Evaluation on nutritive value of four commercial Nile river fish species.

Obany O Deng[1], Goang, O.M.A.[2] and Pio K Deng[3]

1- *Department of Fisheries, Faculty of Animal Production, Upper Nile University South Sudan.* **Email.okukiobany@gmail.com Tel: +211916010762 - +211923386827**

2- *Department of Animal Husbandry and Breeding, Faculty of Animal production, Upper Nile University, South Sudan. Email.m_oyor@hotmail.com*

3- *Faculty of Agriculture, Upper Nile University, South Sudan, Email. Piokowr12@gmail.com*

Abstract

The study was carried out to evaluate and assess the yield of edible, inedible parts and nutritional composition of four River Nile fish species. The fillets percentage yield was found to be 39.3±3.7%, 35.9±9.1%, 21.8±7.1%, and 37.14 % for *Heterotis niloticus*, *clarias gariepinus*, *tetraodon lineatus*, *Malapterurus electricus* respectively. Proximate analysis revealed that the protein was 20.3±0.07, 18.3±0.04, 18.1±0.08 and 19.3±0.08% for *Heterotis niloticus*, *clarias gariepinus*, *tetraodon lineatus* and *Malapterurus electricus*. Fat content were 4.2±0.02%, 2.2±0.01%, 3.2±0.03% and 3.1±0.02% for Heterotis *niloticus*, *clarias gariepinus*, *tetraodon lineatus and Malapterurus electricus* respectively. Moisture content was found to be 74.0±0.02%, 77.8±0.08%, 77.3±0.01% and 76.4±0.03% respectively. And ash content was 1.5±0.06%, 1.7±0.06%, 1.3±0.04% and 1.3±0.02% respectively. Protein, fat, contents were significantly high in *Heterotis niloticus*, whereas moisture and ash contents were significantly high in *clarias gariepinus*. The study concluded that all species under investigation were rich in food nutritive value.

Key words: Nutritive value, commercial fish, Nile River.

Introduction

Fish is an important source of food for mankind all over the world. From times immemorial fish provides not only high-value protein, but also a wide range of essential micronutrients, including various vitamins, minerals and omega-3 fatty acids. There is an increasing interest in fish consumption because of it high PUFA. The long chain PUFA has gained attention because of prevention of human coronary artery disease (Dhaneeh, etal., 2012) (Ward and Singh, 2005), improvement of retina and brain development (Crawford, 1993), decreased incidence of breast cancer, rheumatoid arthritis, multiple scelerosis, asthma, psoriasis, inflammatory bowel disease (Simopoulos, 2002; JHCI UK, 2004). It is recognized that essential amino acids play an important role in human nutrition and health promotion (Limin et al., 2006). Clucas and Sutcliffe (1981) stated that, Fish Fillets is a strip of flesh cut from a whole fish parallel to the backbone, it could be block or single fillet of which it is in high demand in developed world. The terms fillet and edible portion are difficult to define exactly since the portion eaten varied from one country to another. Onyia, et al. (2010) reported that the edible fraction of the different fish species varies widely between 30% -50% of total weight. Fish meat consists of several components that all contribute to its overall chemical composition. These components, which include moisture, protein, lipids and minerals, can differ in nature and quantity according to their function and availability (Love, 1980; Huss, 1988). The meat composition may also vary at the different anatomical positions of the body since these have different functions and therefore different chemical compositions (Love, 1980). Meat composition is affected by both exogenous and endogenous factors (Shearer, 1994). Exogenous factors that affect meat composition include the diet of the animal (composition, frequency) and the environment in which it is found (salinity, temperature). On the other hand, endogenous factors that affect meat composition include gender, size, life cycle stage and body position (Shearer, 1994). This study was carried out to determine fillet yield and proximate chemical (protein, Moisture, lipid and ash content of four edible fishes, most commonly consumed by the local population of White Nile State.

2 Materials and methods

2.1 Study area:

The study was carried out in Kosti landing site directly on bank of Nile River. Kosti is a city found in White Nile state, Sudan. It is located 13°16 latitude and 32° 66 longitude and it is situated at elevation 387 meters above sea level. The Nile River, considered the longest river in the world, it is approximately 4,258 miles (6,853 kilometers) long flowing northward through the tropical climate of eastern Africa and into the Mediterranean Sea. (en.wikipedia.org/wiki/Nile).

2.2 Sample collection:

Four freshwater fish species (*Clarias gariepinus*, *Malapterurus electricus*, *Heterotis niloticus*, *Tetraodon lineatus (fahaka)* Were collected from Kosti landing site along White Nile, during October 2014. Total fish lengths were measured and significant differences were found among different species. After collection samples were kept in plastic bags transported insulated icebox to the laboratory.

2.2 Sample preparation and Estimated parameters

On arrival at the laboratory, the samples were identified to species level (using certified keys by Sandon. H 1950), cleaned and weighed using sensitive electronic balance scale. Furthermore fish samples were filleted, eviscerated, de-headed and skinned using sharpen knives. The weight of viscera, fillet with skin, head, skeleton and fins (with some adhesive meat), were weighed separately to determine the percentages in proportional to the total body weight.

2.3 Proximate composition of different species

Moisture content, crude protein, fat and ash were determined for wet flitted samples according to standard methods of Association of Official Analytical Chemists (AOAC, 2002) as follows:

2.3.1 Determination of Moisture Content

The samples were first weight (Initial weight) then dried in an electric oven at 105^{0}c for 24-30 hours to obtain a constant weight. The moisture content was calculated as follows:

$$\textbf{Moisture content \%} = \frac{\text{Initial weight} - \text{Dry weight}}{\text{Initial weight}} \times 100$$

2.3.2 Determination of Crude Protein

The Kjeldal method for estimation of nitrogen was applied. Nitrogen content was converted to protein percentage by multiplying by 6.25 as follows:

Nitrogen (%) = T × 0.1 × 0.014 × 20 ÷ Weight of sample × 100.

Crude protein % = N × 6.25 = CP%

2.3.3 Determination of Ash

Ash content was measured by weighing out sample into silica dish ignited and cooled before weighting then dish and content were ignited first and consequently at 500 ^{o}c until Ash got grey/white color.

$$\textbf{Ash \%} = \frac{\text{Fresh weight} - \text{Ash weight}}{\text{Fresh weight}} \times 100$$

2.3.4 Determination of Fat: fat content was measured by drying the samples at 100^{0C} in an oven and then the crude fat extracting using petroleum ether in a Soxhlet extractor for 4 hours.

2.3.5 Statistical analysis

Pearson Correlation Coefficient was employed for the better understanding of relationship between the percentage of body composition (fillet, head, frame, viscera, and inedible) and proximate composition (protein, moisture, lipid, ash content), with various fish species, using the statistical package of SPSS 21.0. One way ANOVA was also employed to understand the variation in the quantity of nutrients with respect to different species.

3 Results and discussion

3.1 Body characteristics

The present study was carried out on two mains aspect; body weight characteristics (Table 1) and proximate chemical composition of the four second grades fish species in White Nile River. The assessment on body characteristics of four fish species revealed that *Heterotis niloticus* had the highest fillet percentage of 39.30%, *Malapterurus electrics* had 37.91%, *Clarias* gariepinus had 35.91% and *Tetraodon lineatus* had lowest fillet percentage 21.84% (Table 2) with their significant different at level ($p<0.05$). The values of condition factor 'K' recorded in the present study were 1.0214, 0.777, 1.989, and 1.874 respectively (Table 3). The results indicated that fish species under investigation were in good condition. The results was in line with other studies that suggest that a higher body mass contributes to higher fillet yield due to a lower proportion of head, bones and fins (Onyia, et al 2010)**.** And was higher than the statement that the fillet fraction of the different fish species varies widely between 30% - 50% of total weight (Babiker, 1981; Obanu and Ikeme ,1988 ; Eyo, 2001). The filleting yield of the studied fish species was a reflection of their anatomy, that was in agreement with the findings of Eyo (1989) and Ali and others (1996) who stated that species with large heads and skeleton relative to musculature give lower filleting yield than those with smaller heads and skeletons**.**

3.2 Proximate composition

The results of proximate chemical composition of four fish species in White Nile River was presented in table (4). The total protein content were found to be 20.28±0.07 %, 18.34±0.04 %, (18.17±0.01%, and 19.25±0.08% *Clarias gariepinus*, *Malapterurus electricus*, *Heterotis niloticus*, *Tetraodon lineatus* respectively. The differences observed among the selected species could be as a result of fish consumption or absorption capability and conversion potentials of essential nutrients from their diets or their local environment (Omer, 1984; Onyia, et al., 2010; Jabeen and Chaudhry. 1995)**.** The moisture content were 74.00±0.02%, 77.81±0.08%, 77.30±0.01%, and 76.42±0.03% *for Clarias gariepinus, Malapterurus electricus, Heterotis niloticus, Tetraodon lineatus* respectively (Table 4).

Table (1): Body characteristics of Four Freshwater Fish Species.

Parameters / Species	T. B.W (g) M±St.D	T.L (cm) M±St.D	S.L(cm) M±St.D	H.W (g) M±St.D	V.W (g) M±St.D	S.W (g) M±St.D	Frame M±St.D	Fillet M±St.D
Heterotis niloticus	730.0±202.4[a]	41.5±4.65[a]	38.0±4.61[a]	136.3±30.9[a]	63.8±30.7[a]	100.0±50.5[a]	135.0±21.2[a]	283.8±66.3[a]
Clarias gariepinus	468.3±122.5[b]	39.2±3.8[b]	34.7±3.5[b]	126.7±24.7[b]	18.3±10.4[d]	51.7±2.9[b]	73.3±7.6[c]	173.3±72.5[b]
Tetraodon lineatus	275.0±76.0[d]	24.0±5.4[c]	20.2±4.7[d]	43.5±21.3[c]	45.0±28.1[b]	31.7±16.3[c]	101.5±60.9[b]	60.8±30.5[d]
Malapterurus electrics	356.7±122.9[c]	26.7±3.5[d]	23.0±3.0[c]	41.7±12.6[d]	23.3±10.4[c]	100.0±22.5[a]	51.7±22.5[d]	135.0±58.9[c]

[a,b,c,d] Means superscript in the same column are significant different at level ($p<0.05$).
whereas:
T.B.W= Total body Weight, T.L= Total length, S.L= Standard length, H.W= Head Weight, V.W= Viscera Weight

Table (2): Slaughter yield of Four Freshwater Fish Species.

Parameters / Species	Head % M±St.D	Viscera % M±St.D	Skeleton % M±St.D	Frame % M±St.D	Edible (fillet) % M±St.D	Inedible % M±St.D
Heterotis niloticus	18.9±0.96[b]	7.08±3.19[b]	13.41±4.48[b]	19.0±2.71[b]	39.30±3.67[a]	58.37±4.42[c]
Clarias gariepinus	27.54±3.87[a]	3.72±1.19[d]	11.56±3.01[c]	16.19±3.14[c]	35.91±9.10[c]	59.01±8.11[c]
Tetraodon lineatus	16.22±7.15[c]	15.12±7.62[a]	13.26±7.62[b]	35.63±16.09[a]	21.84±7.05[d]	78.16±7.19[a]
Malapterurus electrics	11.81±0.60[d]	6.42±0.72[c]	28.80±3.54[a]	14.15±1.51[d]	37.14±3.56[b]	61.19±2.11[b]

[a,b,c,d] Means superscript in the same column are significant different at level ($p<0.05$).

Table (3): Average length, weight and condition factor of four fish species.

Fish species	Parameters		
	Average Weight (g)	**Average Length (cm)**	**Condition Factor (K)**
Heterotis niloticus	730.0	41.5	1.0214
Clarias gariepinus	468.3	39.2	0.777
Tetraodon lineatus	275.0	24.0	1.989
Malapterurus electrics	356.7	26.7	1.874

Whereas: $K=100*w/l^3$

The present results are quite similar with results obtain from other African fresh water fishes such as *Oreochromis niloticus, Clarias gariepinus, Sarotherodon and Heterotis niloticus* with values 75%, 66%, and 79% respectively (Fawole, et al, 2007). There were significant differences (P<0.05) between the four species. The highest and the lowest level of moisture content were observed in *Malapterurus electricus* and *Clarias gariepinus* respectively. Fat contents in *Clarias gariepinus*, *Malapterurus electricus*, *Heterotis niloticus*, *Tetraodon lineatus* were 4.21±0.02%, 2.15±0.02%, 3.22±0.08, and 3.13±0.05%, respectively (Table 4). The significant (P<0.05) differences in fat content could be due to variation of species and age (Rasoarahona, et al 2005). All the species under investigation contain low level fat than the level specified by Ozogul and Ozogul (2006) who stated that fatty fish usually contain a minimum of 5–8% fat in edible tissue. As such these fish species can be said to be lean fish. Ash content was 1.52±0.06%, 1.71±0.06%, 1.32±0.04%, and 1.29±0.02% for *Clarias gariepinus, Malapterurus electricus, Heterotis niloticus, Tetraodon lineatus* respectively (Table 4). The average value of the ash contents for the four fish species ranged from (1.29% – 1.71%). This results agreed with the range of ash values (1.35% - 1.66%) obtained for rainbow trout (Gokoglu, et al. 2004), and also within the range of (0.95% - 2.50%) reported for silver catfish by Weber et al (2008). But the range was lower than the range of (2.5% - 6.25%) obtained in raw mince of five different Indian fish species (Huss, 1995).

Table (4): illustrate proximate chemical composition of four commercial fishes

Parameters / Samples	Moisture	C.P	Fat	Ash	N.F.E
Heterotis niloticus	$74.00{\pm}0.02^{c}$	$20.28{\pm}0.07^{a}$	$4.21{\pm}0.02^{a}$	$1.52{\pm}0.06^{a}$	$52.01{\pm}0.04^{a}$
Clarias gariepinus	$77.81{\pm}0.08^{a}$	$18.34{\pm}0.04^{c}$	$2.15{\pm}0.01^{c}$	$1.71{\pm}0.06^{a}$	$44.38{\pm}0.17^{c}$
Tetraodon lineatus	$77.30{\pm}0.01^{a}$	$18.17{\pm}0.08^{c}$	$3.22{\pm}0.03^{b}$	$1.32{\pm}0.04^{a}$	$45.40{\pm}0.03^{c}$
Malapterurus electrics	$76.42{\pm}0.03^{b}$	$19.25{\pm}0.08^{b}$	$3.13{\pm}0.05^{b}$	$1.29{\pm}0.02^{a}$	$47.24{\pm}0.01^{b}$
^{a,b,c,} Means in the same column with superscript are significant different at (p≤0.05),					

4 Conclusion

The research concluded that there are different variations in fillets and also in chemical composition in different fish species. The fish species differed significantly ($p < 0.05$) in the moisture, protein and fat contents, but the ash contents were similar. All the four experimental fish species are rich in protein content and contribute towards a safe and healthy nutritious food for human consumption.

5 References:

1. Ali.M.E, Babiker.S A., and Tibin.I M. Body Characteristics, yield indices and proximate composition of commercial fish species of Lake Nubian. Processing of FAO Expert Consultation on fish technology in Africa (1996), Kenya and FAO Fisheries Report No. 574:211-214.
2. AOAC. Official methods of analysis, 17th Ed. Association of Official Analytical Chemists Inc., Arlington, Virginia, USA. 2002, p(69-79)
3. Babiker,M.M. Dietary Nile Fishes: A Reclassification According to Nutritional Merit. (1981). Sudan Notes and Records 62:161–170.
4. Clucas, I. J, Sutcliffe. An Introduction to Fish Handling and Processing. Tropical Products Institute. London (1981). P(178-179).
5. Crawford MA. The role of essential fatty acids in neural development: implications for perinatal nutrition. American Journal of Clinical Nutrition (1993) 57: 703S–710S.
6. Dhaneesh KV, Noushad KM, Ajith Kumar TT. Nutritional Evaluation of Commercially Important Fish Species of Lakshadweep Archipelago, India. PLoS ONE (2012) 7(9): e45439. https://doi.org/10.1371/journal.pone.0045439.
7. Eyo, A A. Carcass composition and filleting yield of ten fish Species from Kainji Lake. In FAO Fisheries Expert Consultation on Fish Technology in Africa, Ghana (1989). No. 467 pp. 173-175.
8. Fawole,O.O., Ogundiran.M.A., Ayandiran.T.A., and Olagunju.O.F. Proximate and mineral composition in some selected fresh water fishes in Nigeria. Internet Journal of Food Safety (2007). 9: 52 -55.

9. Gokoglu N., Yerlikaya P. and Cengiz E. Effects of cooking methods on the proximate composition and mineral contents of rainbow trout (*Oncorhynchus mykiss*). Food Chemistry, Great Britain, (2004) V. 84, n1, p.19-22.
10. Huss, H. H. quality and quality changes in fresh fish. FAO Fisheries Technical paper – 348 Rome. (1995). Pp (39-50, 195-199).
11. Jabeen, F. and Chaudhry A. S. Monitoring trace metals in different tissues of Cyprinus carpio from the Indus River in Pakistan. Environ Monit Assess, (1995): 170, 645–656. http://dx.doi.org/10.1007/s10661-009-1263-4.
12. JHCI UK. Eating long chain omega-3 polyunsaturated fatty acids, as part of a healthy lifestyle, has been shown to help maintain heart health. British report. (2004) Available from: http://www.jhci.org.uk/approv/JHCIDossier.pdf Accessed 2011 Dec 12.
13. Limin, L., X. Feng, and H. Jing. Amino acids composition difference and nutritive evaluation of the muscle of five species of marine fish, Pseudosciaenacrocea (large yellow croaker), Lateolabraxjaponicas (common sea perch), Pagrosomus major (red seabream), Seriola dumerili (Dumeril's amberjack) and Hapalogenysnitens (black grunt) from Xiamen Bay of China. Aquat. Nutr (2006). 12: 53–59.
14. Love R M. The Chemical Biology of Fishes. Brown ME (Edn), Academic press. New York, USA. (1980), p(230-232).
15. Obanu,Z.A., and Ikeme A I. Processing characteristics and yield of some fishes species of the river Niger in Nigeria FAO consultation of fish technology in Africa FIIU/R400 Supp. (1988). Pp. (218-221).
16. Onyia,L.U., Milan.C., Manu.J.M., and Allison.D.S. Proximate and mineral composition in some freshwater fishes in Upper River Benue, Yola Nigeria. Continental J.Food Science and Technology, (2010). 4:1- 6.
17. Ozogul Y, Ozogul F. Fatty acid profiles of commercially important fish species from the Mediterranean, Aegean and Black Seas,. Food Chemistry (2007) 100: 1634–1638.
18. Sandon.H. An Illustrated guide to the Freshwater fishes of The Sudan. LONDON McCORQUODALE&Co.1950. P(14-65).

19. Rasoarahona JRE, Barnathan G, Bianchini JP, Gaydou EM (2005) Influence of season on the lipid content and fatty acid profiles of three tilapia species (*Oreochromis niloticus*, *O. macrochir* and *Tilapia rendalli*) from Madagascar. Food Chemistry 91: 683–694.
20. Shearer, K. D. Factors affecting the proximate composition of cultured fishes with emphasis on salmonids. Aquaculture (1994) 119, 63-88.
21. Simopoulos AP. Omega-3 fatty acids in inflammation and autoimmune diseases. Journal of American College Nutrition (2002) 21: 495–505.
22. Ward OP, Singh A. Omega-3/6 fatty acids: alternative sources of production. Process Biochemistry (2005) 40: 3627–3652.
23. Weber, J.; Bochi, V.C.; Ribeiro, C.P.; Victorio, A.M.; Emanuelli, T. Effect of Different Cooking Methods on the Oxidation, Proximate and Fatty Acid Composition of Silver Catfish (*Rhamdia Quelen*) Fillets. Food Chemistry. (2008) 106,140–146.