Nutritional Quality of the Fillet of Three Major Frozen Gadiform Fishes (Panla) Sold in Nigerian Markets

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ABSTRACT

Fish serves as an important food especially in developing countries and has gained attention due to its high protein content and nutritional value of unsaturated fatty acids. It currently has a great market potential when compared with beef, poultry, pork and egg. Gadiformes are major and widely acceptable frozen fishes sold in Nigerian market due to the believe that they possess low fat. The three major species of Gadiformes found in Nigerian markets are *Merluccius merluccius*, *Gadus chalcogrammus* and *Micromesistius poutassou*. This work focus on evaluating and comparing the nutritional qualities of the fillet of these three major frozen Gadiform fishes sold in Nigeria markets. The proximate composition of the fillets were determined according to AOAC methods while the mineral content were determined using Atomic Absorption Spectrophotometer. The fatty acid compositions of the oils extracted from the fillets were determined using GC-MS. The proximate composition showed that the fillet of *Micromesistius poutassou* had the highest protein and lowest fat contents. Both *Merluccius merluccius* and *Gadus chalcogrammus* fillets were high in polyunsaturated fatty acids. The findings made in this study revealed *Merluccius merluccius* and *Gadus chalcogrammus* fillets have similar nutritional qualities. However, all the three Gadiform fillets are of great nutritional importance.

Keywords
Gadiform, Fillet, Major, Frozen, Nutritional, Market, Acceptable, Quality

1. INTRODUCTION

Fish is known as a significant part of a healthy, well-balanced diet due to its exceptional nutritional properties. Fish and seafood are unique dietary sources of cardioprotective docosahexaenoic (DHA) and eicosapentaenoic (EPA) fatty acids (Djedjibegovic *et al*., 2020). People prefer seafood due to high essential amino acids and fatty acids, mineral substances and dietary fibre content. One of the favourite sea foods that are always available in Nigeria is the Gadiform fishes. These fish species constitute a considerable source of low-cost dietary protein and Polyunsaturated Fatty Acids (PUFA) (Özogul and Özogul, 2007; Pacetti *et al*., 2010). The major problem associated with the commercialization of fish is their high susceptibility to deterioration. To retain fish sensory and nutritional properties, several storage methods have been widely used. Apart from salting and sun drying which are two common ancient practices used to preserve food (Khaoula *et al*., 2013) freezing and oven drying techniques are also largely employed (Saldanha *et al*., 2008; Akinwumi *et al*., 2011).

Alaska pollock (*Gadus chalcogrammus*, formerly *Theragra chalcogramma*) is a species of schooling whitefish native to the North Pacific, ranging from central California to the Bering Sea, and into the Sea of Japan (Christina, 2017). Alaska Pollock are lean, fast-growing fish that can reach up to 105 cm in length and to 6.5 kg in weight, and can live 22 years (Christina, 2017). They have three dorsal and two ventral fins in addition to their pelvic and pectoral fins with their lower jaw slightly protrude. The diet of Alaska Pollock is variable based on size, season and region. Juveniles eat primarily zooplankton including copepods and various euphausiids (Christina, 2017). As Alaska Pollock grow and enter adulthood, they begin to include smaller fish and sometimes juvenile Alaska Pollock into their diet. Regardless of age, Alaska Pollock tend to feed more heavily in warmer months to build up a lipid reserve to sustain them through the winter and spring.

Alaska Pollock can be found in both shallow and deep water, but are mostly found at 100-300m deep. They are regarded as semi-demersal fish because their tendency to increasingly swim closer to the ocean floor as they age (Christina, 2017).

European hake (*Merluccius merluccius*) is widely distributed throughout the North-eastern Atlantic Ocean. It is a demersal benthopelagic species that can reach depths that vary from 30 to 1000 meters, although they generally dwell at depths ranging between 70 to 370 meters. They form schools that stick close to the coastline in the summer and keep a greater distance during the winter. Egg-laying season lasts from January to May in the Bay of Biscay, and from May to July in the Celtic Sea. The European hake, a predator at the top of the Northeast Atlantic demersal trophic pyramid, primarily feeds on other species of fish like anchovies (*Engraulisencras icholus*), sardines (*Sardina pilchardus*), blue whiting (*Micromesistius poutassou*), horse mackerel (*Trachurustra churus*) and mackerel (*Scomber scombrus*) (Pérez-Pérez *et al*., 2017)
Blue whiting (*Micromesistius poutassou*) is found throughout the North Atlantic from the Southern Barents Sea and Eastern Norwegian Sea up to Cape Bojador, on the African coast. It is a demersal species of the gadus family. Its habitat is the ocean, and as a benthopelagic species, it lives mainly along the continental shelf and slope, distributed vertically at depths of between 150 and 1000 meters, though it is most commonly found at 300 - 400 meters below the surface. After laying its eggs, it migrates north in the summer (Faroe Islands, eastern Iceland, and Norway) and returns to the area where it laid eggs in January and February. The eggs are pelagic and hatch between February and June. The main area where eggs are laid is to the west of the British Isles, and their growth is quite rapid. The blue whiting's diet (clearly seasonal) is composed mainly of crustaceans, namely copepods, krill, the larvae of decapods and a decapod known as white glass shrimp (Pasiphaeasivado) (Pérez-Pérez, 2017). The work is aimed at evaluating the nutritional quality of the fillet of the three major frozen Gadiform fishes (panla) sold in Nigerian markets.

2. MATERIALS AND METHODS

2.1 Collection and Preparation of samples

Frozen *Merluccius merluccius*, *Gadus chalcogrammus* and *Micromesistius poutassou* were purchased from a frozen fish depot in Abule Egba, Lagos and transported to the laboratory in an insulated ice box. The fish samples were thoroughly washed under a flowing tap to remove any adhering contaminants and drained. They were then dissected with a knife and the intestines, guts and bones were removed. The fillet samples were then homogenized and in a mortar and pestle until a uniform mixture (homogenized) were obtained. The homogenates were stored in the refrigerator for further analysis.

2.2. Determination of Proximate Components of the Gadiform fillets

The proximate composition as moisture, ash, crude protein and lipid of fish fillets were determined by conventional method of (AOAC, 2010) with minor modification. For determination of moisture content 15 g fish samples were taken into a hot air oven at a temperature of 105°C for 24 h until constant weight was obtained. The crude fat was determined according to Bligh and Dyer method (Ozyilmax *et al*., 2017). A total of 5 g samples were taken into a muffle furnace at a temperature of 600°C for 6 h for ash content measurement. Kjeldahl method was used to determine crude protein content of fish samples and a factor of 6.25 was used for converting the total nitrogen to crude protein content of the fish samples.

2.4. Determination of Mineral Contents of the Gadiform fillets

About 10g of homogenized fillet of each of the fish samples was taken and heated up in a muffle furnace at 550°C and ashed overnight. It was then cooled to room temperature. The dried powdered sample was then digested with concentrated nitric acid (65%) and later perchloric acid (60%). Aliquots were then taken and used for the determination of sodium, potassium, calcium, magnesium, iron, copper, and zinc content. Sodium and potassium were determined by flame photometry (Kolade, 2016). Iron, copper, zinc, calcium and magnesium were determined by Atomic Absorption Spectrophotometer (AOAC, 2010).

2.4. Determination of Fatty Acid Composition of the Gadiform Fillets

The fatty acid was determined using the lipid extracted from the crude lipid determination. It was performed by using a GC-MS (Gas Chromatography-Mass Spectrometry (GC-MS) [a Hewlett Packard GC (model 6890)] coupled with a Hewlett Packard model 5972A HP 6890 system MS detector.

3. RESULT AND DISCUSSION

3.1. Proximate Components of the Gadiform fillets

All the three Gadiform fishes have high moisture contents. The moisture content of *Micromesistius poutassou* 72.59% was lower than 74.99% reported by (Kolade, 2016). High moisture content of fish is a disadvantage in that it increases the fish's susceptibility to microbial spoilage, oxidative degradation of polyunsaturated fatty acids and consequently decreases in the fish quality for longer preservation time in agreement with (Omolara and Omotayo, 2008).The fat content showed *Merluccius merluccius* having the highest fat content. The fat content of *Merluccius merluccius* was higher than 1.21% reported by (Ozyilmax *et al*., 2017). The difference in the fat content could be as a result of different fishing time, the availability of food in the environment or life stages of the fish. Fish generally has 0.2-25% fat content and can be classified by its lipid content. Depending on lipid level, fish can be classified into four categories which are lean (<2%), low-fat (2-4%), medium-fat (4-8%), and high-fat (>8%). The *Merluccius merluccius* evaluated in this study falls into the category of low fat fish. *Micromesistius poutassou* had the highest protein content of 21.05%. The high protein content of *Micromesistus poutassou* may be attributed to the fact that it is carnivorous feeding mostly on small fishes and cephalopods (Kolade, 2016).

Table 1- Proximate Components of the Gadiform fillets

Parameters	*Micromesistius poutassou*	*Gadus chalcogrammus*	*Merluccius merluccius*
Moisture content (%)	72.59±0.02	80.79±0.004	79.86±0.045
Crude fat (%)	2.45±0.026	2.67±0.034	2.78±0.048
Crude protein (%)	21.05±0.033	15.02±0.041	15.21±0.023
Crude fibre (%)	0.34±0.006	0.16±0.044	0.20±0.025
Ash content (%)	1.82±0.024	1.21±0.031	1.17±0.033
Carbohydrate (%)	1.75±0.004	0.15±0.032	0.78±0.025

Values are mean ± standard deviation of triplicate determinations

3.2 Mineral Contents of the Gadiform fillets

For *Merluccius merluccius* and *Gadus chalcogrammus*, the mineral concentration was in the order of Na>K>Ca>Mg>Zn>Fe. *Micromesistius poutassou* had the lowest Na, K, Fe and Zn content. The high concentration of calcium portrays that the sampled fish species can play a role in bone and strong teeth formation (Malawi, 2001; Oguzie, 2009). The presence of Zinc in the samples could mean that the sampled fish species can play valuable roles in blood boosting and help in pregnancy for the normal growth of both fetus and mother (Onyia *et al*., 2010). Good concentration of sodium observed in all the fish examined indicates that the water body from which the fishes were collected is very rich in sodium and that must have allowed an active movement of this ion across the gill structure, which in turn may depend on the concentration in the external medium and that the richness in sodium concentrations would boosts the osmoregulatory activities in the organisms (Vadivel *et al*., 2000; Watchman, 2000).

Table 2: Mineral Contents of the Gadiform fillets

Minerals (mg/kg)	*Micromesistius poutassou*	*Gadus chalcogrammus*	*Merluccius merluccius*
Ca	286.50±0.025	180.47±0.008	189.52±0.006
Na	268.20±0.017	392.11±0.023	438.37±0.04
K	195.70±0.034	218.55±0.012	226.40±0.023
Mg	212.60±0.034	189.10±0.025	194.35±0.05
Fe	2.45±0.045	4.80±0.05	5.90±0.024
Zn	3.12±0.012	5.15±0.023	5.99±0.03

Values are mean ± standard deviation of triplicate determinations

3.3 Fatty Acid Composition of the Gadiform fillets

The total amounts of the saturated fatty acids of *Merluccius merluccius* and *Gadus chalcogrammus* were higher than the monounsaturated and polyunsaturated fatty acids. Similar results were previously reported for *Merluccius merluccius* by (Ozyilmax *et al*., 2016). In SFA, palmitic acid was the predominant fatty acid in all the lipid samples (22.16%, 26.41% and 27.04% for *Micromesistius poutassou*, *Merluccius merluccius* and *Gadus chalcogrammus* respectively. *Micromesistius poutassou* had the highest monounsaturated fatty acid content. This compares well with the result of (Egerton *et al*., 2020). All the oils extracted from the Gadiform fillets had high concentration of polyunsaturated fatty acids. According to (Godwin and Prabhu, 2006), the high degree of unsaturation in fish oils increase the vulnerability to lipid peroxidation. Furthermore, the degradation of the PUFAs group induced by auto-oxidation leads to the formation of volatile compounds that are associated with rancidity (Pazos *et al*., 2005).

Table 3: Fatty Acid Composition of the Gadiform fillets

Fatty Acids (%)	***Micromesistius poutassou***	***Gadus chalcogrammus***	***Merluccius merlucius***
C10:0	0.01	0.01	-
C12:0	1.00	0.05	0.02
C14:0	5.92	6.01	4.12
C16:0	22.16	26.41	27.04
C18:0	1.98	20.52	21.23
C20:0	0.26	0.04	-
C22:0	0.01	0.67	1.98
∑SFA	**31.34**	**53.71**	**54.39**
C14:1	0.14	1.67	1.90
C16:1	6.85	2.99	3.25
C18:1n-9	19.88	5.16	4.53
C18:1n-7	5.46	1.68	2.97
C18:1n-11	1.01	2.13	2.02
C20:1	10.01	0.20	0.25
C22:1n-9	0.81	4.99	5.60
C24:1	0.02	0.01	0.01
∑MUFA	**44.18**	**18.83**	**20.53**
C16:2n-4	0.75	2.57	1.61
C18:2n-6	1.23	1.02	1.05
C18:3n-6	0.19	0.17	0.21
C18:3n-3	1.00	2.10	1.18
C20:2n-6	0.50	1.87	0.99
C20:4n-6	1.23	0.47	0.51
C20:4n-3	0.05	0.40	0.35
C20:5n-3	8.07	4.67	3.98
C22:5n-3	1.45	3.40	3.09
C22:6n-3	10.01	10.79	12.11
∑PUFA	**24.48**	**27.46**	**25.08**
n-3	**20.58**	**21.36**	**20.71**
n-6	**3.15**	**3.53**	**2.76**
n3/n6	**6.53**	**6.05**	**7.50**

4. CONCLUSION

The study showed that the nutritional component (proximate, mineral and fatty acid compositions) of *Merluccius merluccius* and *Gadus chalcogrammus* are similar. *Micromesistius poutassou* had the highest protein content. However, all the Gadiform fishes are good source of protein, minerals, DHA and EPA.

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