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Effects of Cooking Methods on Proximate and Metal Contents of Some Common Fish Species

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Abstract: Cooking methods influence nutritive values of food. Proximate and metal contents of roasted and deep-fried *Scomber scombrus* (Titus), *Clarias gariepinus* (Cat fish) and *Sardinops pilchardus* (Sardine) were determined using standard methods. Protein contents of the fried fish were lower compared to the roasted fish. *Scomber scombrus* had the highest fat content (22.51%) and the least level (17.75%) in *Clarias gariepinus*, irrespective of the type of cooking method used. The highest (740.65 mg/Kg) and the lowest (6.11 mg/Kg) levels of calcium were both recorded in roasted *Clarias gariepinus*. Mineral elements varied in the order of Ca > Mg > Fe > Zn > Cu > Mn for the processed fish. The impacts of the different cooking methods on proximate and mineral contents of the fish were significantly different ($P \leq 0.05$), except for carbohydrate, copper and manganese. Roasting method provided the best results when both nutrients and preservation are the priorities.

Keywords: Fish, Roasting, Frying, Proximate, Mineral Elements

1. Introduction

The contribution of fish to human nutrition and its impact on health have been examined from different perspectives in both developed and developing countries [1]. Fish constitute a major source of protein and healthy lipid for many throughout the world [2]. Fish provides the long-chain polyunsaturated omega-3-fatty acid [3] which might favorably improve lipid profile and reduce cholesterol levels, the risk of coronary heart diseases, stroke and preterm diseases [4]. The principal components of fish are water, protein, lipid and carbohydrate [1].

Mineral elements are commonly found in fish and are important for human nutrition [4]. In living organisms, mineral elements take part in some metabolic processes [4, 6]. The nutritional composition of fish varies greatly from one species to another, depending on age, feed intake, sex and sexual changes connected with spawning, the environment and season [7-10].

Fish is always processed using different methods before consumption. These methods include frying and roasting, which have been used to preserve and increase its availability to consumers [11]. For many foods, cooking process gives them the desired characteristics that are associated with edible food; which are generated through an intricate series of physical and chemical changes that occur. These changes vary depending on the type of food being cooked and the method used to cook it. The changes may improve flavor, texture and color of the food [12]. Cooking of foods, however, may lead to the generation of undesirable compounds. The generation of potential carcinogenic compounds has received particular attention due to the serious nature of their possible consequences [13].

Protein in food is denatured during heating due to violent vibration and ultimate breakage of the weak hydrogen bonds holding the amino acid strands. The denaturation of protein molecules in foods causes a substantial change to the texture of the product [14]. Heating does not affect mineral levels, but are usually leached if cooked in boiling water [15]. Several works [8, 9, 15] on processing methods have been reported, however, information on the use of some cooking methods on some fishes are scarce. The research was therefore carried out to assess the comparative impact of roasting and frying as cooking methods on the proximate and metal contents of some commonly consumed fish species.

2. Materials and Methods

2.1. Sampling

The fish species used in this study (*Scomber scombrus*, *Clarias gariepinus* and *Sardinops pilchardus)* were bought from a local market (Keffi Market) in Nigeria and preserved for further treatment.

2.2. Sample Preparation

Each fish type was deep-fried with vegetable oil in a frying pan and roasted with heat from charcoal. The deep–frying was done in vegetable oil using a frying pan on hot flame, with occasional turning in order to achieve even frying. Frying was carried out at 240°C for 15 minutes. The roasting was done at 165°C for 15 minutes. All samples were homogenized prior to analysis.

2.3. Proximate Analysis

Proximate analyses (moisture content, total ash, ether extract, crude protein, and crude fiber) of the modified samples were carried out in triplicates, according to AOAC [17], while carbohydrate was calculated by difference [18, 19]: % carbohydrate = 100–(% moisture + % protein + % crude fat + % extract + % ash).

2.4. Metal Analysis and Digestion

Two grams (2g) of each of the fish type was weighed into a 100 cm^3 beaker. 20 cm^3 of concentrated nitric acid was added to the sample and heated at 60°C, until white fume was evolved. The sample was then removed from the hot plate and allowed to cool, then filtered into 100 cm^3 volumetric flask and made up to the mark with distilled water. A blank digest was carried out in the same way. The metal ions were determined using Atomic Absorption Spectrometry (iCE 3000 AA02134104 vl.30).

3. Results and Discussion

3.1. Proximate Composition

Proximate contents of *Scomber scombrus* fish (Table 1) show that frying increased the levels of moisture (8.93±0.03 %) and crude fiber (22.51±0.01%). Fat, ash and carbohydrate contents were higher in the roasted fish. Proximate contents in the processed fish were significantly different (P ≤ 0.05). Table 2 shows that proximate profile of the roasted *Sadinorps picardus* was relatively low, except for crude protein (70.70±0.18%) and carbohydrate (0.09±0.05%), which were higher compared to the fried fish. Frying significantly increased the proximate contents of the fish, except for carbohydrate contents.

Roasted *Claria garipinus* (Table 3) contained higher levels of moisture (9.81±0.01%), crude protein (78.20±0.03 %) and carbohydrate (0.04±0.05%). Change in cooking method did not affect carbohydrate content significantly (P ≤ 0.05). Comparing the proximate levels in the roasted fish species (Table 4), crude fat (7.30±0.01%) and carbohydrate were highest in *Scomber scombrus.* The highest moisture (7.92±0.02%) and crude protein (78.20±0.03%) contents were recorded in *Sardinops pilchardus* and *Clarias gariepinus* respectively. Crude protein, crude fat and moisture contents of the roasted fish were significantly different (P≤0.05).

The levels of crude fat in *Scromber scrombus* (22.51±0.01%); moisture (14.24±0.01%), ash (0.83 0.01%) and carbohydrate (0.06±0.01%) in *Sardinops pilchardus*; crude fiber (0.06±0.01 %) and crude protein (69.52±0.05) in *Clarias gariepinus* were highest (Table 5). The proximate contents were significantly different (P ≤ 0.05) in each of the fried fish, except for carbohydrates and crude fiber. Decrease in fat content in roasted fish might be attributed to oxidation and break down of poly-unsaturated fatty acids (PUFA) contained in the fish tissue to products such as peroxides, aldehydes, ketones and the free fatty acids [3, 10, 20, 21] Higher roasting temperature may also account for the loss of fat. Low moisture content recorded for some fish species may avert microbial spoilage and increase the shelf life of such fish species [10]. The moisture contents in this study were lower compared to the values reported by Daniel [22].

High protein content is important in the body as it helps in the replacement of worn out tissue and regulation of body metabolism. Denaturation may be responsible for the low levels of protein recorded for some fish [20], especially during roasting.

Table 1. *Proximate composition (%) of roasted and fried Scomber scombrus.*

Parameter	Roasted	Fried
Moisture Content	7.92±0.02[a]	8.93±0.03[b]
Ash Content	0.61±0.05[a]	0.43±0.01[b]
Crude Fibre	0.01±0.01[a]	0.02±0.01[b]
Crude Fat	17.30±0.01[a]	22.51±0.01[b]
Crude Protein	73.5±0.06[a]	68.06±0.03[b]
Carbohydrate	0.67±0.51[a]	0.05±0.49[a]

Levels with the same alphabet within the same column are not significantly different (P ≤ 0.05)

Table 2. *Proximate composition (%) of roasted and fried Sardinops pilchardus.*

Parameter	Roasted	Fried
Moisture Content	12.52±0.02[a]	14.24±0.01[b]
Ash Content	0.61±0.01[a]	0.83±0.01[b]
Crude Fibre	0.01±0.01[a]	0.02±0.03[b]
Crude Fat	16.08±0.21[a]	20.15±0.01[b]
Crude Protein	70.70±0.18[a]	64.70±0.01[b]
Carbohydrate	0.09±0.05[a]	0.06±0.25[a]

Levels with the same alphabet within the same column are not significantly different (P ≤ 0.05)

Table 3. *Proximate composition (%) of roasted and fried Clarias gariepinus.*

Parameter	Roasted	Fried
Moisture Content	9.81±0.01[a]	12.27±0.04[b]
Ash Content	0.23±0.01[a]	0.39±0.25[b]
Crude Fibre	0.37±0.21[a]	0.06±0.01[b]
Crude Fat	11.35±0.02[a]	17.75±0.02[b]
Crude Protein	78.20±0.03[a]	69.52±0.05[b]
Carbohydrate	0.04±0.05[a]	0.01±0.03[a]

Levels with the same alphabet within the same column are not significantly different (P ≤ 0.05)

Table 4. *Proximate composition (%) of some roasted fish species.*

Parameter	*Scomber scombrus*	*Sardinops pilchardus*	*Clarias gariepinus*
Moisture Content	7.92 + 0.02[a]	12.52±0.02[b]	9.81±0.01[c]
Ash Content	0.61±0.05[a]	0.61±0.01[a]	0.23±0.01[b]
Crude Fiber	0.01±0.01[a]	0.01±0.01[a]	0.37±0.21[a]
Crude Fat	17.30±0.01[a]	16.08±0.21[b]	11.35±0.02[c]
Crude Protein	73.50±0.06[a]	70.70 + 0.18[b]	78.20±0.03[c]
Carbohydrate	0.67±0.51[a]	0.09±0.05[a]	0.04±0.05[a]

Levels with the same alphabet within the same column are not significantly different (P ≤ 0.05)

Table 5. *Proximate composition (%) of some fried fish species.*

Parameter	*Scomber scombrus*	*Sardinops pilchardus*	*Clarias gariepinus*
Moisture Content	8.93±0.03[a]	14.24±0.01[b]	12.27±0.04[c]
Ash Content	0.43±0.01[a]	0.83±0.01[b]	0.39±0.25[c]
Crude Fiber	0.02±0.01[a]	0.02±0.03[a]	0.06±0.01[a]
Crude Fat	22.51±0.01[a]	20.15±0.01[b]	17.75±0.02[c]
Crude Protein	68.06±0.03[a]	64.70±0.02[b]	69.52±0.05[c]
Carbohydrate	0.05±0.49[a]	0.06±0.025[a]	0.01±0.03[a]

Levels with the same alphabet within the same column are not significantly different (P ≤ 0.050)

3.2. Mineral Elements

Mineral elements in food are important for metabolic activities, transmission of nerve impulses, rigid bone formation and regulation of water and salt balance. The levels of mineral elements in the roasted *Scomber scrombus* (Table 6) were generally higher, except for copper (3.43 mg/Kg). Mineral element levels in *Scomber scrombus* were significantly (P ≤ 0.05) affected by a change in cooking methods. Metal levels in the roasted *Sardinorps pichardus* (Table 7) were higher than in the fried fish, except for iron (28.29 mg/Kg). Concentrations of mineral elements in the fried and roasted fish were significantly different (P ≤ 0.05). The levels of calcium and magnesium were generally highest in the fish species irrespective of the cooking method used, while manganese contents were the lowest.

Comparative variations in metal levels in all the roasted and fried fish species are presented in Figs 1 and 2 respectively. Roasted *Scomber scrombus* recorded the highest levels of iron and magnesium, while the highest calcium level was obtained in *Clarias garienipus* (Fig. 1). Concentrations of copper and manganese were relatively low. For the fried fish species (Fig. 2), *Sardinops pichardus* and *Clarias pichardus* recorded the highest and lowest concentrations for all the metals respectively. The level of magnesium was highest in the fish species. The effects of frying and roasting on the levels of mineral elements were significantly different (P ≤ 0.05).

Calcium, as a mineral element, helps to build bone and maintain the blood level. Magnesium is an essential cofactor for multiple enzymes involved in the glucose metabolism and it is hypothesized to play a prominent role in glucose homeostasis. Concentration of copper was in agreement with the findings of Saadettin et al. [23], who reported copper as the third most abundant trace element in the fish.

Table 6. *Mineral contents (mg/Kg) of roasted and fried Scomber scombrus.*

Element	Roasted	Fried
Zinc	32.08[a]	19.67[b]
Copper	3.43[a]	4.10[b]
Magnesium	312.30[a]	261.70[b]
Calcium	262.65[a]	48.56[a]
Iron	289.78[a]	23.79[a]
Maganese	ND	0.02[a]

Levels with the same alphabet within the same column are not significantly different (P ≤ 0.05)

Table 7. *Mineral contents (mg/kg) of roasted and fried Sardinops pilchardus.*

Element	Roasted	Fried
Zinc	19.33[a]	19.33[a]
Copper	5.34[a]	4.10[b]
Magnesium	308.50[a]	303.90[b]
Calcium	212.38[a]	123.79[b]
Iron	22.94[a]	28.29[b]
Maganesse	0.30[a]	0.24[b]

Levels with the same alphabet within the same column are not significantly different (P ≤ 0.05)

Table 8. *Mineral contents (mg/Kg) of roasted and fried Clarias gariepinus.*

Element	Roasted	Fried
Zinc	23.65[a]	16.57[b]
Copper	4.29[a]	2.66[b]
Magnesium	309.30[a]	251.30[b]
Calcium	740.65[a]	6.11[b]
Iron	15.22[a]	27.81[b]
Maganess	1.07[a]	1.22[b]

Levels with the same alphabet within the same column are not significantly different (P ≤ 0.05)

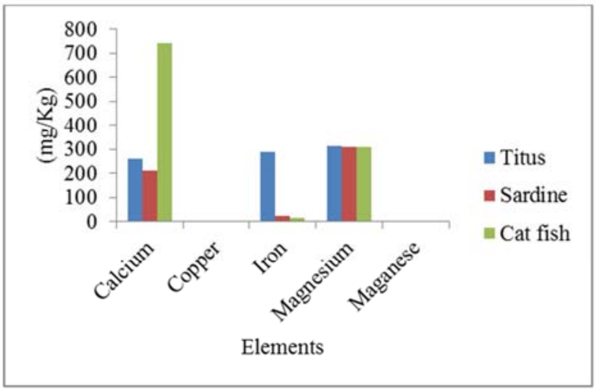

Fig. 1. *Variations in mineral contents (mg/Kg) of fried fish species.*

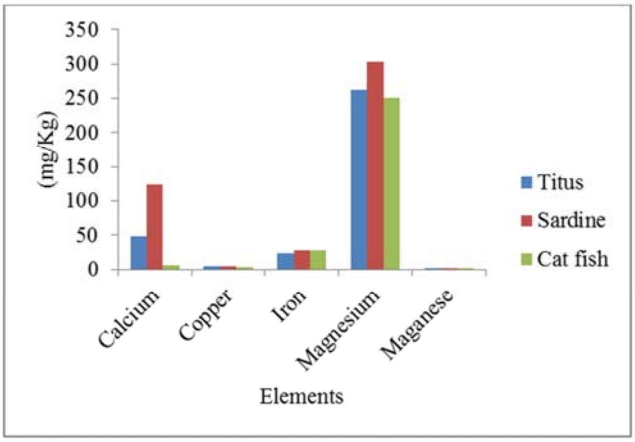

Fig. 2. *Variations in mineral contents (mg/Kg) of roasted fish specie.*

4. Conclusion

Proximate and mineral levels varied according to cooking method used. The highest protein and moisture contents for both the roasted and fried fish species were recorded in *Clarias garienipus* and *Sardinops pichardus* respectively. Concentrations of calcium and magnesium were relatively high, while manganese was the lowest, irrespective of fish species and the cooking method. Proximate and metal contents of the roasted and fried fish were significantly different ($P \leq 0.05$), except for carbohydrate, copper and manganese. Roasting method provided the best results when both nutrients and preservation are of priorities.

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