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Amino Acids and Minerals in Fresh and Processed Catfish, Mackerel and Pork

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Authors' contributions

This work was carried out in collaboration between both authors. Author TN designed the study, performed the statistical analysis, managed the literature searches and wrote the first draft of the manuscript. Author WYA managed the analyses of the study and wrote the protocol. Both authors read and approved the final manuscript.

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ABSTRACT

The main tissue of meat is the muscle and it is a very rich source of amino acids (aspartic acid, glutamic acid, histidine, arginine, valine, methionine, isoleucine, phenylalanine, threonine, and leucine) and some minerals like magnesium, calcium, phosphorus, sodium and potassium. In this study, essential amino acid profile in fresh catfish, mackerel, pork and their processed products were determined using High Performance Liquid Chromatography (HPLC). Minerals were determined in the form of cation (magnesium, calcium, potassium, ammonium and sodium) and anion (fluorine, chlorine, Nitrate, Sulphate and phosphate) by Cadmium.mtw and ASUP5 – 100 marvin.mtw respectively. The most abundant amino acids determined were aspartic acid, glutamic acid, arginine, methionine and threonine which were found in catfish, mackerel and pork. Values observed were higher ($p<0.05$) in catfish and mackerel than pork. Fresh catfish and mackerel recorded higher values in most of the amino acids in both raw product and their frankfurters (CF and MF) than fresh pork. Sulphate values were also higher ($p<0.05$) in raw meat than their

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frankfurters. Higher level of calcium, magnesium, potassium, and sodium were observed in processed pork frankfurter than fresh pork. Minerals such as calcium and sodium were present but are at a smaller quantity in meat.

Keywords: Amino acid; catfish; mackerel; mineral; pork.

1. INTRODUCTION

Meat is the muscle of any flesh of animal species that can be used as food by humans. The increasing awareness of fish as food is due to its nutritional value, health benefits as well as affordability [1]. Nestel et al. [2] observed that fish contains low lipids, high amounts of protein and higher water than beef, pork and chicken and is preferred to other white or red meats. Steffens [3] indicated that the nutritional value of fish meat comprises of moisture, protein, vitamins, minerals and the caloric value. Moore et al. [4], also reported an appreciable amounts of essential amino acids in fish, low levels of saturated fat and cholesterol compared with other animal protein sources. According to USDA [5] and Ocaño-Higuera et al. [6] fish has higher essential amino acids compared to beef which are good for the human body. Mineral elements are separate entities from the other essential nutrients like proteins, fats, carbohydrates, and vitamins. Human nutrition had demonstrated the need for minerals in a diet. Simple or conditioned deficiencies of mineral elements have profound effects on metabolism and tissue structure [7]. Mineral concentrations have not been evaluated in a number omeat species. This study therefore sought to look at some chemical components of fresh and processed meat from different animal's carcass.

The objectives of the study was to determine the amino acids and minerals characteristics of Mackerel, Catfish and Pork and their processed meat.

2. MATERIALS AND METHODS

2.1 Source of Raw Material

Frozen mackerel, fresh catfish and boneless pork were obtained from the Felibat cold store, Akate Farms Company Limited and Kumasi Abattoir Company Limited respectively, all in Kumasi, Ghana.

2.2 Evisceration, Skinning and Deboning

Fresh catfish were stunned and gutted after beheading. The beheaded and eviscerated portions were kept under refrigerated temperatures overnight. Using a pair of pliers, the skin of the mackerel and catfish was removed. A knife was then carefully positioned at the tail fin and cut laterally along the mid rib to obtain filleted boneless fish muscles (Figs. 1 and 2).

Fig. 1. The skin was removed from the fresh pork thigh and deboned using sknning of fresh fish with a pair of pilers

Fig. 2. Boneless pork, mackerel and catfish were weighed separately. Filleting of fresh fish eith a knife were frozen and later minced

2.3 Mincing and Sausage Preparation

Filleted frozen catfish, mackerel, lean pork and pork fat were minced separately using a Mincer (MA®Superwolf, Germany) with a grinding sieve of 5 mm and 3 mm, respectively. Different sieve diameters were used because the meat ingredients have different muscle fibre, and also

to prevent mashing. The procedure for the sausage preparation has been duly published in Nkrumah and Akwetey [8].

2.4 Experimental Design

There were three meat types and each of them were processed into frankfurter – type sausage. Amino acids and minerals were determined in both the fresh meat and their sausages. The samples were coded as C (Fresh Catfish), M (Fresh Mackerel), P (Fresh Pork), CF (Catfish sausage), MF (Mackerel sausage) and PF (Pork sausage). The experimental design was Complete Randomized Design (CRD).

2.5 Statistical Analysis

Data obtained amino acids and minerals were subjected to one-way analysis of variance (ANOVA). Amino acids and minerals were analyzed using GLM Procedure [9]. Significant differences between means were separated at 5% by least significant difference test.

2.6 Amino Acid Determination

Amino acids were determined in samples of fresh pork, mackerel and catfish and their sausage using ion-exchange chromatography of the acid hydrolyzed protein.

Amino acid standards (2.5 moles/L) were purchased from Sigma-Aldrich, 2, 4-dinitrofluorobenzene (DNFB), HPLC grade methanol and acetonitrile were purchased from MES Chemicals (Ghana). Other chemicals used were of analytical reagent grade. Water used for preparation of reagents was double distilled water. HPLC system (Varian) consisting of a Varian Pro Star 210/215/218/SD-1 Pumps, Varian Pro Star 325 LC Detector. Galaxie software for data processing and Genini µL C18 110A 150 * 4.60 mm 5 micron 257052-7 analytical column was used for separation. The mobile phase consisted of Mobile Phase A (0.02 mol/L Na2HPO4 + 0.02 mol/L NaH2PO4) and Mobile Phase B (Methanol: Acetonitrile=10: 90(v/v) mixed in a 70:30 ratio with a flowrate of 1.3 mL/min. The analysis was carried out at room temperature.

2.7 Ions Determination

Ions were determined using 861 Advanced Compact IC (Metrohm) consisting of a peristaltic pump and a conductivity detector. Metrohm software for data processing and Metrosep A Supp 5 100/4.0 mm analytical column was used for separation of anions whiles Metrosep C4 150 150/4.0 mm analytical column for cations separation. The Eluent for anion analysis consists of a mixture of 1. 0 mmol/L of sodium hydrogen carbonate and 3.2 mmol/L of sodium carbonate. The eluent for cation analysis consists of 2 mmol/L of nitric acid. The analysis was carried out at room temperature. The following were determined; sodium chloride, ammonium chloride, sodium nitrate, calcium chloride, sodium phosphate, magnesium sulphate, potassium bromide and potassium fluoride.

3. RESULTS AND DISCUSSION

3.1 Essential Amino Acid Contents of Fish (Mackerel and Catfish) and Pork

Table 1 shows results of essential amino acid contents recorded in this study. It was observed that higher ($p<0.05$) levels of aspartic acid, glutamic acid, arginine, methionine and threonine were in catfish and mackerel than pork.

The levels of essential amino acids recorded in catfish, mackerel and pork sausages in this study supports the fact that high quality proteins contain a lot of the essential amino acids; as this study reported significantly ($p<0.05$) high levels of aspartic acid, glutamic acid, arginine, methionine and threonine levels in catfish and mackerel than P (pork). (C) Catfish and (M) mackerel recorded higher values in most of the amino acids in both raw product and their frankfurters (CF and MF) than PF (Table 1). According to Keith [10], high-quality proteins contain a lot of the essential amino acids. This confirms the earlier research by Nkrumah and Akwetey [8] on the nutritional composition of catfish, mackerel and pork sausages. High crude protein levels were recorded for catfish, mackerel and pork sausages.

This supports report on essential amino acids in pork, fish and beef by FAO [11]. The low levels of Aspartic acid, glutamic acid, methionine and leucine were determined in pork and its corresponding pork sausage. However, MF (Mackerel sausage) recorded the highest levels in most of the amino acids analyzed. This indicates that fish is an excellent source of protein [12]. The high levels of the various amino acids in the fishes and their frankfurters show that the protein in both raw fish and its frankfurter sausage are of higher quality than in fresh pork and its sausage.

Table1. Essential amino acids content of catfish, mackerel and pork

Amino acid (ppm)	C	M	P	SEM
Aspartic Acid	3.73^{a}	2.71^{b}	2.02^{c}	0.0037
Glutamic Acid	0.40^{a}	0.33^{b}	0.15^{c}	0.0019
Histidine	0.17^{c}	1.94^{a}	0.65^{b}	0.0009
Arginine	13.29^{a}	12.91^{c}	13.21^{b}	0.0011
Valine	0.04^{a}	0.04^{a}	0.04^{a}	0.0012
Methionine	0.43^{a}	0.24^{b}	0.11^{c}	0.0011
Isoleucine	0.03^{b}	0.04^{a}	NT	0.0002
Phenylalanine	0.05^{b}	0.02^{c}	0.22^{a}	0.0020
Threonine	0.42^{a}	0.34^{b}	0.21^{c}	0.0006
Leucine	0.03^{b}	0.08^{a}	NT	0.0009

Superscript ^{abc}across rows are significantly different ($p<0.05$); NT= Not detected, C= Catfish, M= Mackerel, P= Pork, SEM= Standard Error of Means

FAO [11] reported of the levels of essential amino acids in some animal protein sources, including fish. Lauritzen [13] also reported that efficiency or degree to which dietary proteins can be used for building parts of the human body is determined principally by the type and relative amounts of amino acids present in the particular protein molecule. From this it could be deduced that the proteins in fish especially raw catfish and mackerel (and their frankfurters) could be more efficient in body building. FAO [11] reported similar results of high methionine and isoleucine preventing excess fat buildup. Methionine helps relieve or prevent fatigue because it reduces histamine release, and may be useful in some allergy cases [10].

Catfish (C) had higher ($p<0.05$) protein content than M (Mackerel) and pork (P), suggesting that not all fish species have higher protein than livestock meats; thus quality of protein in processed meat depends on the content used [8]. Although high protein contents were shown in Catfish than Mackerel, the protein contents for the two fishes were within the normal range of values of protein in fish (15-25%) [14]; Nkrumah and Akwetey [8] also reported of a range of 15.69 and 13.29% in catfish and mackerel and 14.64%.

Mackerel frankfurters (MF) recorded the highest levels of amino acid in the sausages analyzed. The high levels of the various amino acids in catfish and mackerel and their frankfurters show that the protein in both raw fish and its frankfurter sausage are of higher quality than in fresh pork and its sausage. Thus, consumers could possibly derive more nutritional benefits from catfish and mackerel compared to pork.The differences in protein contents of the fish sausages could be due to differences in species, feed availability, sexual maturity, spawning and season of catching [15].

3.2 Cations and Anions in Meats and Sausages

Fig. 2 shows the result for various cations determined in fresh catfish, mackerel and pork. In all, a total of five cations comprising magnesium, sodium, potassium, calcium, and ammonium were recovered in the raw meats samples. Catfish recorded higher values in most of the cations determined except calcium. Higher levels of sodium was recorded in catfish and pork than mackerel. Magnesium content in catfish was higher ($p<0.005$) than mackerel and pork.

In Fig. 3, anions were determined in fresh catfish, mackerel and pork. A total of four anions (sulphate, flouride, chloride, and nitrate) were recovered in the raw meat samples. Mackerel and pork recorded higher values in most of the determined except calcium. Higher ($p<0.005$) levels of sodium was recorded in catfish and pork than mackerel. Magnesium content in catfish was higher ($p<0.005$) than mackerel and pork.

PF was lower in calcium and magnesium than CF and MF. MF recorded higher mineral (Na and K) deposits than CF. Cobos and Díaz [16] reported of higher level of calcium, magnesium, potassium, and sodium in processed pork frankfurter than fresh pork. Similar trends were observed in this study. Low levels of calcium were observed in the frankfurters than their raw meats, in all treatments. Also, higher levels of NH_4^+ were observed for all the raw meats (pork, catfish and mackerel) but lesser values were recorded when processed into (frankfurters).

Table 2. Essential amino acid contents of catfish, mackerel and pork sausages

Amino acid (ppm)	CF	MF	PF	SEM
Aspartic Acid	2.37[b]	3.05[a]	2.03[c]	0.00128
Glutamic Acid	0.78[b]	1.05[a]	0.41[c]	0.40667
Histidine	NT	0.00[c]	1.55[a]	0.00193
Arginine	12.67[b]	12.67[b]	12.71[a]	0.00157
Valine	0.52[b]	0.69[a]	0.07[c]	0.00239
Methionine	0.70[a]	0.70[a]	0.08[b]	0.00176
Isoleucine	0.59[b]	0.87[a]	0.26[c]	0.00008
Phenylalanine	0.09[a]	0.02[b]	0.01[c]	0.00075
Threonine	1.21[b]	1.45[a]	1.06[c]	0.00341
Leucine	0.26[b]	0.59[a]	0.18[c]	0.00305

Superscript [abc]across rows are significantly different (p<0.05); NT= Not detected
CF= Catfish frankfurter, MF= mackerel frankfurter, PF=pork frankfurter

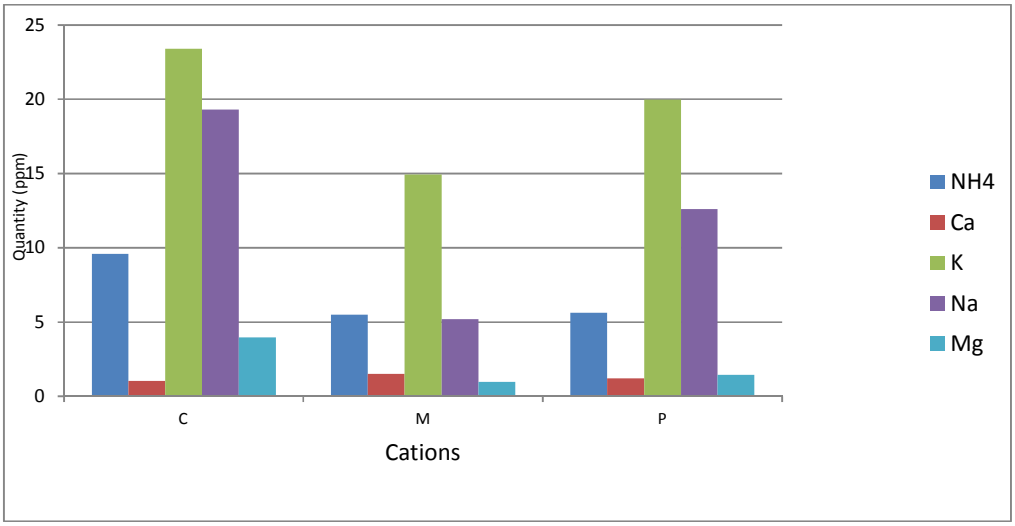

Fig. 2. Cations in fresh catfish (C), mackerel (M) and pork (P)

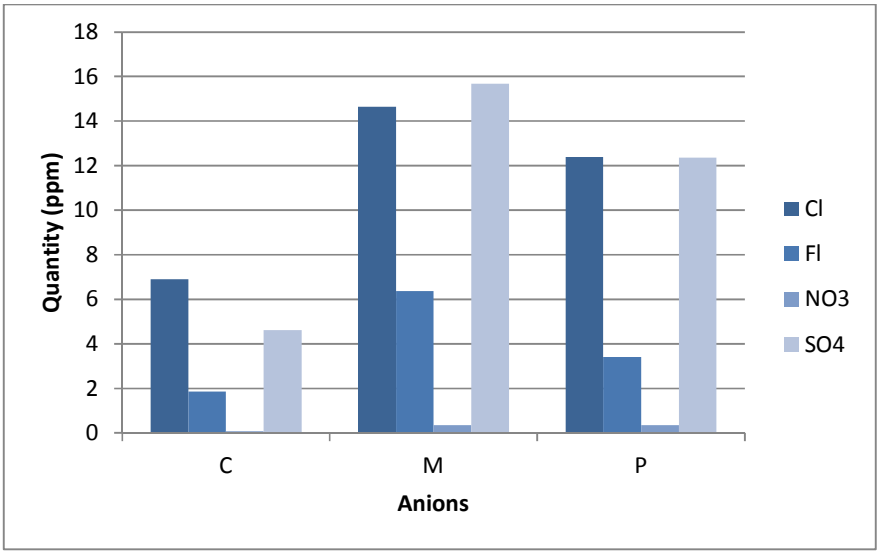

Fig. 3. Anions in fresh catfish, mackerel and pork

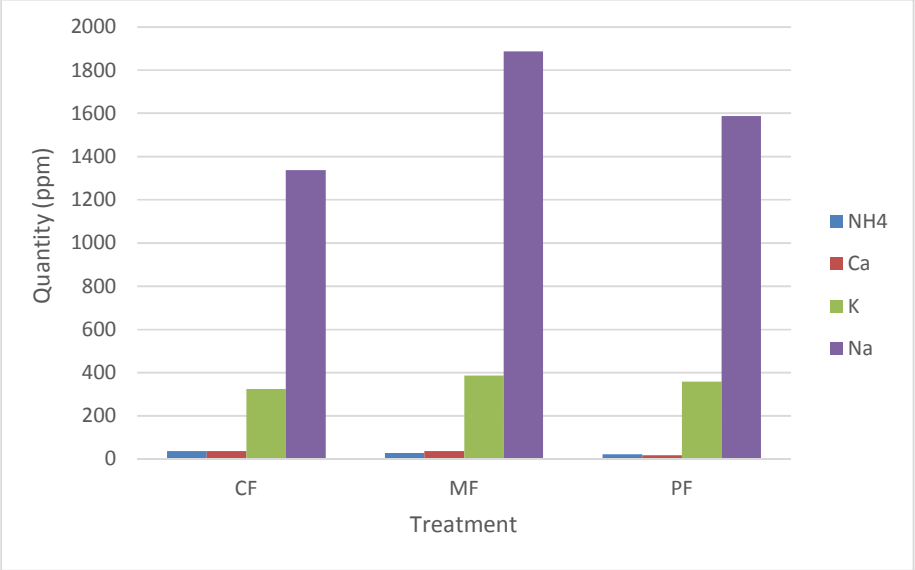

Fig. 4. Cations in catfish, mackerel and pork sausages

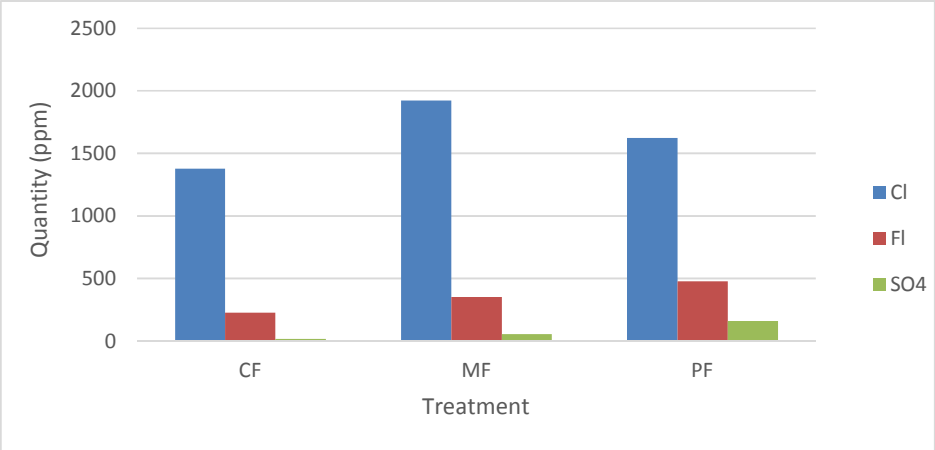

Fig. 5. Anions in catfish, mackerel and pork sausages

Chloride was higher in all processed meat samples. Limited amounts of sulphate and fluoride were recorded in processed catfish than mackerel and pork. Higher values were reported for chloride in both raw meat and frankfurters in all the treatments. Sulphate values were also higher in raw meat than their frankfurters. Tacon [17] reported that, the eating quality of food/meats including taste, texture, appearance and stability depends on the concentration of mineral. It is important to note that phosphate was not detected in all the raw meats used in the study but was recovered in the frankfurters because it was added in the form of polyphosphate during product formulation [19,20].

Olapade et al. [18] reported that fish is a good source of vitamins B (thiamin, riboflavin and vitamin B_{12}), vitamins A and D as well as minerals such as calcium, phosphorous and iron. This indicates that the presence of other ingredients and or the processing method used could affect ion composition in a product. It is also important to know that mineral content of meat during processing can affect the physiochemical properties [17,8].

4. CONCLUSION

Catfish and mackerel were higher in amounts of essential amino acids compared to pork in both fresh and processed products. Most of the cations were higher in raw fish (mackerel and catfish) and their sausages than pork. Mackerel recorded the highest values in most of the anions determined in both raw and processed product followed by pork.

5. RECOMMENDATION

Future trends in meat and meat product processing are related to the advances in healthier and functional products with improved health effects. It can be therefore recommended that, further studies be done on fish to determine the fatty acids profile as well as texture profile ensure good eating quality.

DISCLAIMER

Authors have declared that no competing interests exist. The products used for this research are commonly and predominantly use products in our area of research and country. There is absolutely no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for any litigation but for the advancement of knowledge. Also, the research was not funded by the producing company rather it was funded by personal efforts of the authors.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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