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
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 × 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 $p < 0.05$. 

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

![Figure 1](image_url)
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. 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 Gökogle, Verlikaya 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 freezing in oil. It has been shown also that boiled fish exhibit better storage properties due to low moisture retention

REFERENCES

Abraha, B., Admassu, H., Mahmud, A., Tsige, N., Shui, X. W., Fang, Y. 2018. Effect of processing methods on nutritional and physico-chemical composition of fish fillets. Food Processing & Technology, vol. 6, no. 4, p. 376-382. https://doi.org/10.15406/mojfpt.2018.06.00191

Alizade, E., Chapelle, N., Delamballerie, M., 2009. Effect of freezing and cooking processes on the texture of Atlantic salmon (Salmo salar) fillets. In: Proceedings of the 5th CIGR Section VI International Symposium on Food Processing, Monitoring Technology in Bioprocesses and Food Quality Management. Potsdam, Germany. p. 262-269.

Alizade, E., Chapelle, N., Delamballerie, M., Le-Bail, A. 2009. Effect of freezing and cooking processes on the texture of Atlantic salmon (Salmo salar) fillets. Proceedings of the 5th CIGR Section VI International Symposium on Food Processing, Monitoring Technology in Bioprocesses and Food Quality Management. Potsdam, Germany. p. 262-269.

AOAC. 2005. Official methods of analysis of AOAC International. 18th ed. Arlington, USA : Association of Official Analytical Chemists. ISBN: 978-0935584752.

Binici, A., Kaya, G. K.-2018. Effect of brine and dry salting methods on the physicochemical and microbial quality of clupe (Squalius cephalus Linnaeus, 1758). Food Science Technology, vol. 38, p. 66-70. https://doi.org/10.1590/1678-457x.15717

Costa, S., Afonso, C., Bandarra, N. M., Gueiçfio, S., Castaneira, L., Carvalhio, M. L., Cardoso, C., Nunes, M. L., 2013. The emerging farmed fish species meagre (Argyrosomus regius): How culinary treatment affects nutrients and contaminants concentration and associated benefit-risk balance. Food Chemistry and Toxicology, vol. 60, p. 277-285. https://doi.org/10.1016/j.fct.2013.07.050

Diaz-Tenorio, L. M., Garcia-Carreho, F. L., Pacheco-Aguilar, R. 2007. Comparison of freezing and thawing treatments on muscle properties of white leg shrimp (Litopenaeus vannamei). Journal of Food Biochemistry, vol. 31, no. 5, p. 563-576. https://doi.org/10.1111/j.1745-4514.2007.00130.x

El-Lahamy, A. A., Khalil, K. I., El-Sherif, S. A., Mahmud, A. A. 2018. Impact of cooking methods and frozen storage on quality parameters of mullet fish (Mugil cephalus) steaks. Journal of Food Technology Preservation, vol. 2, no. 3, 7 p. Available at: https://www.alliedacademiac.org/articles/impact-of-cooking-methods-and-frozen-storage-on-quality-parameters-ofmullet-fish-mugil-cephalus-steaks.pdf

García-Arias, M. T., Pontes, E. Á., García-Linares, M. C., García-Fernández, M. C., Sánchez-Muniz, F. J. 2003. Cooking-freezing-reheating (CFR) of sardine (Sardina pilchardus) fillets. Effect of different cooking and reheating procedures on the proximate and fatty acid compositions. Food Chemistry, vol. 83, no. 3, p. 349-356. https://doi.org/10.1016/S0308-8146(03)00095-5

Gökçe, M. A., Taşbozan, O., Çelik, M., Tabakoğlu, Ş. S. 2004. Seasonal variations in proximate and fatty acid compositions of female common sole (Solea solea). Food Chemistry, vol. 88, no. 3, p. 419-423. https://doi.org/10.1016/j.foodchem.2004.01.051

Gokoglu, N., Yerlikaya, P., Cengiz, E. 2004. Effects of cooking methods on the proximate composition and mineral contents of rainbow trout (Oncorhynchus mykiss). Food Chemistry, vol. 84, no. 1, p. 19-22. https://doi.org/10.1016/S0308-8146(03)00161-4

Chukwu, O., Shaba, I. M. 2009. Effects of drying methods on proximate compositions of Catfish (Clarias gariepinus). World Journal of Agricultural Science, vol. 5, no. 1, p. 114-116.

Kim, J. D., Lall, S. P. 2000. Amino acid composition of whole body tissue of Atlantic halibut (Hippoglossus hippoglossus), yellowtail flounder (Pleuronectes ferrugineus) and Japanese flounder (Paralichthys olivaceus). Aquaculture, vol. 187, no. 3-4, p. 367-373. https://doi.org/10.1016/S0044-8486(00)00322-7

Kocatepe, D., Turan, H., Taşkaya, G., 2011. Effects of cooking methods on the proximate composition of black sea Anchovy (Engraulis encrasicolus, Linnaeus 1758). GIDA, vol. 36, p. 71-75.

Kocatepe, D., Turan, H., Taşkaya, G., Kaya, Y., Erden, R., Erdogdu, F. 2011. Effects of cooking methods on the proximate composition of black sea Anchovy (Engraulis encrasicolus, Linnaeus 1758). GIDA, vol. 36, no. 2, p. 71-75.

Küçükgilmez, A., Celik, M., Yaran, Y., Ersoy, B., Cikirci, M. 2006. Effects of different cooking methods on the proximate composition and mineral contents of sea bass (Dicentrarchus labrax). Advances Food Science, vol. 28, no. 4, p. 223-227.

Magnussen, O. M., Hemmingsen, A. K. T., Hardarsson, V., Nordtvedt, T. S. Eikevik, T. M. 2008. Freezing Fish. In Evans, J. A. Frozen Food Science and Technology. Australia : Blackwell Publishing, 365 p. ISBN-9781444302325. https://doi.org/10.1002/9781444302325.ch7

Manthey, M., Karnop, G., Rehbein, H. 1988. Quality changes of European catfish (Silurus glanis) from warm water aquaculture during storage on ice. International Journal of Food Science + Technology, vol. 23, no. 1, p. 1-9. https://doi.org/10.1111/j.1365-2621.1988.tb01013.x

Marimuthu, K., Thilaga, M., Kathiresan, S., Xavier, R., Mas, R. H. M. H. 2012. Effects of different cooking methods on proximate and mineral composition of striped snakehead fish (Channa striatus, Bloch). Journal of Food Science and Technology, vol. 49, no. 3, p. 373-377. https://doi.org/10.1007/s13197-011-0418-9

Martinez-Alvarez, O., Gómez-Guillén, C. 2013. Influence of mono- and divalent salts on water loss and properties of dry salted cod fillets. LWT - Food Science and Technology, vol. 53, p. 387-394. https://doi.org/10.1016/j.lwt.04.013

Mujaffar, S., Sankat, C. K. 2005. The air drying behaviour of shark fillets. Canadian Biosystems Engineering, vol. 47, no. 3, p. 11-13.

Saguy, I. S., Dana, D. 2003. Integrated approach to deep fat frying: Engineering, nutrition, health and consumer aspects. Journal of Food Engineering, vol. 56, no. 1-2, p. 143-152. https://doi.org/10.1016/S0260-8774(02)00243-1

Tangduangdee, C., Bhumiratana, S., Tia, S. 2003. Heat and mass transfer during deep-fat frying of frozen composite foods with thermal protein denaturation as quality index. Science Asia, vol. 29, p. 355-364.

Tangduangdee, C., Sakarin, B., Suwit, T. 2003. Heat and mass transfer during deep-fat frying of frozen composite foods with thermal protein denaturation as quality index. Science Asia, vol. 29, p. 355-364.
USDA. 2015. *Composition of foods: Raw, Processed, Prepared*. USDA National Nutrient Database for Standard Reference Release 27. Documentation and User Guide. 154 p. Available at: https://www.ars.usda.gov/ARSUserFiles/80400535/DATA/sr27/sr27_doc.pdf

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