COMPARATIVE STUDY OF FATTY ACID CHARACTERISATION OF CAGE CULTURED AND CAPTURED CATFISH (*Clarias gariepinus*) IN BRACKISH WATER

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In furtherance to the on-going studies on what is responsible for the fatty acid composition of the most widely cultured fish (*Clarias gariepinus*) in Nigeria, this work see to evaluate the comparative study of the cage cultured and captured catfish in brackish water of Ibeju-lekki area of Lagos State. Nigeria.

Lipids in the muscles of the cultured and wild catfish were extracted using the Bligh & Dyer method of lipid extraction. Extracted lipids were then analyzed by gas chromatography to determine the composition and relative abundance of the fatty acids present.

The percentage of total saturated fatty acids (SFA) was higher in the muscles of the cage cultured catfish (33.19%) than in the muscles of the wild catfish (22.86%). The percentage of total mono unsaturated fatty acids (MUFA) was however higher in the muscle of wild catfish (73.62%) than in the muscle of the cage cultured catfish (51.47%). The poly unsaturated fatty acids (PUFA) were 15.35% and 3.54% in the cage cultured and wild catfish respectively. The cultured African catfish also had more omega-3 (PUFA) than the wild ones (10.32% to 1.41% respectively). The cage cultured specie contain essential fatty acids particularly eicosapentaenoic acids and docosahexaenoic acids for promoting good health and prevention of cardio-vascular diseases in humans. This shows that cultured catfish can compete well with counterparts from the wild which refutes otherwise reports that says cultured catfish has bad fats.

Key words: Comparative study, fatty acids, cage cultured, captured, *Clarias gariepinus* and brackish water.

INTRODUCTION

BACKGROUND INFORMATION OF THE STUDY

Fish is an important food for 400 million Africans, contributing essential protein, minerals and micronutrients to their diet. Despite the high dependence on fish as a source of animal protein, fish consumption in Sub–Sahara Africa is the world's lowest with an estimated consumption of an additional 1.6 million tons of fish yearly (Adeyeye, 2009).

Fish and meat are the chief sources of animal protein in the diets of many communities in Nigeria. In fact, fish is fast becoming the major source of animal protein due to the stability and lower cost compared to meat. Demand for fish is increasing due to a high population growth rate (Adeyeye, 2009). Demand for fish products was reported to have doubled as other animal protein sources are becoming more costly due to pressure on demand by the ever increasing population (Ojo and Fagbenro, 2004). Fish being a cheap and most affordable animal protein to the common man provides up to 40% of animal protein consumed by an average Nigerian (Fagbenro *et al.,* 2004). Nigerians have had to shift to the consumptions of fish which is mostly in fresh and frozen forms.

Fish products are similar to meat and dairy products in nutritional quality, depending on the methods used in preservation or preparation (FAO, 2013). The protein content of fish ranged from 15 to 20% (FAO, 2013), also containing high amounts of the essential amino acids, particularly lysine in which cereals are relatively poor. Therefore fish protein can be used to complement amino acid pattern and raise the overall protein quality of a mixed diet. Moreover, the sensory properties of an otherwise bland diet can be improved through fish products, thus facilitating and contributing to greater consumption (FAO, 2013). In addition, sea foods are a rich source of high-quality proteins, vitamins, mineral elements and the only significant source in the human diet of ω-3 polyunsaturated fatty acids (PUFA) that play beneficial and protective role against cardiovascular, chronic and inflammatory diseases (Khawaja et al., 2014).

Fish is one of the most important animal protein and other vital nutrients' sources that are widely consumed by all races and classes of people (Abolude and Abdullahi, 2005). Fish muscle contains significantly low lipids and high water quantities compared to that of beef or chicken and is favored over other white or red meats (Nestel, 2000). Lipids from fish are well known as a rich source of long-chain n-3 polyunsaturated fatty acids (LC n-3 PUFA) such as eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) which cannot be synthesized by humans and commonly obtained from the diet (Alasalvar *et al.,* 2002). Fatty acid consists of a hydrocarbon chain (CH_2) with a carboxyl group (COOH) at one end and a methyl group at the other. Fatty acids are classified as saturated or unsaturated depending on presence or absence of double bonds and consequently, number of hydrogen atoms present (Khawaja *et al.,* 2014). Saturated fatty acids have the maximum number of hydrogen atoms and therefore no double bond, while polyunsaturated fatty acids contain two or more double bonds. The polyunsaturated fatty acids are termed as Omega 3 and omega 6 fatty acids (abbreviated as ω-3 and ω-6 or n-3and n-6), depending on the position of first double bond in the hydrocarbon chain, and are required for human nutritional benefits (Osman *et al.,* 2001).

In Nigeria catfish of the family Clariidae have adapted to nearly all parts of the country, with steady rise in its culturing in recent years. This has resulted in the growth of agriculture in the country (Oresegun *et al.,* 2007). This is largely due to the environment friendly nature of these species coupled with its resistance to adverse conditions (Osibona *et al.,* 2006). Catfish is one of the major fisheries commodities in Africa, Asia, Europe and the Americas, and its production is on the increase every year.

The body can synthesize most of the fats it needs from the diet. However, two essential fatty acids, linoleic and linoleic acid cannot be synthesized in the body and must be obtained from food. These basic fats, found in plant foods, are used to build specialized fats called omega-3 and omega-6 fatty acids. Omega-3 and omega-6 fatty acids are important in the normal functioning of all tissues in the body.

Deficiencies in these fatty acids lead to a host of symptoms and disorders including abnormalities in the liver and the kidneys, reduced growth rates, decreased immune function, depression, and dryness of the skin. Adequate intake of the essential fatty acids results in numerous health benefits. Documented benefits include prevention of atherosclerosis, reduced incidence of heart disease, stroke and relief from the symptoms associated with ulcerative colitis, menstrual pain and joint pain. Omega-3 fatty acid levels have also been associated with decreased breast cancer risks. In an ecological study conducted, fish consumption was associated with a reduced risk from all ischemic heart disease and stroke mortality across 36 countries (Zhang *et al.,* 2002). Polyunsaturated fatty acids from fish have been reported to have preventive and/or curative effects for several diseases including arterial hypertension, cancers and inflammatory diseases (Turkmen *et al.,* 2005). It may also aid in lowering the risk of Dementia, Alzheimer's diseases (Grant 1997), and prevent the cardiovascular diseases (Cahu *et al.,* 2004).

PROBLEM STATEMENTS

There is an inter and intra species variability in the composition of fatty acids of fish lipids (and of the specific polyunsaturated fatty acids in particular). This could be explained by the existence of a large number of external and internal factors. The external factors are environment, culturing method, and tropic effects. The internal factors include fish species, feeding regime and digestion, life cycle stage, quantitative and qualitative characteristics of lipids- triacyglycerols, phospholipids and their topographical origin- dorsal and ventral part of muscle tissue (Buchtova *et al.,* 2004).

Environmental factors including salinity, natural food and temperature have been shown to influence the fatty acid composition of fish (Ibarz *et al.,* 2005). There are a number of experiments conducted to demonstrate the effects of other factors such as temperature, seasonal variation, age and species type on the fatty acid composition of aquatic animals especially fish (Rasoarahona, *et al.,* 2004). The differences in nutritional composition of various fish species can only be known through appropriate analytical procedures on the fish samples. Some fishes are higher in n-3 and n-6 polyunsaturated fatty acids depending on their sources and type of food consumed. Fishes that feed on natural foods i.e. natural fish food are believed to be high in these n- 3 and n-6 fatty acids. It is of considerable interest for the farming industry and consumers to be aware of the compositional and nutritive differences between farmed and wild fish. Whether the diet is natural or compounded the fatty acid composition of fish muscle is clearly influenced

by their diet (Justi *et al.*, 2003) - thus the content of the diet provided will influence the lipid composition in fish.

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 in demand between wild caught and farm raised catfish and the reasons for this divergence are mainly due to tastes and safety (Justi et al., 2003).

Some recent reports says catfish especially the cultured ones have bad fat (Anisulowo, 2012) therefore leaving farmers, dietitians, consumers and the general populace confused as to what or not to believe

JUSTIFICATION

Moreover, information of the fatty acid content and amino acid profiles of fish is important in determining the suitability of fish oils for processing and the suitability of fishmeal as protein supplement in animal feeds. In addition, such information will be useful to dieticians who may need to prescribe diets for people who are health conscious and those with certain medical conditions who may need to restrict their fat intake to polyunsaturated fatty acids (Ssali, 1988). Stansby (1982) cited by Vlieg *et al.* (1983) reported that the relationship between the type of fat ingested and, arteriosclerosis coupled with the need for controls of obesity have made the knowledge of proximate composition of fish in high demand. Many heart specialists recommend that their patients use generous quantities of fish in their diets, both as a means of avoiding excessive consumption of saturated fatty acids and as a means of obtaining adequate protein in their diet without taking in excess fat. Therefore, this study focuses on the comparative analysis of the fatty acid of captured and cage cultured catfish (*Clarias gariepinus*) in brackish water and in Lagos, Nigeria.

Fish is a key ingredient on the global menu, it is a vital factor in the global environmental balance and an important basis for livelihood worldwide (UNICEF, 2006). Haruna (2003) and World Fish Center (2005), posited that fish is an indispensable source of micronutrients. These important nutrients can be supplied by fish because they contain very light connective tissue (Eyo, 2001). Fatty acid may be found in scarce amount in free form, but in general they are combined in more complex molecule with ester or amide bonds. The isolation of free fatty acid from biological material is a complex task and precaution should be taken at all times to prevent or minimize the effects of low level unsaturated fatty acid and cholesterol. The health benefits of fatty acids cannot be overemphasized because they act as the basic nutrients in the daily physiological operations in humans.

The essence of this research work is to analyze the differing composition of these fatty acids in captured and cage cultured catfish (*Clarias gariepinus*) and to ascertain the suitability of these variations in the diet of the target populace. Lastly, to give a confirmed information for proper guidance of the general populace

This project will in no small measure add to the existing knowledge and work done by other authors in this area of comparative proximate composition of captured and cultured fishes.

OBJECTIVES

To determine the fatty acid composition in cage cultured catfish

To determine the fatty acid composition in captured catfish

To evaluate comparatively the fatty acids of cage cultured and captured catfish

METHODOLOGY

DESCRIPTION OF STUDY AREA

The samples were collected from two different locations in Epe and Ise fishing communities in Epe and Ibeju Lekki Local Government areas of Lagos State respectively. The sample from Epe fishing community was from the wild while the sample from Ise fishing community was from cage culture. The samples were then conveyed in polythene bags to the laboratory for analysis.

The geographic location of the sampling location of Epe and Ise was captured using Global Positioning System (GPS). Epe lies between 6°27′18″N 3°23′03″E/6.455027°N 3.384082°E/6.455027; 3.384082 Coordinates while Ise lies between 6°27’ 2.977” and Latitude of 4°2’ 58.636 in Lagos State, Nigeria.

EXTRACTION OF OIL AND FATTY ACID ANALYSIS

Fresh African catfish (*Clarias gariepinus*) samples were collected from two different places (cage cultured catfish from Ise Brackish water and Wild catfish from the wild at Epe in Lagos State. The fish weighed 2.5kg, while the cultured fish weighed 500g. The fish were filleted separately and cut into pieces and crushed using mortar and pistol. 60ml of distilled water was added to 30ml of chloroform and 40ml of methanol mixed thoroughly for homogeneous mixture for 5 minutes. The solutions were added to 60.07g of the crushed fish in each case. The solution was filtered using funnel for the separation of filtrate from residue of fish particles. The filtrates were mixed with chloroform in a separating funnel for extraction of oil. The settled oil was decanted from the separation funnel into round bottom flasks. The extracts were placed in an oven for about 80^{o}C. The oil extracted, were later poured into the specimen bottle for fatty acid profile analysis. The Analysis was carried out using GCMS equipment at NIOMR central laboratory. The fatty acids were converted to their methyl ester and heptane. Internal examinations were employed for estimation of actual fatty acid, in the fat identification and quantification of fatty acids was carried out by gas chromatography (AOAC, 2012). The analyses were carried out by the Nigerian Institute for Oceanography and Marine Research (NIOMR) central laboratory.

The fishes were filleted and homogenized lipids were extracted from the homogenized edible portion of flesh by the standard AOAC (Bligh and dye method).The homogenizer is to get the total fat. Chloroform and methanol were used as solvent at ratio 2:1. 1g was methylated. After the methylation, the samples were taken to the Gas Chromatography. The fatty acid composition

of filleted *Clarias gariepinus* and caviar oils were determined by Gas chromatography (GC) technique. For the determination of fatty acid composition, the oil samples were converted to their corresponding methyl esters by methanol esterification Therefore, the oil samples were first hydrolyzed for 10min adding the specific amount of 0.5N methanol, chloroform and water and then fatty acid was methylated using Bf3-methanol reagent. The fatty acid methyl esters were quantified by gas chromatography method using a capillary column.

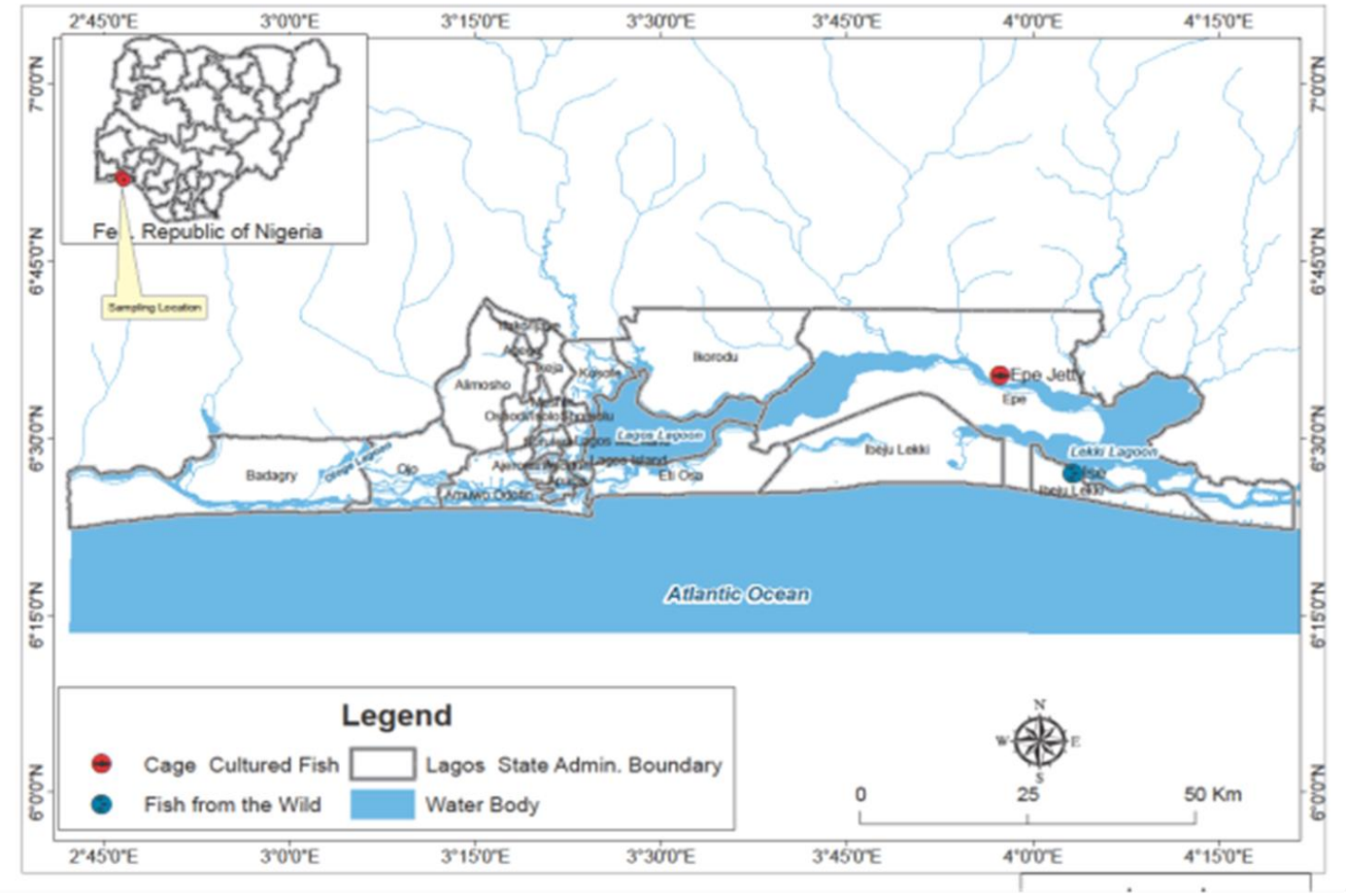

Figure 1: MAP SHOWING THE STUDY AREA

RESULT AND DISCUSSION

The fatty acid composition of *Clarias gariepinus* in fresh fillet shows a significant difference between that from the wild and that from cage culture. A total of 14 fatty acids were identified in the species from the wild while the cage cultured species had 17 fatty acids that were identified on measuring them against a 37- congener fatty acid methyl esters standard by means of a gas chromatography.

Fatty acid profiles from the result showed that stearic acid ($C_{18:0}$) was the predominant saturated fatty acid in the *C. gariepinus*. This is related with the results recorded by Ackman (1989) who observed that Stearic acid ($C_{18:0}$) was a key metabolite in fish which level was not influenced by diet. Cis-10-Heptadecanoic acid ($C_{15:1}$), the major monounsaturated fatty acid in this species, was considered to be of exogenous origin and usually a reflection of the type of fish diet (Ackman, 1989). The principal acids in the polyunsaturated group were linoleic ($C_{18:2}$), eicosapentaenoic ($C_{20:5}$, EPA) and docosahexaenoic ($C_{22:6}$, DHA).

The saturated fatty acids in this research work indicated values of Stearic acid 17.06 and 28.82, Palmitic acid 4.83 and 0.85, Pentadecanoic acid 0.35 and nill, Mysristic acid 0.62 and nill for wild and cultured *Clarias gariepinus* respectively.

The monounsaturated fatty acid, cis-10-Heptadecanoic acid ($C_{15:1}$) was most abundant by percentages in the species from the wild (57.98%) and (35.34%) for the cage cultured catfish. Stearic acid ($C_{18:0}$) was the saturated fatty acid (SFA) (Fig 2) with the highest percentage in both species with (17.05%) in species from the wild and (28.82%) in that from the cage culture.

Eicosapentaenoic acids (EPA), Linolenic acid were present in the species from the cage culture (4.76%, 1.63% and 2.36%) while it was unavailable in the species from the wild. Docosahexaenoic acid (DHA) was another very essential polyunsaturated fatty acid (PUFA) (Fig.2) that was present in both species but more in that from cage culture (3.20% and 1.41%) respectively.

By means of comparison, SFA (Fig.2) and PUFA (Fig.2) were more abundant in the species from the cage culture (33.22% and 16.19%) than that from the wild (22.48% and 4.94%) while MUFA (Fig.2) were more in the species from the wild (72.21%) than that from the cage culture (48.26%).

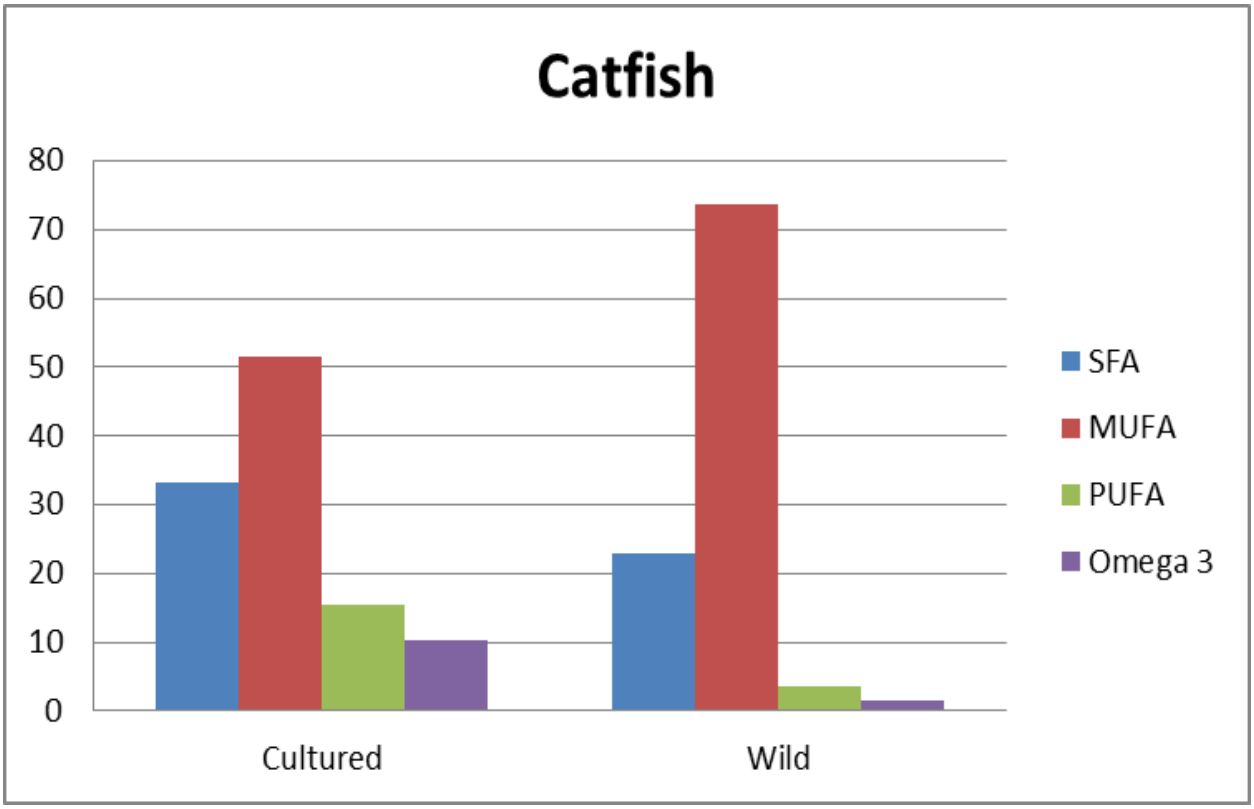

Figure 2: **Indicating the fatty acid profile of cage cultured and captured *Clarias gariepinus***

C. gariepinus is thus, a good source of high protein low-lipid contents as well as omega-3 polyunsaturated fatty acids, particularly EPA and DHA. The recommended daily intake of EPA and DHA is 1g/day (Barlow *et al.*, 1990). Reasonable amounts of the studied species fillets are needed to provide this dose. Sargent (1996) noted that n-3 polyunsaturated (PUFA), principally DHA, has a role in maintaining the structure and functional integrity of fish cells. In addition, DHA has a specific and important role in neural (brain and eyes) cell membranes. Moreover, DHA is considered a desirable property in fish for human nutrition and health.

Omega 3 fatty acid part of the estimated PUFA (Fig.2) above was more abundant in the species from the cage culture than that from the wild (10.32% and 2.81%) respectively thus negating Anisulowo, 2012 that says cultured catfish has bad fats.

In conclusion, Catfish especially the cultured ones are rich sources of good fats and its consumption is therefore encouraged to promote health.

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