresh) fish. Brined and fried fish had significantly high levels of ash (17.70% and 9.20%) ($p < 0.05$). There were significant differences ($p < 0.05$) in moisture content for *P. argenteus* where the lowest levels were recorded in boiled fish (25.20%).

Chemical composition of fish varies widely depending on the fish species, age, nutrition, size and sex, growth place, catching season, and the environmental conditions (Manthey, Karnop and Rehbein, 1988). The increase in the fat content of the fried fish fillets is related to oil absorption during the cooking process. Also, reported that the increase in dry matter content was observed in the fried and grilled fish fillets. The decreased moisture content was noticed in all the cooking methods except for the boiled fillets. Increased ash content was noticed in all the cooked fillets when compared to raw fish fillets. That deep-fried fish had the highest protein value comparing other cooking methods. Water loss, occurring during cooking resulted in increasing protein content in the fried fish samples (Gökçe et al., 2004; Gokoglu, Yerlikaya, and Cengiz 2004). The higher lipid content of fried fish than other methods is mainly due to the absorption of oil by the fish and losing moisture during frying process (the apparent higher ash content of a fried sample is due to more loss of moisture took place during deep-frying cooking comparing with another method (Küçükgülmez et al., 2006)). A higher level of protein in this study agrees with earlier reports (Saguy and Dana, 2003).

Cooking methods that require heat can affect the nutritional composition of fish depending on the intrinsic composition, temperature, and time the product is exposed and the method used. The water loss may be attributed to the evaporation, dehydration of the fillet fibrils, and probably to some heat-induced protein denaturation during boiling, which causes less water to be entrapped within the protein structures (Chukwu and Shaba, 2009; Costa et al., 2013).

Quality properties of processed fish at the time of consumption and eating greatly depends on different factors such as; the freshness and fish quality, the cooking methods,

and the storage or preservation conditions followed before cooking. Fish spoilage is usually more rapidly than other animal muscle foods and this spoilage is primarily bacterial. Therefore, good preservation techniques must prevent the bacterial spoilage of fish without affecting its quality and nutritional value (El-Lahamy et al., 2018).

Marimuthu et al. (2012) showed that the increase in dry matter content was observed in fried fish fillets. The highest moisture content (77.2%) was recorded in raw fillets. Increased ash content was noticed in all the cooked fillets when compared to raw fish fillets. Moisture loss was also found in baked fillets of snakehead fish. However, the dehydration rate comparatively was lower than during frying. These changes were similar to those reported by Gokoglu, Yerlikaya and Cengiz (2004) in rainbow trout and García-Arias et al. (2003) in sardines. Water losses, occurring during frying resulted in higher protein content in fried fish as compared to the raw fish fillets (García-Arias et al. 2003). Accordingly, the increase in ash, protein, and fat content found in cooked silver catfish fillets is explained by the reduction in moisture. These results were similar to our present study.

Abraha et al. (2018) reported that generally fish processing methods (high and low-temperature treatments) including, chilling, freezing, canning, smoking, drying, salting and frying, and various combinations of these, to give the fish product a form which is attractive, fresh to the consumers and prolong and suitable storage life. These processing methods have different applications, techniques, and significant influences and effects on the chemical, physical, and nutritional composition of processed fish. This is because heating and exposure to a high concentration of salt lead to chemical and physical changes. Ultimately different quality could be obtained via these methods, hence subsequent effects on processed fish's shelf life also vary (Magnussen et al., 2008; Díaz-Tenorio, García-Carreño and Pacheco-Aguilar, 2007).

CONCLUSION

The results obtained from this study showed that the highest protein (38.17%) and moisture (40.40%) contents found for fried fish *Pampus argenteus*, while lowest moisture content (25.20%) found for boiled fish. The least lipid content (9.94%) found for brined fish ($p < 0.05$). Fish provides the most dietary animal valuable protein to people in Iran. Findings also confirm earlier reports that processing alters nutrients content in fish. Although fried fish are mostly liked by many people, results in this study have demonstrated that more nutritional benefits could be obtained when fish are processed through the boiling method.

Lower amounts of lipids in boiled samples were presumably the result of the spread of fat into stock during boiling. As far as fat is concerned, the loss introduced by heat treatment is not as explicit as in the case of water. Boiling, both with and without the addition of salt and, caused a substantial (10% on average) drop in the amount of fat. The loss of fat and nutrients in boiling was less than frying in oil. It has been shown also that boiled fish exhibit better storage properties due to low moisture retention

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