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QUALITY EVALUATION OF OIL EXTRACTED FROM CATFISH AND MACKEREL AS COMPARED WITH COMMERCIAL COD LIVER OIL

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A B S T R A C T

This study evaluated the quality of oil extracted from catfish and mackerel in comparison with what obtains in commercial cod liver oil. Oil were extracted from two common fishes in Africa (Catfish and Meckerel) and analyzed for Proximate, Physical, Chemical and Mineral contents using standard methods. The fatty acid profiles were also determined with the use of Gas chromatography, while the sensory properties were determined through the use of a 10 man panel. Results revealed from the analysis conducted that there was no significant difference at $P< 0.05$ between the values of the oil extracted from Catfish, Meckerel and the commercial available Codliver oil in majority of the parameters determined. The rate of poverty in most part of Africa makes the diet taken inadequate in terms of nutrition, there is need to take in supplements in order to cater for the deficiencies in the diet. Since Codliver oil which is taken as a food supplements can still not be affordable by some, it is imperative to seek out alternatives. Therefore the oil from Catfish and Meckerel can be used as alternative to Codliver oil.

Keywords: Codliver oil, mackerel oil, catfish oil, fatty acid profile.

INTRODUCTION

Fish farming is the fastest-growing animal based food production sector, particularly in the developing countries – mainly from China and other Asian countries (Green facts, 2004). Africa produces only 1% of world aquaculture fish with Nigeria being the major producer, followed by Egypt, Uganda and Kenya (FAO, 2007).

Every year a considerable amount of total fish catch is discarded as processing leftovers and that include trimmings, fins, frames, head, skin and viscera. Some of the by products are utilized, but the main bulk is dumped as waste, creating both disposal and pollution problems. These wastes have high content of nutritive compounds like protein of high biological value, unsaturated essential fatty acids, vitamins and antioxidants, minerals or trace metals and physiological beneficial amino acids and peptides which is substrate of the fish meal production.

In Nigeria, the consumption of fish has been found to increase due to the nutritional values that can be obtained. Yearly, considerable amount of fish are consumed based on the fact that it is a good source of protein, vitamins and minerals (USDA, 2011).

Fish oil is derived from the tissues of oily fish, which contain the omega-3 fatty acids eicosapentaenoic acid (EPA), and docosahexaenoic acid (DHA), precursors of certain eicosanoids that are known to reduce inflammation throughout the body, (Moghadasian, 2008; Cleland *et al.,* 2006) and have other health benefits. Marine and freshwater fish oil varies in contents of arachidonic acid, EPA and DHA. L(Innis ,1995) The various species range from lean to fatty and their oil content in the tissues has been shown to vary from 0.7–15.5% (Innis, 1995). They also differ in their effects on organ lipids. Studies have revealed that there is no relation between total fish intake and estimated omega−3 fatty acid intake from all fish and serum omega−3 fatty acid concentrations. (Gruger *et al.,* 1964) Only fatty fish intake, particularly salmonid, and estimated EPA + DHA intake from fatty fish has been observed to be significantly associated with increase in serum EPA + DHA. (Gruger *et al.,* 1964). Fish oil supplements are available as liquids, capsules, and

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tablets. Research has shown that most of this fish contains oil which often have been used for conditions related to the heart and the blood system (Butcher *et al.,* 2002), it has been found to lower blood pressure or triglycerides level (Glavas, 2002). Fish oil has also been used for preventing heart disease and stroke when taken in the recommended amount (Hooper *et al.,* 2004).

While fish oil can be obtained from eating fish, it can also be gotten by taking fish supplements which are rich in omega-3 fatty acids and provide about 1 gram of omega-3 fatty acids which is about 3.5 ounces of fish (USDA, 2011). Presently, many Americans have turned to omega-3 fish oil supplements (Minis *et al*., 2006). Dietary fish and fish oil supplements have benefits for healthy people and also those with heart disease. Omega-3 fish oil contains both docosahexaenoic acid (DHA) and eicosapentaenoic acid (EPA) (Inga-Britt *et al*., 2004). Omega-3 fatty acids are very important in preventing and managing heart disease. (AHA, 2008; Turkmen *et al*., 2003; Nordov *et al*., 2001).

In Nigeria, fish supplements are sold in stores for those who can afford them but based on the poverty level of most Nigerians leaving in the rural settlement makes it impossible for them to afford the high cost of this oil supplements. It is important to find an alternative source of this nutrient at an affordable cost to low income earners. Therefore it is important to determine the physiochemical, minerals and fatty acid profile of two fishes which are regularly consumed and to compare the quality of the oil from this fishes with commercially sold fish oil. This will ascertain if oil consumed from the fish is adequate enough to maintain a good health.

MATERIALS AND METHODS

Different samples of the Cat fish (specie) and mackerel fish (specie) were bought from Oja Oba market in Osogbo, Osun State market. Commercial fish oil capsules were also purchased from pharmatical stores in Osogbo. The *fish* were identified by Dr. Adeleke of the department of biological science, Osun State University. All chemicals and reagents used were of HPLC grade (highest purity) and purchased from Darmstadt, Germany (Merck). The standard of fatty acids methyl esters were obtained from Sigma Chemical Co (St. Louis, MO, USA).

Material Preparation: The fishes were washed, drained and kept in the refrigerator at a temperature of 4^0C until needed.

Oil Extraction: According to standard method ISO 659 (1998), finely ground fish (about 5g) (particle size =2 mm), were used to obtain oil by Soxhlet extraction using n-hexane for 6 h. The rotary evaporator was used to remove solvent at 40 °C. The oil was dried by nitrogen streaming and stored at 20°C for further analysis.

Determination of Moisture Content: Moisture content of fish was determined by the method of (AOCS, 1993). Five grams of test portion was taken in dish container and dried in an oven at 130°C for 2h. Heated portion was allowed to cool in a desiccator to room temperature and loss of weight determined.

Determination of Protein Content: Kjeldahl digestion method (acid digestion and distillation) was used to determine total protein from seed residues as the nitrogen content of the sample multiplied by nitrogen factor. For the protein calculation nitrogen conversion factor (6.25) was used according to the official standard method (AOCS, 1993).

Determination of Crude Fiber: According to the AOCS official standard method (1993), fiber content was determined using 2.5g defatted fish. The meal residue for digestion was boiled with sulfuric acid solution (0.26 mol/L), followed by washing and separation of insoluble residue, after digestion the residue + sodium hydroxide (0.31mol/L), was boiled followed by washing and separation, with distilled water, and drying. The residue was dried, ashed at 600 °C in a muffle furnace and loss in mass was calculated.

Determination of Ash Content: Powdered fish samples about 0.5 g was ignited and incinerates at 550°C for about 12 h in muffle furnace, and then ash content determined according to standard method of (AOCS, 1993).

Determination of Carbohydrate Content: By the difference of mean values the content of carbohydrate was estimated, i.e. Carbohydrate content = 100 - [%Lipids + %Proteins + %Ash + %Moisture].

Physical evaluation of oil: Refractive index as well as Specific gravity was determined by the method of (AOCS, 1993.

Determination of Peroxide Value: Peroxide value defined as the milliequivlents of active oxygen per kilogram of oil (meq of O2 kg-1) expressed in the unit of milliequivalents, was determined, when potassium iodide reacted with a mixture of oil and chloroform/acetic acid in dark according to the method of (AOCS, 1993).

Determination of Saponification Value: It is the number of KOH required to saponify 1 gram of oil. Saponification value through hydrolysis of ester under alkaline condition was determined according to the method of (AOCS, 1993).

Determination of Iodine Value: The iodine value of oil was determined according to the method of (AOAC, 1997). In which the dissolved oil sample (CCl_4 used as solvent) was mixed with 25ml of Wijís (0.1mol/L) solution and reacted with freshly prepared (10%) potassium iodide solution. The standard potassium thiosulphate (0.1M) was used for titration with liberated iodine from solution. Starch was used as an indicator in this procedure.

Determination of Acid Value: Acid value used to measure the free acids (total amount) found in a given quantity of fat. Number of milligrams of KOH (potassium hydroxide) utilized to neutralizing the free acids found in one gram of the oil sample were determined by the method of (AOCS, 1993).

Determination of Fatty Acid Composition: Standard IUPAC method (Paquot, 1997) was used for the preparation of fatty acid methyl esters and analyze by gas chromatograph (model 8700) Perkin Elmer, fitted with a capillary column SP-2340 polar (60 m x 0.25 mm), and FID (flame ionization detector). As a carrier gas nitrogen (oxygen free) was used at a flow rate of 3.5 mL/min. Injector temperature: 260°C; detector temperature: 270°C, initial oven temperature: 130°C; and final temperature: 220°C with ramp rate: 4°C/min. A sample volume of 2.0 Ï L was injected. Fatty acid methyl esters quantification and identification was carried out by comparing the retention time of peak area with those of pure standards purchased from Sigma Chemical Co (St. Louis, MO, USA), under the same conditions. In lipid fraction the results were expressed as a percentage of individual fatty acids.

Determination of Metal Content: The sample solutions (diluted digest) were subsequently analyzed using Atomic Absorption Spectrophotometer (AAS) (Perkin-Ether model 3030).

Sensory Evaluation: A taste panel evaluation of oil samples was conducted using Cod liver oil as control and a trained panel of 10 members.

Samples were coded with 3-figure random number and presented in random order to each panellist at ambient room condition (25-30^{o}C).The judges were asked to score for colour, taste, flavour and acceptability using a 5-point hedonic scale, where 1 and 5 represent dislike extremely, respectively.

Data Analysis: The mean values (means ±SD) were calculated from replicates of each experiment. Significant differences among means were determined by the analysis of variance (ANOVA) and comparison between means ($P<0.05$) was carried out by statistical package Statistica 7.1 (StatSoft, Inc., Tulsa, OK, USA) software.

RESULT AND DISCUSSION

Table 1 shows the result of the proximate analysis carried out on the samples of mackerel and catfish, the fat content of mackerel (16.44%) was observed to be higher than of catfish (15.26%), there was no significant difference at ($p<0.05$) between the protein content of catfish (20.00%) with the protein content of the mackerel (19.19%). The data compares favourably in general with the data of Thurston *et al.,* 1959.

The ash content observed in catfish (2.13%) was higher than that observed in mackerel (1.44%) this difference which may be due to volume of minerals retained by the catfish. The value of moisture content of mackerel was 57.46% while that of catfish was (55.26%) this values are not significant difference. Catfish contain a higher proportion of carbohydrate than mackerel fish and this ranged from 7.27% for catfish to 5.47% for mackerel. Similar result was reported by Stansby, 1954.

Table 1. Proximate analysis composition.

Parametres	Fat	Protein	Ash	Moisture	Carbohydrate
Fish type	(%)	(%)	(%)	(%)	(%)
Cat fish	15.26±0.013^a	20.00±0.013^a	2.13±0.013^a	55.26±0.012^a	7.27±0.016^a
Mackerel	16.44±0.006^a	19.19±0.008^a	1.44±0.013^b	57.46±0.005^a	5.47±0.013^b

Values are means of for determinations ± S.D.

The values for the physical properties of each sample are recorded in Table 2. There was no significant difference in the values of the specific gravity of the three oil samples. The value of the refractive index of the three oil samples where significant not difference, this values ranges between 1.441 for Cod liver oil to 1.457 for Catfish oil. The Colour of the three oil samples were different, Cod liver oil was light yellow in colour, Catfish oil was Golden yellow

while that of Mackerel was dark brown. Same was reported by Ramakrishnan *et al*. (2013). The difference may be due to the fact that Cod liver was refined and mackerel fish was exposed to temperature above 40^0C or due to the formation of brown pigments from the reaction of carbonyls produced from oxidation of polyunsaturated fatty acids with amino acids and proteins. The saponification value of mackerel oil was the highest (233.93 mg/g) followed by cod liver oil (233.58 mg/g) while catfish oil has the least value (233.21 mg/g) (Table 3) the values are not significantly different at P< 0.05. Saponification value is the number of milligrams of potassium hydroxide required to neutralize the fatty acid resulting from the complete hydrolysis of 1g of the samples. Catfish oil having the least saponification value is less prone to rancidity.

Table 2. Physical properties.

Samples	Specific gravity@20^0c	Refractive index @20^0c	Colour
Codliver oil	0.851±0.006[a]	1.441±0.001[a]	Light yellow
Catfish oil	0.854±0.001[a]	1.457±0.001[a]	Golden yellow
Mackerel oil	0.853±0.001[a]	1.451±0.001[a]	Dark brown

Values are means of for determinations ± S.D.

Table 3. Chemical properties of the oil.

Samples	Saponification Value (mg/g)	Iodine value (g/100g)	Peroxide Value (meq)	Free Fatty Acid Value (mg/g)
Codliver oil	233.58±0.013[a]	85.95±0.006[a]	20.59±0.024[a]	1.0096±0.00[a]
Catfish oil	233.21±00.13[a]	84.33±0.008[a]	20.18±0.013[a]	1.063±0.00[a]
Mackerel oil	233.93±0.007[a]	85.80±0.03[a]	20.58±0.01[a]	1.122±0.00[a]

Values are means of for determinations ± S.D.

On the other hand, the iodine value of cod liver oil (85.95 g/100g) was the highest followed by mackerel oil (85.80 g/100g) while Cat fish oil has the least value (Table 3). The values are not significantly different at P< 0.05. The iodine value shows the number of iodine absorbed by 100g of the oil. The higher the iodine value, the higher the degree of un-saturation and the better the oil.

The peroxide value obtained from the oil samples ranged from 20.18meq/kg for the catfish oil to 20.5meg/kg for the cod liver oil. Cod liver oil has the highest value of peroxide (20.59meq/kg) followed by mackerel oil (20.58meq/kg) and catfish oil (20.18meq/kg), the lower the peroxide value, the lower the ability of the oil to go rancid. The free fatty acid (FFA) obtained from the analysis ranged from 1.0096 % for the Cod liver oil 1.122 % catfish oil (1.063%) and cod liver oil (1.0096%). FFA measures the extent the decomposition of lipase action and decomposition is accelerated by heat and light. The lower the FFA value, the better the oil as the lipase content of the oil is low. The FFA values for the three different oils were significantly not different at P< 0.05.

The mineral profile of fish oil samples are shown in table 4. Mackerel fish oil had the highest content of calcium (5.60 mg/100g) followed by Cod liver oil (5.50 mg/100g) while Catfish oil has a value of 3.79mg/100g. The calcium content may be useful in the formation of bone and teeth. The result revealed that, Cod liver oil as well as Mackerel fish is more suitable for people who have deficiencies in calcium.

Table 4. Mineral Profile (mg/g) of the oil sample.

	Catfish oil	Codliver oil	Mackerel oil
Calcium (mg/g)	3.97±0.01[b]	5.60±0.40[a]	5.50±0.30[a]
Potassium (mg/g)	269.91±0.24[a]	212.04±2.28[a]	265±0.22[a]
Iron (mg/g)	1.80±0.00[a]	1.20±0.01[b]	1.85±0.01[a]
Copper (mg/g)	1.09±0.04[a]	0.80±0.6[a]	0.83±0.05[a]
Phosphorus (mg/g)	220.00±2.60[a]	232.00±6.16[a]	235±6.20[a]
Zinc (mg/g)	0.80±0.00[a]	0.40±0.02[a]	0.91±0.01[a]

The potassium content of catfish (269.9 mg/100g) was the highest and the value was not significantly different from that of cod liver oil (265mg/100g) but significantly different from that of Mackerel fish (212.04mg/100g) at P< 0.05. Potassium is responsible for regulating of pH, osmolality and in cell membrane transfer.

The copper, Iron and Phosphorus content of the three oils were not significantly different at P< 0.05 (Table 4). Copper is found in all body tissue, larger amount in liver, brain, heart and the kidney while Iron is a component of haemoglobin and myoglobin this is important in oxygen transfer while phosphorus plays an important role in the energy changes of the body. The value of Zinc content of cod liver oil (0.91mg/100g) was significantly not different from that of Catfish oil (0.80mg/100g) but significantly different from that of Mackerel fish oil (0.40mg/100g). Zinc is present in most tissues with higher amount in liver, voluntary muscles and bone. It may be of importance in nucleic acid metabolism (Lyon, 1972).

From table 5, the total value of saturated fatty acid was significantly not different, but Catfish oil had the lowest value of 24.30%. Saturated fatty acid has little use in the body; the value obtained revealed the suitability of the oils from the two fishes when compared to value obtained for Cod liver oil.

There was no difference in the concentration of the total unsaturated fatty acid of the three different oils. Since unsaturated fatty acid are useful for the body, particularly in the ability to lower the level of undesired lipid component on the blood streams. The result revealed the suitability of the oil extracted from the two fishes in the lowering of undesired lipid component. Significant differences were observed in the values of Linoleic acid in Cod liver oil and oil extracted from the two fishes. Linoleic acids are designed essential fatty acids because their absence in human diet has been associate with health problem such as skin and stunted growth.

Table 5. Fatty acid profile (%).

	Codliver oil	Catfish oil	Mackerel oil
Myristic 14:0	4.23	1.30	3.78
Palmitic 16:0	9.17	18.90	15.94
Stearic 18:0	11.16	4.10	7.30
Oleic 18:1	34.98	52.90	53.20
Linoleic 18:2	30.28	17.10	13.78
Linolenic 18:3	2.80	0.80	1.99
Total saturated	24.56	24.30	27.02
Total Unsaturated	68.06	70.8	68.97

Table 6 show the Sensory score for analysis carried out on taste, colour, flavour and general acceptability. The scores obtained for cod liver oil were colour (7.4), taste (7.1), flavour (5.7), acceptability (7.4), the scores obtained for catfish were colour (7.2), taste (7.6), flavour (6.5), acceptability (6.3) while those for mackerel oil sample were colour (6.5),taste (5.1),flavour (6.3),acceptability (6.1).This result showed a little significant compared with the standard sample A. Catfish was preferred for its taste and flavour but cod liver was preferred in terms of colour and this may be due to the refining of the oil.

Table 6. Sensory evaluation.

Quality	A	B	C	Order of pref
Taste	7.1b	7.6a	5.1d	BAC
Colour	7.4a	7.2b	6.4c	ABC
Flavour	5.7b	6.5a	6.9a	CBA
Acceptability	7.4a	6.3b	6.1b	ABC

The oil samples were coded as follow.

Cod liver oil – A (Standard) Catfish oil –B Mackerel oil –C.

CONCLUSION

In conclusion, results obtained have shown that there was significant difference in the values obtained from the Cod liver oil and those of Catfish oil and mackerel oil in most of the parameters determined which shows that the oil from Catfish and mackerel because of its availability to the low income earners in Africa, it is easily affordable and can as well perform the roles of the oil of Cod liver oil in man and so can be used as a substitute to imported Cod liver oil.

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