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Fatty Acid Analysis of Oil Extract from African Catfish (*Clarias gariepinus*) and Trunkfish (*Mormyrus rume*)

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Abstract

This study investigates the fatty acid composition of the two commonly consumed freshwater fishes: African catfish (Clarias gariepinus) and Trunkfish (Mormyrus rume) from the Komadugu River at Gashua, Yobe State, Nigeria. Table-sized fish samples of each of the two species were bought from different landing sites and transported in cool boxes to the Federal University Gashua for laboratory analysis. Oil extraction and fatty acids analysis were carried out using standard methods for gas chromatography. The fatty acid profiles include saturated fatty acids (SFAs), monounsaturated fatty acids (MUFA), and polyunsaturated fatty acids (PUFA). The results elucidated that M. rume had the highest oil yield of 84.73 % per 100g, which is slightly higher than the fillets of C. gariepinus (35.65 % per 100g). SFAs varied from 1.21 – 22.06%, MUFA (C18:1) was detected only in M. rume with a concentration of 0.30% and PUFA varied from 61.17% in M. rume to 68.57% in C. gariepinus. The major SFAs were palmitic (C16:0) and myristic (C14:0) acids. The two species have high-quality essential fatty acids that are of benefit in human nutrition and health. M. rume had a Monounsaturated fatty acid and the highest oil yield than C. gariepinus, while the ratio of PUFA/SFA was 1.37 for M. rume and 2.29 for C. gariepinus, which are higher than the value 0.45 recommended by the Department of Health and Social Security, United Kingdom. This is an indication that the oils from both species of fish have the potential to not raise the cholesterol level when consumed.

Keywords: Claridae, Mormyridae, Aquaculture, By-Products, Fatty Acids, Fish Oil Extract.

Introduction

The Nigerian fisheries and aquaculture sector contribute 3.24% direct employment opportunities to over 500,000 people and supporting over two million people indirectly

(Anandganesh, et al., 2016). The reported value of fish exports from Nigerian as per the year 2013 is approximately 6.29 billion (Food and Agriculture Organisation [FAO], 2016). Total fisheries production in the year 2022 was estimated at 1.1 million tonnes to which inland waters contributed 36%, aquaculture 28% while marine 36% (FAO, 2025).

However, according to FAO (2024), in 2022, global aquaculture production rose to 130.9 million tonnes, valued at USD 312.8 billion, Inland aquaculture contributed 62.6 % of farmed aquatic animals while marine and coastal aquaculture contributed 37.4 % making aquaculture to surpass capture fisheries in aquatic animal production. Globally an estimated 61.8 million people were employed in the primary production sector, mostly in small-scale operations; of the total aquatic animal production, 89% was used for human consumption, equivalent to an estimated 20.7 kg per capita in 2022. The rest 11% went on non-food uses which are mostly fishmeal and fish oil.

The huge industry of fish processing accommodates diverse production processes which include filleting, curing, salting, smoking and canning. These processes generate huge amount of solid waste and by-product which often represent more than 50% of the total fish weight (Shahidi, 2006). Some of the solid waste and by-products of fish can be a valuable source for extraction of health promoting fish oil which is rich in polyunsaturated fatty acids (PUFA), especially omega-3 (n-3) fatty acids (Chow, 2018). The amount of oil extracted usually depends on several factors that include the fish species, size of the fish, body part from which the oil is extracted, natural diet of the fish or the fish feed composition, and occasionally the geographical location of the fish (Maqsood et al., 2012;). Approximately 2-25% of the fish body weight is fat, 15-30% is protein and the remaining 50-80% is water (Deepika et al., 2020).

African catfish (*Clarias gariepinus*) and Trunkfish (*Mormyrus rume*) are among the major freshwater fish species captured and cultured in Nigeria. Ramakrishnan et al. (2013) reported that about 50% of fish body weight is usually wasted during and after fish processing with specific discards being trimmings (gut, fins, tails) and skin. Therefore, there is need for exploring the potential of value addition avenues for freshwater fish products and by-products through oil extraction. This study focused on extraction of fish oil, assessment of the quantity and analysis of its fatty acids, as well as comparison between oil extracts from the two freshwater fish species: *C. gariepinus* and *M. rume* that are of commercial importance in Nigeria.

Materials and Methods

Description of the Study Area

The research was conducted in Federal University Gashua in collaboration with Yobe State university Chemistry Laboratory, Yobe State, Nigeria. Gashua is located between latitudes $12^{0}52'$-$12^{0}87'$N and longitudes $11^{o}12'$-$11^{0}71'$E. The area falls within the Sahelian region of West Africa. The ambient temperature varies from 23-28^{0}C in December - January and reaches up to 38 - 43^{0}C April - June. The mean relative humidity from 30 - 35% with minimum in February - April and maximum of about 70% in August (NIPOST, 2009).

Fish Sample Collection

Two samples of mature table size of each of the two species (*C. gariepinus* and *M. rume)* were randomly obtained from Fishermen at different landing sites of River Komadugu at Gashua. A total of five per fish species and 10 for both fish species were transported in cool boxes to Federal University Gashua for laboratory analysis in collaboration with the Chemistry laboratory of Department of Chemistry, Faculty of Science, Yobe State University, Damaturu where Gas Chromatography was carried out.

Processing of Fish Samples

Standard methods of the Association of Official Analytical Chemists (AOAC, 1994) were used in processing the fish samples. The fresh fish samples were washed and dried. The samples were separated into different anatomical fractions head, bones and flesh and processed. The flesh samples were oven dried at 105°C. A 220g of the dried samples were milled into homogenous powder. The powdered dried fish sample were stored in airtight container at room temperature. The powdered sample were later used for analyses.

Fish Oil Extraction and Yield Determination

Every oil extract from fish sample were weighed using Sartorius weighing balance model: ED4202S. The fish samples were thoroughly washed in running tap water. The visible fat deposits were removed and weighed. The samples were minced (for homogeneity) using a generic meat mincer No. 12. and oil extraction from a weighed sample were done following the standard method (A.O.A.C 1990). The oil of processed fish samples was stored in cool container at room temperature. The oil extracts were later used for fatty acids profile analyses.

Fatty Acid Profile Analysis

Exactly 1ml of oil sample was dissolved in 50ml of chloroform and transferred to a looml volumetric flask. After which 1ml of Hilditch reagent was added and the reaction mixture was then sealed and placed in a water bath for 30 minutes at 40°C. This was followed by extracting 1ml from the reaction mixture, and was then mixed with 1ml of hexane and 1ml of water. The mixture was shaken vigorously for 2 minutes. When a stable emulsion was formed it was then centrifuge at 4000 rpm for 10 minutes at 25°C. Half of the top hexane phase was transferred to a small test tube for injection into gas chromatographic chamber for analyses. Fatty acid analyses were carried out using the Association of Official Analytical Chemist method (A.O.A.C, 1990). Fatty acids of the fishes were analysed and results obtained were expressed as the percentage of each fatty acid with respect to the total fatty acids' weights.

Data Analysis

Independent t-test was used to compare the percentage oil yield of the two fish species. All statistics were performed using SPSS 22 version 1 for Windows. Ratio of PUFA/SFA for

every fish species was determined using the formula: Ratio of PUFA/SFA = ΣPUFA/ΣSFA.

Results

The percentage oil yield of the two different species of *C. gariepinus* and *M. rume* is presented in Table 1. *M. rume* had the highest oil yield of 84.73± 0.03%/100g which is higher than the fillets of *C. gariepinus* (35.65 ± 3.42 %/100g).

Table 1: Percentage Oil Yield of Oil Extracts from *Clarias gariepinus* and *Mormyrus rume*

Fish	Percentage Oil Yield per 100g	p-value
Mormyrus rume	84.73 ± 0.05	0.00
Clarias gariepinus	35.65 ± 0.08	

Table 2 revealed that six fatty acid methyl ester mixtures were identified in oil extracted from *C. gariepinus*. A polyunsaturated fatty acid (C18:2 Linoleic Acid) was recorded. Linolenic Acid had the highest concentration (16.36 %) among the saturated fatty acids while arachidic acid had the lowest (1.21%).

Table 2: Fatty Acid Profile of *Clarias gariepinus* Oil Extract

Fatty acids	Concentrations (%)
Saturated fatty acids	
C12:0 (lauric acid)	5.06
C14:0 (myristic acid)	16.36
C17:0 (Heptadecenoic acid)	1.37
C18:0 (stearic acid)	5.96
C20:0 (Arachidic acid)	1.21
Polyunsaturated acids	
C18:2 (linoleic acids)	68.57

The results of the fatty acid profile of *M. rume* oil were presented in Table 3. Six fatty acids were detected out of which two were unsaturated (Oleic Acid and Linoleic acid).

Table 3: Fatty Acid Profile of *Mormyrus rume* Oil Extract

Fatty acids	Concentrations (%)
Saturated fatty acid	
C12:0 (lauric acid)	12.65
C14:0 (myristic acid)	7.78
C16:0 (palmitic acid)	22.06
C18:0 (stearic acid)	2.08
Monounsaturated fatty acids	
C18:1 (oleic acid)	0.03
Polyunsaturated fatty acids	
C18:2 (linoleic acids)	61.17

Discussion

The oil yield of *M. rume* was higher than that of *C. gariepinus.* This might be probably one of the reasons *M. rume* became more rancid and spoiled faster than *C. gariepinus.* There are variations in fatty acids compositions of these two fish species studied. These individual differences may be explained by the nutritional status of each species (Deepika et al., 2020). Dominant fatty acids in oils extract from the studied fishes were mostly saturated (C12:0, C14:0, C16:0, C17:0, and 18:0) and one each monounsaturated (C18:1) and polysaturated (C18:2). This was in agreement with the findings of many studies on similar fish species (Ugoala et al., 2009; Osibona, 2011; Okey, 2022). The high proportion of saturated fatty acids observed could be due to low iodine value in the fish oils. Fatty acids (16:0; 18:0; 16:1; 18:1) are preferred substrates for mitochondrial ß-oxidation and heavily catabolized via the TCA cycle to generate metabolic energy in fish. Similarly, Okonji et al., (2015) identified six fatty acids from wild catfish from Ikpoba River, Benin-city, Edo state, Nigeria.

The most abundant saturated fatty acids were palmitic, myristic and stearic acids as obtained by Ugoala et al. (2009) and Osibona et al. (2011) for African fishes. Monounsaturated fatty acid (C18:1) was detected in *M. rume* only in this study. Similar findings were reported by Ugoala et al., (2009) who did not detect monounsaturated fatty acids in both *C. gariepinus* and *M. rume* in their studies on constituent fatty acids of some freshwater fish species in Nigeria.

Polyunsaturated fatty acids (C18:2) was detected in both the two species studied. This agrees with the findings of Okey (2022) and Ugoala et al. (2009) who obtained similar results. However, the concentrations were higher in this study. Polyunsaturated fatty acids have a lot of health benefit. Also, the high percentage of unsaturated fatty acid could be attributed to their natural habitat as organisms synthesize or accumulate polyunsaturated fatty acids to ensure membrane fluidity at reduced temperatures.

According to the Department of Health and Social Security, United Kingdom (1984), food with polyunsaturated and saturated fatty acids ratio of PUFA/SFA below 0.45 have been considered to be undesirable as such food has the potential to raise blood cholesterol levels. In this study, the ratios of PUFA/SFA were 1.37 and 2.29 for *M. rume* and *C. gariepinus* respectively and are higher than the value 0.45 recommended. This corroborates the findings of Chigbo et al. (2018) who reported PUFA/SFA ratio of 2.20 for *C. gariepinus*

Conclusion

The two species had high quality essential fatty acids. *Mormyrus rume* had a Monounsaturated fatty acid and highest oil yield than *Clarias gariepinus* while the ratio of PUFA/SFA was 1.37 for *M. rume* and 2.29 for *C. gariepinus* which are higher than the value 0.45 by Department of Health and Social Security, United Kingdom recommended. This is an indication that the oils from both species of fishes have the potential of not raising the cholesterol level when consumed.

Recommendation

The solid wastes and by-products of freshwater fishes particularly *Clarias gariepinus* and *Mormyrus rume* could be explored for oil extraction as additional value addition avenue in the processing industries.

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