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# Effects of Drying Methods on the Proximate Composition of C*lupea harengus* (Atlantic Herring) Processed Fish Powder

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**ABSTRACT**

This study explores the impact of different drying methods on the proximate composition of fish powder derived from *Clupea harengus* (Atlantic herring). Fresh fish samples (J1) were compared with self-processed samples obtained through smoke drying (J2) and oven drying (J3), using a modern dual-energy kiln at 80°C for 3 hours. Additionally, market-purchased smoke-dried (J4) and sun-dried (J5) samples were analyzed. Proximate analysis indicated significant differences ($P<0.05$) in moisture content (5.29% – 13.0%) and carbohydrate levels (12.39% – 24.70%) between fresh (J1) and dried samples (J2-J5). Protein (46.92% – 59.77%), fat (10.4% – 16.48%), and ash (4.27%) contents did not significantly differ ($P>0.05$) between J2 and J3 but were significantly different ($P<0.05$) from J4 and J5. Micronutrient analysis revealed varying levels of calcium (769.5 – 1667.3 mg), iron (7.78 – 36.42 mg), phosphorus (165 – 183.1 mg), and zinc (8.53 – 19.43 mg). Processing *C. harengus* whole results in fish powder with decreased moisture values, denser nutrient concentrations, and improved shelf life stability. The self-processed samples (J2 and J3) showed higher nutritional values compared to market-purchased samples (J4 and J5), indicating that proper handling, processing, and storage methods are crucial for superior fish powder quality. Dried *C. harengus* processed into fish powder can offer a nutrient-rich supplement that may enhance food fortification and boost nutritional intake, especially for newborns, young children, and nursing mothers.

**Keywords:**

*C. harengus, Smoke-dried, Oven-dried, Sun-dried, Fish powder, Proximate composition*

## Introduction

Fish are a crucial source of essential nutrients, including protein, amino acids, vitamins, and micronutrients, vital for healthy living and the prevention of malnutrition (Kwasek et al., 2020; Islam et al., 2018). Small pelagic fish species such as *C. harengus*, which are rich in protein, omega-3 fatty acids, and essential micronutrients, are often considered low-value or discard species due to their size (Akther et al., 2018). Processing these cost-effective species into value-added products, such as fish powder, can efficiently increase their utilization and sustainably boost fish production output (Abbey et al., 2017). Fish powder is valued for its nutrient density, stability, extended shelf life, and versatility in food incorporation (Sathivel and Bechtel, 2006). It is used to fortify and enhance foods, helping to reduce protein and micronutrient malnutrition (Gomez et al., 2023; Shaviklo et al., 2019).

Understanding the nutritional content of fish powder is essential for its effective integration into protein-rich diets (Jahan and Isam, 2017).

Despite the importance of different drying methods, there is limited data on the proximate composition of *C. harengus* processed into fine fish powder. This study aims to evaluate the effects of various drying methods on the nutritional composition of *C. harengus* fish powder.

## Materials and Methods

### Collection of Fish Samples

Fresh and dried *C. harengus* samples were purchased from Ogbe-ijaw market, Warri South West Local Government Area, Delta State. Market-purchased smoke-dried and sun-dried samples were packed in sterile polythene bags, while fresh fish samples were transported in ice chest packs to the wet laboratory at the Department of Aquaculture and Fisheries Management, University of Benin. The fresh samples were frozen at -12°C prior to the experiment.

### Sample Preparation

The frozen fish samples were thawed, cleaned under running water, and placed on a covered rack to drain before processing. The experimental samples were labeled and weighed as follows: J1 = 100 grams (fresh sample), J2 = 200 grams (self-processed smoke-dried samples), J3 = 200 grams (self-processed oven-dried samples), J4 = 200 grams (market-purchased smoke-dried sample), and J5 = 200 grams (market-purchased sun-dried samples). J2 and J3 were processed using a modern rectangular dual-energy kiln at 80°C for 3 hours. The dried fish samples were pulverized with an electric blender and sieved through a 0.3µm mesh filter to obtain fine fish powder, which was then packaged in labeled Ziploc bags for analysis.

### Proximate Composition Analysis

Proximate composition (moisture, protein, ash, fat, and carbohydrate) of the *C. harengus* fish powders was determined using standard methods (AOAC, 2003). Moisture content was assessed by drying 1 g of the sample in an electric oven at 105°C for 24 hours. Protein content was measured using the Kjeldahl method. Fat content was extracted using chloroform-methanol (2:1, v/v) and quantified by the Folch method (Folch et al., 1957). Ash content was determined by incinerating 1 g of the sample in a muffle furnace at 600°C for 3 hours (Farzana and Mohajan, 2015). Total carbohydrate content was calculated as the difference in weight. All proximate analyses were performed in triplicate.

### Trace Elements Analysis

Trace elements such as calcium, iron, phosphorus, and zinc were analyzed using standard methods. Calcium was determined by flame photometry. Iron and zinc concentrations were measured using Atomic Absorption Spectrophotometry (APHA). Phosphorus was determined using the Vanadomolybdate yellow color method (Kumar et al., 2007).

**Statistical Analysis**

Data were analyzed using GENSTAT statistical software version 2015. Means were separated using Duncan's Multiple Range Test (DMRT) at a 5% probability level.

**Results**

**Table 1: Mean value Proximate Composition of *Clupea harengus* fish powder**

| Treatments | Moisture | Protein | Fat | Ash | Carbohydrate |
|---|---|---|---|---|---|
| J1 | 79.76±0.19$^{e}$ | 12.29± 0.36$^{a}$ | 3.21± 0.26$^{a}$ | 1.31± 0.09$^{a}$ | 3.43± 0.16$^{a}$ |
| J2 | 5.29± 0.05$^{a}$ | 59.59± 0.15$^{d}$ | 16.48± 0.05$^{e}$ | 6.25± 0.09$^{d}$ | 12.39± 0.33$^{c}$ |
| J3 | 6.67± 0.11$^{b}$ | 59.77± 0.60$^{d}$ | 15.43± 0.45$^{d}$ | 6.03± 0.14$^{d}$ | 12.10±1.08$^{b}$ |
| J4 | 7.64± 0.25$^{c}$ | 49.72± 0.43$^{c}$ | 13.98± 0.25$^{c}$ | 5.24± 0.04$^{c}$ | 23.42± 0.87$^{d}$ |
| J5 | 13.0± 0.11$^{d}$ | 47.63± 0.09$^{b}$ | 10.4± 0.09$^{b}$ | 4.27± 0.11$^{b}$ | 24.70± 0.07$^{e}$ |

Values are expressed as mean± SD. Means with the same alphabetic superscripts along vertical axis is not significantly different at 5% probability

Key: $J_1$ = Fresh fish samples; $J_2$ = Self processed smoke-dried samples; $J_3$ = Self processed oven-dried samples $J_4$ = Market purchased smoke-dried sample; $J_5$ = market purchased sun-dried samples;

**Table 2: Mean Mineral analysis of *Clupea harengus* fish powder**

| Treatments | Calcium | Iron | Phosphorus | Zinc |
|---|---|---|---|---|
| J1 | 1282.6±12.54$^{b}$ | 8.45± 0.06$^{a}$ | 166.9± 3.96$^{ab}$ | 9.84± 0.30$^{a}$ |
| J2 | 1410± 19.5$^{c}$ | 7.82± 0.13$^{a}$ | 176.5± 3.5$^{ab}$ | 8.74± 0.16$^{a}$ |
| J3 | 769.5± 19.71$^{a}$ | 12.61± 0.63$^{b}$ | 165± 3.2$^{a}$ | 11.54± 0.66$^{a}$ |
| J4 | 1404± 18.21$^{c}$ | 7.78±0.15$^{a}$ | 175.1± 3.4$^{ab}$ | 8.53±0.16$^{a}$ |
| J5 | 1667.3± 0.26$^{d}$ | 36.42±0.88$^{c}$ | 183.1± 2.57$^{b}$ | 19.43±1.97$^{b}$ |

Values are expressed as mean± SD. Means with the same alphabetic superscripts along vertical axis is not significantly different at 5% probability

Key: $J_1$ = Fresh fish samples; $J_2$ = Self processed smoke-dried samples; $J_3$ = Self processed oven-dried samples $J_4$ = Market purchased smoke-dried sample; $J_5$ = market purchased sun-dried samples;

**Discussion**

This study examined the proximate composition and trace elements of *C. harengus* fish powder subjected to various drying methods. Fresh fish samples (J1) exhibited the highest moisture content and the lowest protein and fat levels compared to dried samples. This result is consistent with Singh et al. (2014), indicating that drying significantly reduces moisture content, thereby enhancing the stability and shelf life of fish powder. Among the drying methods, smoke and oven drying preserved a higher

proportion of protein and fat compared to sun drying, aligning with previous studies by Vázquez et al. (2021).

The observed differences in mineral content across drying methods emphasize the impact of processing techniques on nutrient preservation. Smoke-drying (J2) and oven-drying (J3) were more effective in preserving calcium and phosphorus compared to sun drying (J5), in agreement with findings by Rahman et al. (2015). Sun drying resulted in lower protein content and higher carbohydrate levels, suggesting nutrient degradation and conversion during the extended drying process.

The high calcium, iron, phosphorus, and zinc content in the processed fish powder is attributed to the fish's skeletal structure and metabolic needs (Musa, 2009). Self-processed samples (J2 and J3) showed higher nutritional values than market samples (J4 and J5), indicating that the quality of dried fish samples depends on proper handling, processing, and storage methods.

## Conclusion

The drying methods used significantly influence the proximate composition and nutrient content of *C. harengus* fish powder. Smoke and oven drying methods offer better preservation of essential nutrients compared to sun drying. These findings highlight the importance of selecting appropriate drying methods to enhance the nutritional quality of fish powder for human consumption.

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