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Proximate and Mineral Compositions of Mudskipper Fish (Periophthalmus Babarus) in the Mangrove Swamp of Calabar River, Southern Nigeria

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Abstract:
Proximate and mineral compositions of Periophthalmus babarus were carried out with standard methods. The fish samples were collected from Mangrove Swamp of Nsidung Beach, Calabar River, Nigeria. The results revealed the presence of Total protein ranging from 54.5 to 56%, Total fat 4.7 to 5.2%, Dry matter 89.69 to 90%, Crude fibre 1.11 to 1.16%, Ash content 17.77 to 18.02%, Moisture content 9.75 to 10.25%, Energy value 269 to 299% and Carbohydrate 1.12 to 2.28%. Minerals included Calcium (1.99 to 2.20 mg/kg), Phosphorus (0.85 to 0.89 mg/kg), Sodium (0.33 to 0.38 mg/kg), Manganese (0.19 to 0.22 mg/kg) and Potassium (0.19 to 0.22 mg/kg). The results showed that the most abundant macro element present in the fish samples was Calcium (Ca). Iron was the most abundant microelement ranging from 0.027 to 0.038mg/kg, followed by Magnesium ranging from 0.018 to 0.021 mg/kg, Copper ranging from 0.001 to 0.002 mg/kg and Zinc ranging from 0.0022 to 0.0025 mg/kg. The result shows that all heavy metals analysized were below acceptable limit. The result also shows that the most abundant vitamin present in the fish samples was Niacin. The study therefore, showed that this fish (Periophthalmus babarus) are good sources of minerals and some vitamin. It could be inferred that the mineral elemental levels of this species is a function of the availability preferential accumulation. However, it revealed from this study that, micro-nutrients were low, which could be due to the fact that the body needs of the fish are met and the concentrations in the water body is low. It therefore becomes necessary to consider the mineral status of the fish and the persistent food safety of the fish prior to consumption in addition to the prevailing choice for fish as a high protein source. This work has unveiled the importance of this fish as good sources of protein and some macro-nutrients. Since nutritional value of the fish examined are now known, consumers can now know what benefits to derive when these fish species are eaten.

Key words: *Proximate; Mineral; Composition; Mangrove; Periophthalmus babarus*

1. Introduction

Mudskippers are fishes that are adapted to survive on land. They are small and unique fishes often seen hopping across mudflats near mangrove swamps, rivers or estuaries along the coasts of the pacific, Atlantic and Indian Oceans (Murdy, 1989). They have burrows in the mud, but spend most of their time out of water skipping over the mud and crawling up mangrove roots to catch insects, worms, etc. when out of water; their gills get oxygen from air they trap in their mouth (Maxlan, *et al.*, 2005). The most distinguishing characteristics of mudskipper is the ability to move about on land. It is aided in this regard by highly modified pectoral, pelvic and anal fin. This enables the fish to pull itself along and even leap quite rapidly (Ali and Kiumars, 2010). Mudskipper is known for its high nutritional value. It is rich in protein and contains all the essential amino acid in the right proportions and it also contains a good selection of minerals (Tremblay, 2011). The giant mudskipper (*Periophthalmus schlosseri*) is also rich in fatty acid and contains omega (ω) 3 which has favourable effects in the cognitive development of children (Manal, 2009). Also, omega 3 present in *P.schlosseri* can reduce the risk of heart disease, high blood pressure and protect against cancer (Shahar *et al*., 1999). According to Jaafar and Larson (2008) *Periophthalmus babarus* belongs to the sub family *oxudercinae* within the family *Gobiidae (Gobies).* They constitute a group of 25 air breathing species in four genera (*Periophthalmadon, Periophthalmus, Bolephthalmus and Scartelaos).* The common species reported in Nigeria is *Periophthalmus babarus* (Jaafar and Larson, 2008). Mudskipper is economically important and actively fished by the local inhabitants of Oron in Akwa Ibom State which serves as a special delicacy and also used in traditional medicine for the cure of frequent urination by children. *P. babarus* are excellent sources of high quality proteins which are superior to those of meat (FAO, 2004). It also serves as a source of ingredient for livestock meal (Bene and Heck, 2005). Nutrition plays a vital role in physical activities and health. It promotes growth and development and also regulates the body processes which are essential for cell growth, maintain and repair. The proximate nutrient composition of mudskipper (*P. babarus*) includes; the macro nutrients which are the carbohydrate, protein and

fats. The micro nutrients are the moisture, vitamins and minerals, which include a range of substances that must be present in diet even if only in minute quantity, promote good health and maintain life (Tremblay, 2011). Mudskippers are widely distributed in the brackish water, rivers, creeks and lagoons and are usually seen during low tide (Jaafar and Larson, 2008). This present study is aimed at investigating the proximate and mineral composition of *Periophthalmus babarus* in the Mangrove Swamp of Nsidung Beach, Calabar River.

2. Materials and Methods

2.1. Description of Study Area

The Calabar River in Cross River State, Nigeria flows from the north part of the city of Calabar, joining the larger Cross River of about 8 kilometres to the south with the longitude of $8^0$18'0E and latitude of $4^0$58'3N (Andem *et al*., 2013). Calabar River drains part of the Oban Hills in the Cross River National Park (Effiong, 2011). The geology of the river basin includes the Pre-Cambrian Oban Massif, Cretaceous sediments of the Calabar flank and the recent Niger Delta sedimentary basin**.** The basin is about 43 kilometres wide and 62 kilometres long, with an area of 1,514 square kilometres. The region has a rainy season from April until October, during which 80% of the annual rainfalls, with peak of the rainfall in June and September. Annual rainfall averages 1,830 millimetres. Average temperatures range from 24 °C (75 °F) in August to 30 °C (86 °F) in February. Relative humidity is high, between 80% and 100%. Drainage is poor, so the basin is subject to flooding, gully erosion and landslides. A 2010 study said that flooding had increased in recent years (Eze and Effiong, 2010). Nsidung beach is a commercial area with a large market located at the River side, domestic wastes from human households is being emptied into the River. It is also a landing site for fishermen and distribution to other sectors. Nsidung Beach has the Latitude: N 4^0 57' 326''; Longitude: E 8^0 18' 557'' at 26 feet altitude.

2.2. Collection of Samples

Three samples of *P. babarus* was purchased from fishermen on Nsidung Beach, Calabar River. The samples were carefully washed with distilled water, to remove sediment and mud from its body. Freshly caught samples were stored in a nylon bag and brought to the supervisor for confirmation of species. The samples were taken for analysis in biochemistry laboratory, University of Calabar, Cross River State, Nigeria.

2.3. Analysis of Samples

Analysis was carried out according to the standard procedures outlined by Association of Analytical Chemists (AOAC, 2005). These were included; total protein, total fat, Dry matter, moisture content, ash content, crude fibre, gross energy value and carbohydrate content. All determinations were performed in triplicates.

2.4. Statistical Analysis

The data collected were subjected to Descriptive Statistics to analysized for the mean, range and standard deviation of mudskipper fish (*P. babarus*) in the Mangrove swamp of Nsidung Beach, Calabar River.

3. Results

3.1. Proximate Composition of Mudskipper fish (Periophthalmus babarus) in the Mangrove Swamp of Calabar River

Summary of the mean percentage proximate composition of the analysized samples of mudskipper fish (*Periophthalmus babarus*), in the mangrove Swamp of Calabar River is shown in Table 1. The food values analyzed showed varied values of their presence in the body tissue of the fish analyzed; with the percentage dry matter, total protein and Ash content recording higher value in that order; followed by moisture content, total fat, carbohydrate and crude fat. The fish samples presented a relatively higher and lower amount of proximate concentrations. The fish had the total protein ranging from 54.5 to 56% with mean and standard deviation value of 55.2 ± 0.76, Total fat ranging from 4.7 to 5.2% with mean and standard deviation value of 4.9 ± 0.26, Dry matter ranging from 89.69 to 90% with mean and standard deviation value of 89 8 ± 0.16, Crude fibre ranging from 1.11 to 1.16% with mean and standard deviation value of 1.10 ± 0.03, Ash content ranging from 17.77 to 18.02% with mean and standard deviation value of 17.9 ± 0.13, Moisture content ranging from 9.75 to 10.25% with mean and standard deviation of 10.0 ± 0.25, energy value ranging from 269 to 299% with mean and standard deviation of 283.7 ± 16.0 and carbohydrate ranging from 1.12 to 2.28% with mean and standard deviation of 1.88 ± 0.66. The energy values analyzed showed relatively higher values in fish samples.

Parameters	Composition of Fish Sample (%) (*Periophthalmus barbarus*)				
	Sample 1	**Sample 2**	**Sample 3**	**Range**	**Mean ± S.D**
Total Protein	55	54.5	56	54.5-56	55.2 ± 0.76
Total Fat	4.7	5.2	4.8	4.7-5.2	4.9 ± 0.26
Dry Matter	90	89.77	89.69	89.9-90	89.8 ± 0.16
Crude Fibre	1.11	1.16	1.15	1.11-1.16	1.10 ± 0.03
Ash Content	17.77	17.82	18.02	17.77-18.02	17.9 ± 0.13
Moisture content	10.25	10.0	9.75	9.75-10.25	10.0 ± 0.25
Energy value	285	299	269	269-299	283.7 ± 16.0
Carbohydrate	2.28	2.25	1.12	1.12-2.28	188 ± 0.66

Table 1: Proximate Composition (%) of the Mudskipper fish in the Mangrove Swamp of Calabar River

3.2 Mineral Composition of Mudskipper fish (Periophthalmus babarus) in the Mangrove Swamp of Calabar River

The mean mineral contents of the fish (*Periopthalmus babarus*) are shown in Table 2. Calcium (Ca) has the highest mineral content ranging from 1.99 to 2.20 mg/kg with mean and standard deviation value of 2.10 ± 0.10 5mg/kg, followed by Phosphorus (P) ranging from 0.85 to 0.89 mg/kg with the mean and standard deviation value of 0.87 ± 0.02mg/kg, Sodium (Na) ranging from 0.33 to 0.38 mg/kg with the mean and standard deviation value of 0.35 ± 0.025 mg/kg, Manganese (Mn) ranging from 0.19 to 0.22 mg/kg with mean and standard deviation value of 0.21 ± 0.017 mg/kg, Potassium (K) ranging from 0.19 to 0.22 mg/kg with mean and standard deviation value of 0.20 ± 0.015 mg/kg. The results showed that the most abundant macro element present in the fish samples was Calcium (Ca). Iron (Fe) was the most abundant micro element ranging from 0.027 to 0.038 mg/kg with the mean and standard deviation value of 0.03 ± 0.006 mg/kg, followed by Magnesium (Mn) ranging from 0.018 to 0.021 mg/kg with the and standard deviation value of 0.02 ± 0.002 mg/kg, Copper (Cu) ranging from 0.001 to 0.002 mg/kg with the mean and standard deviation value of 0.00 ± 0.01, Zinc (Zn) ranging from 0.0022 to 0.0025 mg/kg with the mean and standard deviation value of 0.00 ± 0.00 mg/kg. The result shows that all heavy metals analysized were below acceptable limit.

Mineral composition of the Mudskipper fish (mg/mkg) (*Periophthalmus barbarus)*					
Mineral Parameters	**Sample 1**	**Sample 2**	**Sample 3**	**Range**	**Mean ± S.D**
MACRO ELEMENTS					
Sodium (Na)	0.35	0.38	0.33	0.33-0.38	0.35 ± 0.025
Manganese (Mg)	0.22	0.19	0.22	0.19-0.22	0.21 ± 0.17
Potassium (K)	0.2	0.19	0.22	0.19 – 0.22	0.20 ± 0.015
Phosphorous (P)	0.88	0.85	0.89	0.85 – 0.89	0.87 ± 0.021
Serum (Se)	0.01	0.01	0.02	0.01 – 0.02	0.01 ± 0.006
Calcium (Ca)	2.1	1.99	2.2	1.99 – 2.20	2.10 ± 0.105
MICRO ELEMENTS					
Iron (Fe)	0.033	0.027	0.038	0.027 – 0.038	0.03 ± 0.006
Zinc (Zn)	0.0022	0.0024	0.0025	0.0022-0.0025	0.00 ± 0.00
Copper (Cu)	0.001	0.001	0.002	0.001 -0.002	0.00 ± 0.01
Magnesium (Mn)	0.02	0.021	0.018	0.018 – 0.021	0.02 ± 0.002
HEAVY METALS					
Lead (Pb)	0.001	0.01	0.001	0.001-0.01	0.00 ± 0.005
Mercury (Hg)	0.001	0.0001	0.0001	0.0001-0.001	0.00 ± 0.001
Arsenic (As)	0.000	0.000	0.000	0.00-0.00	0.00 ± 0.00
Cadmium (Cd)	0.001	0.001	0.0001	0.0001-0.001	0.00 ± 0.001

Table 2: Mineral composition of the Mudskipper fish (Periophthalmus babarus) on mg/kg dry weight in the Mangrove Swamp of the Calabar River

3.3. Vitamin Composition of Mudskipper fish (Periophthalmus babarus) in the Mangrove Swamp of Calabar River

The mean vitamin composition of the fish (*Periopthalmus babarus*) is shown in Table 3. Niacin has the highest vitamin content ranging from 44.0 to 51.0 mg/100g with mean and standard deviation value of 47.3 ± 3.5mg/100g, followed by Panth acid ranging from 9.98 to 11.0mg/100g with mean and standard deviation value of 10.49 ± 0.51mg/100g, Vitamin B2 ranging from 2.97 to 3.44mg/100g with the mean and standard deviation value of 3.22 ± 0.24mg/100g, Vitamin E ranging from 2.02 to 2.03mg/100g with the mean and standard deviation value of 2.03 ± 0.006mg/100g, Vitamin D ranging from 0.04 to 0.06mg/100g with mean and standard deviation value of 0.05 ± 0.01 mg/100g, Vitamin B12 ranging from 0.02 to 0.03 mg/100g with mean and standard deviation value of 0.03 ± 0.006 mg/100g. No content were detected in vitamin C, A, B1 and B6. The results showed that the most abundant vitamin present in the fish samples was Niacin.

Vitamin composition of the Mudskipper fish (mg/100g or µg/100g) (*Periophthalmus barbarus)*					
Vitamin Parameters	**Sample 1**	**Sample 2**	**Sample 3**	**Range**	**Mean ± S.D**
Vitamin C (mg/100g)	0.00	0.00	0.00	0.00-0.00	0.00 ± 0.00
Vitamin A (iu)	0.00	0.00	0.00	0.00-0.00	0.00 ± 0.00
Vitamin E (µg/100g)	2.03	2.03	2.02	2.02-2.03	2.03 ± 0.006
Vitamin B1 (mg/100g)	0.00	0.00	0.00	0.00-0.00	0.00 ± 0.00
Vitamin B2 (mg/100g)	2.97	3.44	3.25	2.97-3.44	3.22 ± 0.24
Niacin (mg/100g)	44	51	47	44-51	47.33 ± 3.5
Vitamin B6 (mg/100g)	0.00	0.00	0.00	0.00-0.00	0.00 ± 0.00
Panth Acid (µg/100g)	11	10.5	9.98	9.98-11	10.49 ± 0.51
Vitamin B12 (mg/100g)	0.02	0.03	0.03	0.02-0.03	0.03 ± 0.006
Vitamin D (mg/100g)	0.06	0.05	0.04	0.04-0.06	0.05 ± 0.01

Table 3: Vitamin composition of the Mudskipper fish (Periophthalmus babarus) on mg/100g or µg/100g dry weight in the Mangrove Swamp of Calabar River

4. Discussion

Total protein, dry matter, Ash content and moisture contents were the major constituents, which had been considered in evaluating the nutritional value of the studied fish. The nutritional elements showed variable values in the fish analyzed; with total fat, crude fibre and carbohydrate recording the lowest. This makes important living resources of dietary protein as other sea and freshwater fish (Zuraini *et al*., 2006). High lipid had less water and more protein than low-lipid fishes. This is in-line with the report of Steffens (2006), that protein forms the largest quantity of dry matter in fish. All the fish samples examined contained appreciable concentrations of calcium, phosphorus, sodium, magnesium, potassium and serum suggesting that these fishes could be used as good sources of minerals. Calcium was observed to dominate other minerals in all the samples. The four heavy metals analyzed were present, but below tolerable limits. The variations recorded in the concentration of the different nutritional components in the fish examined could have been as a result of the rate in which these components are available in the water body (Yeannes and Almandos, 2003) and the ability of the fish to absorb and convert the essential nutrients from the diet or the water bodies where they live. This is supported by the findings of (Fawole *et al*., 2007). Other elements (such as iron, zinc, copper and manganese) varied in concentration among the studied fish. Most of these Micro elements are equally important in trace amounts as observed, but they tend to become harmful when their concentrations in the tissues exceed the metabolic demands (Ako and Salihu, 2004). Minerals are important for vital body functions such as acid, base and water balance. Calcium is good for growth and maintenance of bones, teeth and muscles (Turan *et al*., 2003). Normal extra cellular calcium concentrations are necessary for blood coagulation and for the integrity, intracellular cement substances (Okaka and Okaka, 2001). Sodium is an activator of transport ATP-ases in animals and possibly also in plants (Adeyeye, 2005). There is also a direct relationship of sodium intake with hypertension on human (Dahl, 1972). Iron is an important constituent of heamoglobin (Onwordi *et al*., 2009). The presence of zinc in the fishes could mean that the fishes can play valuable roles in the management of diabetes, which result from insulin malfunction (Okaka and Okaka, 2001). Concentrations of Calcium (Ca+) were observed to have appreciably dominated other elements analyzed in all the fish samples examined. This tends to disagree with the work done by Fawole *et al*., (2007) at Asa reservoir, in Ilorin, Kwara State Nigeria; where the dominant element in the fishes sampled was sodium. It could be inferred from the high concentration of Calcium (Ca+) in the tissues of the fish species that the water body from which the fishes were collected is rich in Calcium (Ca+). This must have allowed an active movement of this ion across the gill structure, which in turn may depend on the concentration in the external medium and that the richness in Calcium (Ca+) concentrations would boost the osmoregulatory activities in the organisms (Bently,1971). The concentration of Phosphorus in the fish samples examined ranked second among the mineral elements analyzed. The variations recorded in the concentration of mineral in fish muscles examined could be as a result of the rate in which they are available in the water body and the ability of the fish to absorb these inorganic elements from their diet and the environment where they live (Adewoye and Omotosho, 1997). Other elements (such as iron, copper, zinc, Magnesium, lead and cadmium) composition of the fish samples recorded variations in their concentrations both within and between the selected fish sampled. This variation in concentrations of the mineral elements in sampled fish tissues agree with the work of Windom *et al*., (1987) which stated that such variation was due to the chemical forms of the elements and their concentrations in the environment. The concentrations of the mineral elements in the fish tissues are in the following order (i.e. Fe>Mn>Zn>Cu.>Pb.> Cd). Cadmium detected was very low, below acceptable limit. This report is in agreement with the one obtained by Ako and Salihu (2004). The levels of most of these mineral elements present are in trace amount and are still below World Health Organization limits for human consumption. Concentrations of Niacin were observed to have appreciably dominated vitamin more than other vitamins analyzed in all the fish samples examined. This could be due to absorption capability and conversion potentials of essential nutrients from their diets or their local environment (Adewoye and Omotosho, 1997). Similar findings have been reported by (Effiong and Mohammed, 2008; FAO, 2004). Other vitamins such as (Panth acid, vitamin B2, vitamin E, vitamin D and vitamin B12) compostion of fish samples recorded variation in their concentrations both within and between the selected fish sampled. Nevertheless our present results varied with the report of Ogueji and Auta (2007) who recorded the dependent elevations of vitamin levels in the tissues of *Clarias gariepinus*. concentrations of the vitamins in the fish tissues are in the following order (i.e. Panth acid > vitamin B2 >Vitamin E > vitamin D > vitamin B12). Vitamins C, A, B1 and B6 did not

show any detectable limit. This report is also in agreement with (Ogueji and Auta 2007); which repoted that the vitamins level in the fish tissues could have been due to the influence of food consumed by the fish.

5. Conclusion

The study therefore, showed that this fish (*Periophthalmus babarus*) are good sources of minerals and some vitamins. It could be inferred that the mineral elemental levels and vitamins of this species is a function of the availability preferential accumulation. However, it revealed from this study that, micro-nutrients were low, which could be due to the fact that the body needs of the fish are met and the concentrations in the water body is low. It therefore becomes necessary to consider the mineral status of the fish and the persistent food safety of the fish prior to consumption in addition to the prevailing choice for fish as a high protein source. This work has unveiled the importance of this fish as good sources of protein and some macro-nutrients. Since nutritional value of the fish examined are now known, consumers can now know what benefits to derive when these fish species are eaten.

6. References

1. Adewoye, S.O. and Omotosho, J. S. (1997). Nutrient Composition of some freshwater Fishes in Nigeria. Bio. Res. Com., 11(4):333-336.
2. Adeyeye, E. I. (2005). Distribution of major elements (Na, K, Ca, and Mg) in the various anatomical parts of Fadama crops in Ekiti State, Nigeria. Bull. Chem. Soc., Ethiopia, 19: 175-183.
3. Ako, P.A. and Salihu, S. O. (2004). Studies on some major and trace metals in smoked and over-dried fish. Jou. App. Sci. and Environ. Mana., 8: 5-9.
4. A.O.A.C. (2005). Official Methods of Analysis. Association of Analytical Chemists. 15th Ed. Washington D. C.
5. Andem, A. B., Okorafor, K. A., Eyo, V. O and Ekpo, P. B. (2013). Ecological Impact Assessment and Limnological Characterization in the Intertidal Region of Calabar River Using Benthic Macroinvertebrates as Bioindicator Organisms. Int. J. of Fish. Aqua. Stud., 1(2):8-14.
6. Ali, A. and Kiumars, P. (2010). Chemical and proximate composition properties of different fish species obtained from Iran. World Jou. Fish Mar. Sci., 2:237-239.
7. Bentley, P. J. (1971). Endocrine and Osmoregulation, Springer-Verdag Heidelberg, Pp: 220-230.
8. Bene, C and Heck, S. (2005). Fish and food security in Africa. NAGA World Fish Centre Quarterly, 28(4):8-13.
9. Dahl, L. K. (1972). Salt and hypertension. Animal Journal of Clinical Nutrition, 25: 231-238.
10. Food and Agricultural Organization (FAO) (2004). The composition of fish. Available from http://www.fao.org/wairdoes/tx5916e/×5916co1.htm., Pp: 1-80.
11. Effiong, B. N and Mohammed, I. (2008). Effect of seasonal variation on the nutrient composition in selected fish species in Lake Kainji, Nigeria. Nat. and Sci., 6 (2): 1-5
12. Effiong, J (2011). Changing Pattern of Land Use in the Calabar River Catchment, Southeastern Nigeria. Jou. Sus. Deve., 4 (1): 1913-9063.
13. Eze, E. B and Effiong, J (2010). Morphometric Parameters of the Calabar River Basin: Implication for Hydrologic Processes. Jou. Geo. Geolo., 2 (1): 916-977
14. Fawole, O.O., Ogundiran, M. A., Ayandiran, T. A and Olagunju, O. F. (2007). Mineral Composition in some selected fresh water fishes in Nigeria. Jou. Foo. Saf., 9: 52-55.
15. Jaafar, Z. E. and Larson. H. L (2008). A New species of mudskipper, Teleostei, Gobiidae, Oxudercinae from Australia, with a key to the Genus, Zoolo. Sci., 25:946 -952.
16. Manal, A. (2009). Gobiidae. Eagle wood Cleff Press, New Jersey. Pp. 142.
17. Maxlan, F. G. Lawson, E. O., Boran, S. (2003). Ecology of the Mudskipper, P. babarus in the Mangrove swamps of Lagos Lagoon Nigeria. Ph.D. Thesis University of Lagos, Nigeria, Pp. 180.
18. Murdy, A. (1989). Coastal Marine Science. Longman Press, London. Pp. 21.
19. Okaka, J .C and Okaka, A. N. O. (2001). Food composition, spoilage and shelf life extension. Ocjarco Academic Publishers, Enugu, Nigeria, Pp. 54-56.
20. Onwordi, C.T., Ogungbade, A. M and Wusu, A. D. (2009). The proximate and mineral composition of three leafy vegetables commonly consumed in Lagos, Nigeria. Afri. Jou. Pure and App. Chem., 3: 102-107.
21. OguejI, E. O. and Auta, J. (2007). Investigation of biochemical effect of acute concentration of lambda-cyhalothrin on African Catfish (Clarias gariepinus, Tuegels). Jou. Fish. Int., 2(1): 86-90.
22. Steffens, W. (2006). Freshwater fish-wholesome foodstuffs. Bul. Jou. Agric. Sci., 12: 320-328.
23. Tremblay, L. A. (2011). Vitamins and Minerals in fish. F:/vitamins and minerals in fish Livestrong, Com.
24. Turan, M., Kordali, S., Zengin, H., Dursun, A and Sezen, Y. (2003). Macro and micro-mineral content of some wild edible leaves consumed in Eastern Anatolia. Acta Agric. Scand. Sect. B, Plant Soil Sci., 53: 129-137.
25. Windom, H., Stein, D., Scheldon, R. and Smith, J. R. (1987). Composition of trace metal Concentrations in muscle of a benthopelagic fish. (Cory phaenoides armatus) from the Atlantic and Pacific oceans. Deep. Res., 34 :(2)213-220.
26. Yeannes, I.M. and Almandos, M. E. (2003). Estimation of fish proximate composition starting from water content. Jou. Foo. Comp. Anal., 16: 81-92.
27. Zuraini, A., Somchit, M. N and Solihah, M. H. (2006). Fatty acid and amino acid composition of three local Malaysian Channa species. Fish. Foo. Chem., 97: 674-678