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Comparative Study of Proximate, Fatty and Amino Acids Composition of Wild and Farm-Raised African Catfish *Clarias gariepinus* in Kaduna, Nigeria

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Abstract: Proximate, fatty and amino acids composition of wild and farm-raised African catfish Clarias gariepinus from River Kaduna and Fadama fish pond (NAF base, Kawo) in Kaduna were evaluated. Juvenile and matured fishes from the two existing environment were investigated to ascertain differences in body composition of the fishes. The range of proximate composition were; moisture content 69.3-79.3%, crude protein 10.40-11.43, lipid content 1.15-2.08 and ash content 1.02-1.22%. Variation in percentage composition exist among individuals but there was however no significant differences($p>0.05$) in the mean body composition of the fish. A total of seven major fatty acids, seven trace metals and seventeen amino acids was found in the fish. Linoleic acid a polyunsaturated fatty acids which cannot be synthesized by humans was found in wild catfish while the matured catfish had a higher amount of unsaturated fatty acids. Farm-raised cat fishes had a higher amount of total amino acids while histidine and cysteine were low in both wild and farm-raised catfish samples. This study showed that wild and farm-raised catfish is beneficial to health and that water quality should be maintained.

Key words: Wild and farm-raised catfish, proximate composition, amino and fatty acids, Kaduna, Nigeria

INTRODUCTION

Rivers and lakes carry over 40% of the world's known fish species and water bodies in Nigeria harbour a variety of fish species. Fish is one of the cheapest sources of animal protein and accounts for about 40% of the total animal protein intake of the average Nigerian (Sadiku and Oladimeji, 1991).Some of the most important species accounting for about 90% of Nigeria's fishery include croakers, catfishes, tilapias, threadfins, soles and the clupeids. Fresh water fish constitute 69.6% of the total fish supply available to Nigeria and they represent a major source of animal protein supply to Nigeria (Osibona *et al*., 2009). Presently, there has been expansion of aquaculture in Nigeria, especially the culture of African catfish *Clarias gariepinus* due to their tolerance to a wide range of temperatures, fast growth, adaptation to diverse environments, as well as to low oxygen and high salinity levels (Osibona *et al*., 2009).

Fishes are excellent protein source that also delivers various minerals and vitamins necessary for good health. Meanwhile Scientists have reported that societies with high fish intake have considerably lower rates of acute myocardial infarctions, ischemic heart diseases and atherosclerosis (FDF, 2004). The increased awareness of the health benefits of eating fish has raised the estimated fish demand in Nigeria to 1.80 million tones based on a population of 120 million people and a per capita consumption of 15 kg, which is the global average (FDF, 2004).

The body composition of fishes is the result of its feed (Justi *et al*., 2003) and it can be affected by intrinsic factors such as temperature (Takeuchi and Watanabe, 1982), age or stage of development (Soivio *et al*., 1989), salinity (Borlongan and Benitez, 1992), migratory habits, (De Silva *et al*., 1997), factors related to metabolism (Robin *et al*., 2003) and extrinsic factors such as habitat (De Silva *et al*., 1998).

Fish regardless of location of capture is highly nutritious, tasty and easily digested and it is much sought after by a broad cross section of the world population. However, there is the perception that there are differences between wild caught and farm raised catfish and the reasons for this divergence are mainly due to tastes and safety.

Knowledge of composition of wild and Farm-raised catfish is important because it provides information on the nutritional data that is relevant for dieticians and the entire populace and also shows how the content varies with location of capture. Moreover, it gives information of the fatty acid content and amino acid profiles of fish which is important in determining the suitability of fish and its products for processing for meal and supplements.

Therefore, this study focuses on the comparative analysis of the proximate, amino and fatty acids of wild and farm raised catfish *Clarias gariepinus* in Kaduna, Nigeria.

MATERIALS AND METHODS

Study area: Kaduna metropolitan city is the state capital of Kaduna State in North-central Nigeria. It is located in Nigeria at Latitude 10.9^0 and 10.15^0N and

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7.5^0 and 7.9^0 E with an area of 46,053 Km^2 It is a stream (class H-Hydrographic) in Nigeria with an elevation of 55 meters above sea level. Its coordinates are 8°45'0" N and 5°48'0" E. Kaduna River is a main tributary of the Niger River in Nigeria. Fadama fish farm is located near Nigeria Air force in, Kawo which is the agricultural area of Kaduna, Nigeria.

Collection and preservation of specimens: Samples for this study were obtained from River Kaduna and Fadama Fish Farm (near NAF base, Kawo) in Kaduna, Nigeria. Live specimens of *Clarias gariepinus* were purchased and stored in a cooler and conveyed to the chemistry laboratory, Nigerian Defense Academy, Kaduna. A total of 20 specimen (six females and fourteen males) of African catfish (*Clarias gariepinus*) were randomly selected and utilized. Ten specimens were obtained from the wild while another ten specimen were obtained from the farm and all fishes were captured in January. Proximate composition of fish samples was carried out in chemistry laboratory, Nigerian Defense Academy, Kaduna, while amino acid determination was done in Zoology laboratory, University of Jos. Fatty acid analysis was carried out in National Research Institute for Chemical Technology, (NARICT) Zaria, Kaduna State.

Biometric measurements: Fish samples were thawed in the open air in the laboratory and individual data for fish length, weight and sex were taken and recorded. The standard length was measured with the aid of a graduated fish measuring board. The weight was measured with a Satorious top loading electronic weighing balance Satorious-Werke GMBH model (Type 1106/ Fabr. Nr. 2608053). The sex was determined by visual examination of the gonads.

Analytical methods: Each fish sample was gutted, cleaned, finely minced and then homogenized. Samples for the different chemical analyses were then taken from the homogenized material. Triplicate determinations were carried out on each sample.

Proximate composition analysis: The moisture content of the fish species was determined using the air oven drying method by using a known weight of the fillet at 105°C until a constant weight was obtained (AOAC, 1994). Ash content was determined by incineration of the dried sample obtained from moisture determination in a muffle furnace at 525°C for 24 h. Crude protein content was calculated by converting the nitrogen content, determined by Kjeldahl's method (6.25xN) (AOAC, 1994). The lipid extractions were performed by modification of the method of Bligh and Dyer as described by AOAC (1994).

Amino acid analysis: The preparation of the samples was adapted from the procedure described by Benitez (1989). Two hundred milligram of fish sample was defatted and hydrolyzed by extracting the lipid with chloroform/methanol. Defatted sample was hydrolyzed using 6N HCl, the filtrate was loaded in Techno sequential machine. The net height of each peak produced by the chart recorder of TSM (each representing an amino acid) was measured. The half-Height of the peak on the chart was found and the width of the peak on the half height was accurately measured and recorded. Approximate area of each peak was then obtained by multiplying the height with the width at half-height.
The norleucine equivalent (NE) for each amino acid in the standard mixture collected in the form of chromatogram. The analyzer was ion exchanged with several buffers at varying pH running through the column. Each sample took about 4 h to run through the system.

Fatty acid analysis: Fats were extracted from the sample and converted to free fatty acids by saponification. The fatty acids were converted to their methyl esters and into heptane. Internal standards were employed for estimation of actual fatty acids present in the fat. Identification/quantification of fatty acids was achieved by gas chromatography-mass spectrophometer., the former being resolved by elution times (AOAC, 1994).

Statistical analysis: Student t test, least significant difference LSD.

RESULTS

Proximate composition: Table 4.1 shows the results of the proximate composition of four composite specimen of the wild and farm raised catfish from River Kaduna and Fadama fish farm (Near NAF base, Kawo) in Kaduna, Nigeria. The values represent the mean of duplicate determinations and standard deviation. However Mean values of triplicate determination and standard deviation were reported for moisture content while the values for Nitrogen free Extract were obtained by difference (Table 1).

Amino acids: Table 4.2 shows the results of the Amino acids composition of wild and farmed catfish from River Kaduna and fadama fish farm (NAF base, kawo) in aduna, Nigeria. The sequence of the amino acids are ordered according to their peak as shown in the chromatogram and the values are given as mg/g A total of seventeen different amino acids was recorded in all fish sample as shown in Table 3. All the essential amino acids (valine, threonine, leusine, isoleucine, histidine, methionine, tyrosine, lysine and phenylalanine were present in all fish samples. The total amount of

Table 1: Proximate composition of wild and farm-raised catfish

Fish samples		Moisture (%) content*	Crude (%) protein**	Total (%) fat**	Ash (%) content (g)**	Nitrogen (%) free extract
Wild catfish	RCF_{ju}	79.3±3.0	10.87±0.5	1.15±0.2	1.02±0.3	7.66
	RCF_{ma}	70.5±11.9	11.43±0.7	1.84±0.2	1.22±0.2	15.01
Farm-raised	PCF_{ju}	73.2±4.6	10.98±0.8	1.34±0.7	1.10±0.4	13.38
catfish	PCF_{ma}	69.3±10.0	11.40±0.6	2.08±0.1	1.19±0.3	17.03
	Range	69.3±79.3	10.40±11.43	1.15±2.08	1.02±1.22	7.66-17.03
	Mean	73.93±5.04	10.91±0.28	1.6±0.36	1.13±0.10	
	CV	6.89	2.56	22.24	8.89	
	$LSD_{0.05}$	15.31	1.28	1.61	0.35	

RCF_{ju}: Juvenile River Catfish
RCF_{ma}: Matured River Catfish
PCF_{ju}: Juvenile pond Catfish
PCF_{ma}: Matured River Catfish

Table 2: Fatty acids composition of wild and farm-raised catfish

Fatty acids	Carbon atoms	Fatty acid class	Wild catfish RCF_{ju}	Wild catfish RCF_{ma}	Farm raised catfish PCF_{ju}	Farm raised catfish PCF_{ma}
Eicosanoic acid	C20:0	PUFA	2.05	40.03	48.34	49.78
Linoleic acid	C18:2	PUFA	11.98	11.65	2.44	0.17
Stearic acid	C18:0	SFA	1.19	0.99	20.99	0.62
Oleic	C18:1	MUFA	49.85	17.69	3.06	23.73
Palmitic acid	C16:0	SFA	28.83	2.17	23.73	2.18
Pentadecanoic acid	C15:0	SFA	4.79	14.46	0.93	23.37
Myristic acid	C14:0	SFA	0.75	0.67	0.51	0.15
Cholesterol	-	-	-	11.89	-	-
$LSD_{0.05}$	-	-	22.53	15.28	21.71	19.45

*Mean values of triplicate determinations and standard deviation
**Mean values of duplicate determinations and standard deviation
CV: Coefficient of variation
$LSD_{0.05}$: Least significant difference at (p>0.05)
PUFA: Polyunsaturated fatty acids
MUFA: monounsaturated fatty acids and SFA: Saturated fatty acids

amino acids in mg/g was 86.83>91.33>98.96>107.96, respectively for Matured River Catfish(RCF_{ma}) Juvenile River Catfish (RCF_{ju}), Juvenile pond Catfish (PCF_{ju}) and Matured pond Catfish (PCF_{ma}). Total amino acids was highest in Matured pond Catfish (PCF_{ma}) with a value of 107.96 mg/g. The dominance of amino acids are in the order; Glutamic acid > Aspartic acid > Glycine > Lysine > Leucine > Arginine > Alanine > Proline > Valine > Serine > Isoleucine > Threonine > Phenyalanine > Tyrosine > Methionine > Histidine > cysteine.

Fatty acids: The result of the percentage Fatty acids composition of wild and farmed catfish for fish samples is presented in Table 2. The sequence of the fatty acids are ordered according to their chromatographic retention times and the values are given as weight percentages of the total acid methyl esters (Table 2). Seven major fatty acids namely; *Eicosanoic acid, linoleic acids. Stearic acid*, *Oleic acids*, *Palmitic acids*, *Pentadecanoic acids and Myristic acids* were detected. The most dominant individual fatty acids in all fish sample was Eicosanoic acid (C20:0) with a percentage composition of 49.78, 48.34 and 40.3 and 2.05 respectively for Matured pond Catfish (PCF_{ma}), Juvenile pond Catfish (PCF_{ju}) and Matured River Catfish(RCF_{ma}) and Juvenile River Catfish (RCF_{ju}). This was followed by Oleic acid (C18:1) which had a% composition of 49.85 in Juvenile River Catfish (RCF_{ju}), 23.73 in Matured pond Catfish (PCF_{ma}) and 17.69 in Matured River Catfish (RCF_{ma}). Stearic acid was highest in Juvenile pond Catfish (PCF_{ju}) with a value of 20.99%. Palmitic acid (C16:0) was the dominant saturated fatty acids in the juvenile fishes with a value ofs 28.83% in Juvenile River Catfish (RCF_{ju}) and 23.73% in Juvenile pond Catfish (PCF_{ju}) while pentadeconoic acids was the dominant saturated fatty acids in the matured fishes with a value of 14.46% in Matured River Catfish (RCF_{ma}) and 23.37 in Matured pond Catfish (PCF_{ma}). Linoleic acids is dominant in the fish samples from the wild with a value of 11.98% in Juvenile River Catfish (RCF_{ju}) and 11.65% in Matured River Catfish(RCF_{ma}). All samples had low amount of myristic acids as seen in Fig. 3 (Table 2).

DISCUSSION

Proximate parameters (protein, carbohydrate, lipids ash and moisture) are basic components of metabolic activities that have to do with supply of energy that is used to drive the major physiological processes (Walker *et al.*, 2001). A comparative study of Proximate Composition Of Wild And Farm-Raised Catfish showed no significant difference (p>0.05). However, coefficient of variation of 22% for total lipid indicated that there was a large disparity in total lipid content between wild and farm-raised Catfish and this was also reflected in the percentage moisture content.

Moisture content of the Wild And Farm-Raised catfish recorded in this study is in accordance with previously reported range in other fishes (Gallagher *et al.*, 1991). The highest moisture content was recorded in juvenile River Cat Fish (RCF_{ju}) and the lowest was

Table 3a: Essential Amino acids composition of wild and farmed catfish

		Lys	His	Thr	Val	Met	Ile	Leu	Tyr	Phe
WILD	RCF_{ju}	7.54	2.16	3.91	4.89	2.71	4.08	7.08	3.22	1.06
	RCF_{ma}	7.71	2.23	4.00	5.08	2.94	4.49	7.60	3.38	4.48
Farm	PCF_{ju}	7.01	1.89	3.33	4.24	2.40	3.77	5.60	3.22	3.89
raised	PCF_{ma}	8.49	2.51	4.63	5.99	3.15	4.96	7.26	4.03	5.07
	CV (%)	4.74	8.17	9.17	8.73	9.68	8.35	7.01	2.67	5.04
	$LSD_{0.05}$	2.37	0.99	0.73	1.53	1.60	2.00	2.77	1.31	5.76

RCF_{ju}: Juvenile river catfish PCF_{ju}: Juvenile pond catfish
RCF_{ma}: Matured river catfish PCF_{ma}: Matured pond catfish

Table 3b: Non essential Amino acids composition of wild and farmed catfish

		Arg	Asp	Ser	Glu	Pro	Gly	Ala	Cys
WILD	RCF_{ju}	6.47	9.20	4.51	13.93	5.84	7.83	6.10	0.80
	RCF_{ma}	6.72	9.84	4.86	14.30	6.00	8.04	6.49	0.80
Farm	PCF_{ju}	6.30	8.70	4.00	13.11	5.10	7.10	6.51	0.66
raised	PCF_{ma}	7.32	10.50	5.02	15.04	6.48	8.51	8.10	0.90
	CV (%)	3.15	5.98	9.41	4.32	8.20	6.27	7.45	10.23

RCF_{ju}: Juvenile river catfish PCF_{ju}: Juvenile pond catfish
RCF_{ma}: Matured river catfish PCF_{ma}: Matured pond catfish

recorded in matured pond Cat Fish (PCF_{ma}). This could be attributed to the fact that moisture and lipid contents in fish fillets are inversely related and their sum is approximately 80% (FAO, 1999). The Mean moisture content of all fish sample was slightly lower than that recorded in previous studies. Osibona (2009) reported moisture content of 76.71% and Olagunju *et al.* (2012) reported a value of 74.9%. The difference could be attributed to the geographical area in which the fishes were caught. However, Pearson and Cox (1976) reported that moisture content is very high in most fish species and ranged between 60-80%. Coefficient of variation was 6.89% and this suggests that environment did not seem to influence moisture content of all samples.

Crude protein values recorded in this study was slightly lower than that reported by Pearson and Cox (1976), Zelibe (1989) and Osibona (2009) who reported 15-26%,15-20 and 19.64%, respectively for *C.gariepinus*. The difference in Crude protein values may be attributed to the geographical area in which the fish were caught. Matured River Cat Fish (RCF_{ma}) had the highest value of crude protein, This relative high tissue protein content of the fish may be related to the high protein contents of their common diets which were mostly fish items, crustaceans, molluscs, algae and diatoms (Osibona, 2005), it could also be due to their age. Therefore, *C. gariepinus* may therefore be an ideal source of animal protein. Coefficient of variation was 2.56% suggests that environment did not seem to influence protein content of all samples.

Lipid content observed in this study was not different from those obtained from previous studies. *C. gariepinus* belongs to low oil category of fish. It is considered to be a lean fish, because the total lipid content is below 5% (Ackman, 1989). The lipid content also falls within the range previously detected in catfish (Mendez *et al.*, 1996). The low concentrations of lipid in the muscles of this species could be due to poor storage mechanism and the use of fat reserves (Ssali, 1988). However, it was observed that farmed catfish build up fat more than protein and it is the contrary for those obtained in the wild. Lipid has been observed to vary between individuals of the same species (Ssali, 1988), these variations could be attributed to factors such as the geographical area in which the fish were caught, age, sex and size.

The observed range of ash content indicated that *C.gariepinus* is a good source of minerals such as Iron, zinc and Copper. Ash content in this study is similar to that reported by Osibona (2005). The highest ash content for the four fish samples was recorded in matured River Cat Fish (RCF_{ma}). This could be as a result of either the level of exposure in its environment over the years or the available diet in its regions. Ahlgren *et al.* (1996) had also made similar. Ash content varied significantly with increase in weight and length. This observation was supported by the findings of Muhammad *et al.* (2010) who reported that total lipid and ash contents of fish vary significantly with gradual increase in the weight and length of the fish. Nitrogen Free Extract(NFE) is a representation of the carbohydrate content of the fish sample. Nitrogen Free Extract was higher in matured fishes than juvenile fishes.

Fatty acids composition of *C.gariepinus* indicated seven major fatty acids, similar studies performed on tropical (Clement and Lovell, 1994) and temperate (Ahlgren *et al.*, 1996) freshwater fishes showed the dominance of these fatty acids in the tissue of fish. Several authors (Turner *et al.*, 1990) have concluded that fatty acid profiles in fish reflect the diets of the animals. Although no significant differences ($p>0.05$) in mean readings for both wild and farm raised catfish was observed using a student t test, individual fatty acid composition differed in each fish sample. For instance stearic acid was 20.99% in juvenile pond Cat Fish (PCF_{ju}) but was less than 2%

in all other samples. High amount of stearic acid in juvenile pond Cat Fish (PCF_{ju}) reflects a resultant low amount of oleic acid, because stearic acid is a precursor of Oleic acid, (George, 1995).

Palmitic acid (C16:0) which is known to increase blood cholesterol was the dominant saturated fatty acids in in the juvenile fishes.This is similar to the report of Ackman (1989) who observed that palmitic acid (C16:0) was a key metabolite in fish. while pentadeconoic acids was the dominant saturated Fatty acids in the matured fishes. Linoleic acids a polyunsaturated fatty acid which cannot be synthesized by humans was dominant in the fish samples from the wild while all samples had low amount of myristic acids. Myrisitic acid is commonly found in plant oil, dietary fat and marine animals.

It is evident from this study that the juvenile fishes have a high amount of saturated fatty acids than unsaturated fatty acids Cholesterol was not detected in all fish samples except in RCFma which had a value of 11.89%.This could be attributed to the age of the fish.

Nine essential amino acids namely; lysine, leucine, valine, isoleucine, threonine, phenylalanine, methionine, tryptophan and histidine that are very important for human body were present in *C.gariepinus*. The amino acids are present in the order as shown. Glutamic acid>Aspartic acid>Glycine>Lysine>Leucine>Arginine> Alanine>Proline>Valine>Serine>soleucine>Threonine> Phenylalanine>Tyrosine>Methionine>Histidine>Cystei ne. The dominance of glutamic acid as a major amino acid reported in this study is similar to previous reports on amino acids made by Ogata *et al*. (1983) and Wilson and Poe (1985). Histidine and cysteine had the least amount and the implications of these two amino acid cannot be ignored since low amount of the former can lead to chemical sensitivity and even cause food allergy while that of the former can aggrevate rheumatoid arthritis, anaemia and imbalance of intestinal bacterial flora.

Catfish obtained from the pond have a higher amount of total amino acids than that obtained from the wild. Coefficient of variation for all he amino acids determined were not more than 10% except in Phenylalanine. This indicated that amino acid s composition was not affected by the environment, although Farm-raised catfish had a higher amount of amino acids than that obtained from the wild. However, juvenile River Catfish (RCF_{ju}) had the lowest amount of phenylalanine.

Conclusion: Age (size) and location of capture WAS observed to play a vital role in selecting catfish for consumption. In this study, there are no significant differences in the moisture, protein and ash content. However, total lipid content was related to size and age.Matured fishes had a higher amount of unsaturated fatty acids than the juvenile fishes. Also, linoleic acid which cannot be synthesized by humans were found to be in high amount in fish samples from the wild. Farmed-raised catfish had a higher amount of total amino acids. This can be related to feed formulation and modification.

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