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A Study on the Amino Acid Profiles of Five Fresh Water Fishes Commonly Consumed in Tanzania

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ABSTRACT

Amino acid composition analyses were carried out on five of the most popular and commercial value fresh water fish species: Latesniloticus, Oreochromis niloticus, Rastrineobolaargentea, Limnothrissa. miodon and Stolothrissatanganicae from Tanzanian portions of Lake Victoria and Lake Tanganyika using standard methods and procedures. The dominant amino acids in all the fishes were glutamic acid 14.11 to 14.89g/100g, aspartic acid 9.31 to 9.57g/100g, lysine 6.89 to 8.58g/100g, glycine 6.31 to 7.35g/100g and the least amino acid was cystine 0.81 to 1.12g/100g. There were significant differences (p< 0.05) in the contents among the species. The contents of the amino acids were compared with the {whole hen's egg; FAO/WHO/UNU, 1985} and FAO/WHO (1991) reference values. To assess the nutritional quality of these fishes predicted protein efficiency ratio (P-PER), Essential amino acid index (EAAI) were calculated. This study confirmed that the fish species EAAS were above the FAO/WHO/UNU, (1985) and FAO/WHO (1991), reference values. These fish species could serve as significant sources of EAAS, and lysine present in them could supplement the corresponding deficiency in plant proteins. The fish species could therefore be recommended for supplementation in the preparation of feeds for weaning and pre- weaning children.

Keywords: Amino acids, EAAI, fish species, P-PER, supplementation.

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INTRODUCTION

The low consumption of fish and fish products in Tanzania as compared to other countries less than 15g per individual per day [10] is due, among other reasons to inadequate promotion and lack of sufficient information regarding their nutritional qualities.

Fish is known to be a good source of protein rich in essential amino acids [27]. Amino acid plays a central role as building blocks of proteins and intermediates in metabolism and further help to maintain health and vitality [31]. There are 20 amino acids that can be found in human body, 18 of which are important in human nutrition. Some of the amino acids cannot be synthesized *de novo* by humans and other animals and hence must be supplied in the diet; therefore, they are called essential amino acids [23]. Examples of essential amino acids are Lysine, Methionine and Phenylalanine. Other amino acids e.g. Glutamic acid and Aspartic acid are synthesized by the organism in sufficient amounts and hence are called non-essential amino acids.

The nutritional value of any protein is directly related to the amino acid composition [17]. Dietary proteins in form of amino acids are needed for growth, metabolism and maintenance of the body especially in young ones. The quality of the proteins can be determined in relation to the composition of a standard protein, which is recognized as the most relevant for the assessment of the protein quality in the nutrition of all populations [15].

Although, vegetable protein is being used to increase the intake of protein quality, this has been found to lack some essential amino acids to meet the needs of the populace [25]. An underutilized source of good quality protein may exist in the fresh water fish species with potentials for providing amino acid requirements of human and other animals.

Latesniloticus (Linn.), *Oreochromis niloticus* (Linn.), *Rastrineobolaargentea* (Pellegrin), *Limnothrissamiodon* (Boulenger) and *Stolothrissa Tanganicae* (Pellegrin)are economic important fish species from Lake Victoria and Lake Tanganyika. They are chosen for this study because they are of high commercial values and readily available all year round.

Studies on the amino acids compositions of fresh water fishes have been reported [2-4, 22, 23, 28]. However, little information is available on the amino acid compositions of these five fish species. The objective of this study was therefore to determine amino acid compositions of these five fish species.

MATERIALS AND METHODS

Study Area (s)

Lake Victoria, covering an area of 68,000 km^2 is the second largest Lake in the world after Lake Superior in North America. The Lake lies between latitude 0.7 º N - 3 º S and Longitude of 31.8 º E - 34.8 º E [30]. (Fig.1). Lake Tanganyika is located between latitude 3° 20' and 8 ° 48' S and between longitude 29° 03'and 31° 12' E and is the second deepest Lake in the world following Lake Baikal of Russia [29]. (Fig.1).

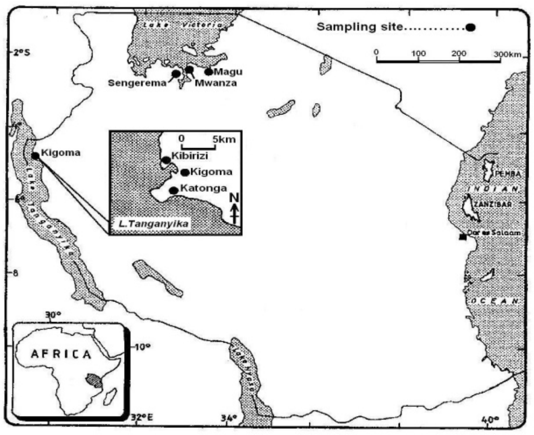

Figure 1: Map of Tanzania showing the sampling sites (Source: Dept. of Geography, UDSM).

Samples collection and Processing

A total of 3,396 samples consisting of 62*L. niloticus,* 67*O. niloticus,* 1660*R. argentea,* 996*S. tanganicae* and 611*L. miodon* were purchased randomly from the commercial catches of the five sampling sites namely: Mwanza, Sengerema, Magu from Lake Victoria, Kibirizi and Katonga from Lake Tanganyika. Fishes were purchased in the early morning hours of February 2013 to September, 2013 (April and May exclusive) (six months period). Samples were filleted, de-boned (*L. niloticus and O. niloticus)* others were processed whole), oven dried at 105^0-109^{0}C for 5hours. The cooled samples were milled into powder. Powdered samples were wrapped separately in aluminium foil and kept in polythene bags labelled appropriately before being transported to Zoology Department University of Jos, Plateau State Nigeria, where the analyses were carried out.

Amino acid analyses

Amino acid profiles of the powdered samples were determined using the method of [11] on a Technicon TSM-1 amino acid analyzer DNA 0209 Model (Technicon Instruments Corporation, Newyork, USA).

Estimation of predicted protein efficiency ratio (P-PER) and Essential amino acid index (EAAI).

Protein efficiency ratio was estimated using the equation adopted by [6] which is: P-PER= -0.468+0.454 (Leu) - 0.105 (Tyr).

The essential amino acid index was calculated using the formula adopted by [20] as follows:

$$EAA\ I = n\sqrt{\frac{100a \times 100b \times 100c \times 100d \times \ldots\ldots j}{ae \times be \times ce \times de \times \ldots\ldots}}$$

Where a, b, c……………j = % essential amino acids in food protein,
Where ae, be, ce, de = value of the same essential amino acids in whole hen's egg protein.
Where n = number of amino acids entering into the calculation.

Statistical analyses

The data obtained were subjected to a one way Analysis of Variance (ANOVA) using Graph Pad Prism Statistical Software Version (6.04) at a significant difference level of P≤0.05.

RESULTS AND DISCUSSION

The five fish species contained essential and non-essential amino acids in different proportions (Table 1). Lysine content ranged between 6.89 to 8.58 g/100g and differed significantly among the five fish species F (4, 10) = 65.49, P<0.0001. The content was higher in *R. argentea* than *L. miodon* (p<0.001), higher in *O. niloticus* than *R. argentea (p*<0.001) and significantly higher in *L. niloticus* than R. *argentea* (p<0.05).

Table 1: Amino acid profiles (g/100 g) of the five sampled fish species

Amino acid	*L. niloticus*	*O. niloticus*	*R. argentea*	*L. miodon*	*S. tanganicae*
Lys^{e}	8.24±0.22^{a}	8.58±0.07^{a}	7.76±0.05^{b}	6.89±0.19^{c}	7.46±0.09^{b}
His^{e}	2.58±0.06^{a}	2.82±0.02^{b}	2.60±0.03^{a}	2.65±0.09^{a}	2.69±0.03^{a}
Arg^{e}	6.29±0.08^{a}	6.33±0.05^{a}	6.34±0.06^{a}	5.94±0.21^{b}	6.10±0.07^{a}
Asp^{n}	9.57±0.11^{a}	9.45±0.08^{a}	9.49±0.09^{a}	9.36±0.16^{a}	9.31±0.07^{a}
Thre^{n}	4.15±0.07^{a}	4.19±0.05^{a}	4.20±0.04^{a}	4.37±0.08^{b}	4.08±0.08^{a}
Ser^{n}	4.21±0.06^{a}	4.22±0.07^{a}	4.20±0.06^{a}	4.02±0.10^{b}	4.14±0.05^{a}
Glu^{n}	14.40±0.18^{a}	14.11±0.06^{a}	14.72±0.14^{b}	14.89±0.22^{b}	14.83±0.10^{b}
Pro^{n}	4.63±0.10^{a}	4.63±0.04^{a}	4.39±0.07^{a}	3.68±0.23^{b}	4.15±0.05^{c}
Gly^{n}	7.32±0.07^{a}	7.35±0.07^{a}	6.96±0.08^{b}	6.31±0.15^{c}	6.76±0.06^{b}
Ala^{e}	6.07±0.05^{a}	6.18±0.08^{a}	5.95±0.06^{a}	5.69±0.10^{b}	6.06±0.05^{a}
Cyst^{n}	1.12±0.03^{a}	1.04±0.03^{b}	0.87±0.02^{c}	0.84±0.04^{c}	0.81±0.01^{c}
Val^{e}	4.70±0.04^{c}	5.00±0.03^{b}	4.54±0.09^{c}	4.11±0.10^{d}	4.43±0.08^{c}
Met^{e}	2.66±0.07^{a}	3.09±0.03^{b}	2.79±0.03	2.51±0.12^{a}	2.95±0.02^{b}
Iso^{e}	4.05±0.04	4.13±0.03^{a}	3.92±0.02	3.73±0.41	3.63±0.02^{b}
Leu^{e}	7.17±0.09^{a}	7.19±0.06^{a}	7.15±0.04^{a}	7.00±0.15^{a}	7.04±0.05^{a}
Tyr^{n}	3.15±0.05^{a}	3.20±0.06^{a}	3.15±0.06^{a}	3.15±0.05^{a}	3.28±0.08^{a}
Phe^{e}	4.37±0.05^{a}	4.09±0.03^{c}	3.98±0.03^{c}	3.89±0.14^{c}	4.13±0.07^{c}

Means and Standard error means in the same row with different superscripts are significantly different at (P< 0.05). e- Essential amino acid, n- non essential amino acid.

Table 2: Quality parameters of the amino acids of the five fish species

Amino acid	*L. niloticus*	*O. niloticus*	*R. argentea*	*L. miodon*	*S. tanganicae*
Total amino acids (TAA)	94.68	95.60	93.01	89.03	91.85
Total essential amino acids (TEAA)	46.13	47.41	45.03	42.41	44.49
% (TEAA)	48.72	49.59	48.42	47.64	48.44
Total non-essential amino acids (TNEAA)	48.55	38.19	47.98	46.62	47.36
% (TNEAA)	51.28	50.41	51.58	52.36	51.56
Total neutral amino acids (TNAA)	53.60	54.31	52.10	49.30	51.46
% (TNAA)	56.61	56.81	56.02	55.37	56.03
Total acidic amino acids (TAAA)	23.97	23.56	24.21	24.25	24.14
% (TAAA)	25.32	24.64	26.03	27.24	26.28
Total basic amino acids (TBAA)	17.11	17.73	16.70	15.48	16.25
% (TBAA)	18.07	18.55	17.96	17.39	17.69
Total sulphur amino acids (TSAA)	3.78	4.13	3.66	3.35	3.76
% (TSAA)	3.99	4.32	3.94	3.76	4.09
% Cystine in TSAA	28.1	25.18	24.17	25.07	21.54
Total aromatic amino acids (TArAA)	7.52	7.29	7.13	7.04	7.41
% (TArAA)	7.94	7.63	7.67	7.91	8.07
Leusine/ leucine ratio	1.77	1.74	1.82	1.88	1.94
Leusine- isoleucine difference	3.12	3.06	3.23	3.27	3.41
% leu -Ile (difference)	43.5	42.56	45.17	46.71	48.44
P - PER(Predicted protein Efficiency Ratio)	2.46	2.46	2.45	2.38	2.38
EAAI(Essential Amino Acid Index)	100	102	97	92	96

Histidine content was in the range 2.58 to 2.82 g/100 g and differed significantly among the fish species $F(4, 10) = 9.788$, $p=0.0017$. The content in *L. niloticus* was lower than that in *O. niloticus* ($p<0.01$). There were no significant statistical differences ($P>0.05$) in histidine contents among *L. niloticus, R. argentea, L. miodon* and *S. tanganicae*. Arginine content 5.94 to 6.34 g/100 g differed significantly among the five fish species $F(4, 10) = 7.451$, $p = 0.0047$. Total amino acids (TAA) of *O. niloticus* were the highest (95. 60 g/100 g) and that of *L. miodon* were the lowest (89.03 g/100 g) Table 2. Total essential amino acids (TEAAs) for the species were 46.13 g/100 g for *L. niloticus*, 47.41g/100 g for *O. niloticus*, 45.03 g/100 g for *R. argentea*, 42.41 g/100 g for *L. miodon* and 44.49 g/100 g for *S. tanganicae*. There was a slightly higher percentage of total essential amino acids in *O. niloticus* at 49.59% of total amino acids than in *L. niloticus* at 48.72%, but these differences were not considered significant ($p = 0.0547$).

Glutamic and aspartic acids were the most concentrated in all the species. Such results were similar to those found by [24] in *C. anguillaris*; [26] in Sardines and [13] in *O. niloticus* respectively. The high levels of glutamic and aspartic acids in these fishes were as a result of conversion of glutamine and asparagines to their parents' dicarboxylic acids (glutamic and aspartic acids) during hydrolysis. [19] reported that glutamic acid, which is widely known is an important source of nitrogen, and is usually used to improve the taste of monosodium glutamate a "Mchuzi" mix commonly used in Asia and West Africa.

The most concentrated essential amino acid (EAA) in all the fish species was lysine. Contrary, to the data on amino acids of natural food products in which lysine reacts with oxidized lipids thereby reducing the lysine contents [12]. This result was comparable to the previous findings [1, 22-23]. However, the values of this study were higher than [15] reference value of 6.7 g/100g.

Unfortunately, lysine was considered as the limiting amino acid in cereal based diet consumed by many human populations [18]. A reduced supply of lysine in the diet may lead to mental and physical retardation because it is an important precursor for the *de novo* synthesis of glutamate, the most significant neuron - transmitter in the mammalian central nervous system. Deficiency of lysine in plant proteins such as cereals can thus be supplemented by consuming these fishes.

Generally, *L. miodon* contained lower concentrations of most amino acids than *L. niloticus, O. niloticus, R. argentea* and *S. tanganicae.* Such differences could be attributed to differences in dietary needs of the respective amino acids. It is also a reflection of differences in protein composition of each species [2].

The nutritive value and quality of dietary protein in fish depends upon the pattern and quality of amino acids present in it [17]. The total amino acids (TAAs) values in this study (89.03 to 94.68g/100g) were comparable to the findings of [8] in *T. guineensis*, [23] in commonly consumed fishes in Nigeria as well, as [9] in *O. niloticus*. However, the values were higher than those reported in G*. niloticus* [7]. The total essential amino acids (TEAA) of this study (42.41 to 47.41 g/100g) were slightly above the whole hen's egg reference protein of (46.30 g/100g) and more than the value of (40.7g/100g) [15]. Similarly, the values concurred well with findings of [23] in four commonly consumed fish species in Nigeria, as well as [9] in *O. niloticus*. Percentage TEAA of the samples (47 to 49.59%) was comparable to 46.2% reported in *Z. Variegates* [5]. However, the value was below those obtained in *G. niloticus* [7]. On the other side, the value was well above the 39% considered adequate for ideal protein food for infants, 26% for children and 11% for adults [14]. These results showed that the percentage amino acid contents of all the five fish species could satisfy human needs from all classes (infants, children and adults).

The predicted efficiency ratio (P-PER) is one of the quality parameter used for protein evaluation [15]. The P-PER in this study ranged between 2.38 to 2.46 and was comparable to the findings [23]. The value was higher than those in *C. anguillaris,* O*. niloticus,* and *C. Senegalensis*[6]. The standard reference for the P-PER is based on casein, a cow's milk protein, which has a P-PER of 2.5 [14] and the values obtained in this study were close to or equal to 2.5. Generally, a P-PER value below 1.5 approximately describes a protein as low or of poor quality [16]. Thus, all the fish samples analysed were of good quality as their P-PER values were above 1.5.

The essential amino acid index (EAAI) is useful as a rapid tool to evaluate food formulations for protein quality, although it does not account for differences in protein quality due to various processing methods or certain chemical reactions [21]. EAAI was based on the recommended value of [15] and the value is 100, while values above 100 are truncated to 100. The EAAI values of 100 and 102 from this study were comparable to the findings of [2] in *O. niloticus* as well, as [24] in *C. gariepinus*, *H. niloticus* and *S. schall*. Based on the calculated EAAI the quality of the amino acid proteins in the samples could be arranged in the following order: O. *niloticus*<*L. niloticus*<*R. argentea*< *S. tanganicae*<*L. miodon*.

An ideal protein should contain 5.5% lysine, 3.5% sulphur amino acids, 4% threonine, 7% leucine and 1% tryptophan [15]. These results showed that all the five fish species have satisfied the ideal protein.

Significantly, the nutritional and amino acids qualities of all the fish species suggest that they could be used to develop supplements for weaning and pre-school age children. Similar concept led to the development of a plant based protein supplement "Ewa-ogi" in Lagos, Nigeria and has proved effective in the prevention of protein- energy malnutrition [1].

CONCLUSION

The high values of EAAs, EAAI and P-PER of the five fish species confirmed that these species are good sources of high quality protein and amino acids to consumers. Thus, these fish species may have the potentials of reducing the incidence of protein- energy malnutrition in Tanzania by direct consumption and supplementation with cereal based diets.

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Conflict of Interest
No any conflict of interests whatsoever among the authors.

Authors Contribution
Abdulkarim and Bwathondi did the research work, Suleiman assisted in statistical analysis, while Ringim did editing and proof readings of the article.

REFERENCES

[1] Abdullahi, S. A., Nigerian Journal of Biochemistry and Molecular Biology, 2000. 15, p.39-44.
[2] Abdullahi, S. A., Nigerian Journal of Agriculture and Environment, 2002.3,p.359-366.
[3] Abdullahi, S. A., Balogun, J.K. Biological and Environmental Science Journal for the Tropics, 2006. 3,p. 153-155.
[4] Abdullahi, S.A., Suleiman, B., Proceedings of 33rd Annual conference of Nigerian Institute of Food Science and Technology,12th-16th October, 2009. Yola, Nigeria.
[5] Adeyeye, E. I., Tropical Science Journal, 2005.45, p. 141-143.
[6] Adeyeye EI. Amino acid composition of three species of Nigerian fish: *Clarias anguillaris, Oreochromis niloticus* and *Cynoglossus senegalensis*. Food Chemistry. 2009; 113(1): 43-6.
[7] Adeyeye, E.I., Adamu, A.S., Bioscience Biotechnology Research Association, 2005. 3, p.265-272.
[8] Aremu, M.O. Olonisakin, A. Opaluwa, O.D..Mohammed, Y. and Salau, R. B., Indian Journal of Multidisciplinary Research, 2007.3,p. 443 – 456.
[9] Aremu MO, Namo BS, Mohammed Y, Archibong CS, Ogah E., Effect of Different Sources of Heat on Nutritional Composition of Tilapia Fish (*Oreochromis niloticus*) Chemistry and Material Research Journal, 2014. 6, 5: 85-93.
[10] Bwathondi, P.O.J., Proceedings of a Seminar on Prevailing Activities on the Lake Victoria Basin with Particular Reference to the Fisheries of the Lake, 8-9 March,1990. Mwanza, Tanzania,p. 5-11,
[11] Benitez, L.V., Association of Fish Society Special Publication, 1989; 4: 166.
[12] Castrillón AM, Alvarez-Pontes E, Arias MT, Navarro P. Influence of Frozen Storage and Defrosting on the Chemical and Nutritional Quality of Sardine ((*Clupea pilchardus*). Journal of the Science of Food and Agriculture. 1996; 70(1): 29-34.
[13]Fabiola, H.M., Martha,E.A.M., Revised Electronic de Veterinarie2012.13,p.4.
[14] FAO/WHO/UNU, Energy and Protein Requirements, WHO Technical Report Series No. 275, Geneva, 1985.p.204.
[15] FAO/WHO. Protein Quality Evaluation Report of Joint FAO/WHO Expert consultative, FAO Food and Nutrient, 1991.
[16] Friedman M. Nutritional value of proteins from different food sources. A review. Journal of Agricultural and Food Chemistry. 1996; 44(1): 6-29.
[17] Halver, J. E. Fish Nutrition, 2nd ed San Diego California, USA. Academic press Inc.1989.p. 280.
[18] Chapman KP, Courtney-Martin G, Moore AM, Langer JC, Tomlinson C, Ball RO, Pencharz PB. Lysine requirement in parenterally fed postsurgical human neonates. The American Journal of Clinical Nutrition. 2010; 91(4):958-65.
[19] Lopez, A., Ingredients in a complete course in canning, Mary land, Canning Trade Baltimore, 1975. P.308.
[20] Macdonald, P., Edwards, R.A., Greenhead, J.F.D., Animal Nutrition (4th ed), UK, Longman Group Ltd, 1996.p. 117
[21] Nielsen, S.S. Introduction to the Chemical Analysis of Foods, New Delhi, CBS Publishers and Distributors,2002. p. 233- 247.
[22] Oduho, G.W., Baker, D.H., Tuitoek, J.K., Agriculture Tropical and Subtropical Journal, 2005; 38: 82-87.
[23] Oluwaniyi OO, Dosumu OO, Awolola GV. Effect of local processing methods (boiling, frying and roasting) on the amino acid composition of four marine fishes commonly consumed in Nigeria. Food Chemistry. 2010; 123(4): 1000-6.
[24] Oyebamiji, O.F., Fagbohun, T.R., Olubanju, O.O., Turkish Journal of Fish and Aquaculture Science, 2008; 8: 7-13.
[25] Qyvind L, Einar L, Amund M, Leif RN, Kjartan S. Nutrient content in fish and Shellfish. Fisk. Div. Skr. Ernaering. 1994; 6:1-101.
[26] Selmi S, Batista I, Sadok S, Bandarra NM, Nunes ML. Chemical Composition Changes and Fat Oxidation in Sardine Mince Following Sodium Bicarbonate and Sodium Chloride Washing. Journal of food process engineering. 2010; 33(6): 1036-51.
[27] Zygmunt U, Joana SR, Maria A, Protein

quality and amino acid profiles of fish products available in Poland, Food chemistry, 2009; 112: 139-145.
[28] Steiner-Asiedu M, Lied E, Lie Ø, Nilsen R, Julshamn K. The nutritive value of sun-dried pelagic fish from the rift valley in Africa. Journal of the Science of Food and Agriculture. 1993; 63(4): 439-43.
[29] Sven,E.J., Gaspard, N.,Sixtus, K.,Lake Tanganyika: Experience and lessons learned brief. 2006.p. 363-376. Retrieved on 15th September, 2012. from www.google.com.
[30] Witte, F.,Van Densen, W.L.T.,Fish Stocks and Fisheries of Lake Victoria. Samara publishing Limited, Canada, Great Britain. 1995.p. 404.
[31] Zygmunt U, Joana SR, Maria A, Protein quality and amino acid profiles of fish products available in Poland, Food chemistry, 2009; 112: 139-145.