Journal of Agricultural, Food and Environmental Sciences, Vol 74 No 2 (2020) 80-85
https://doi.org/10.55302/JAFES20742079o

Original scientific paper

ORGANOLEPTIC ASSESSMENT AND FATTY ACID PROFILES OF NILE TILAPIA *OREOCHROMIS NILOTICUS* REARED UNDER DIFFERENT CULTURE FACILITIES

Oluwalola O.I* and Adebayo O.T.

Department of Fisheries and Aquaculture Technology, Federal University of Technology, Akure, Ondo State, Nigeria, tuyioluwalola@yahoo.com (*corresponding Author)

ABSTRACT
This research was conducted to determine the fatty acid composition and organoleptic assessment of *Oreochromis niloticus* from different culture facilities (plastic, sandcrete tanks and earthen ponds), at the Teaching and Research Farm of the Department of Fisheries and Aquaculture Technology, the Federal University of Technology, Akure, Ondo State, Nigeria. The comparative work was carried out to find out if habitat could influence the nutrient composition of the fish. Standard procedures were used in the analysis of tissue nutrient. Organoleptic assessment study revealed differences in taste indices considered for *O. niloticus* reared in plastic, sandcrete tanks and earthen ponds ($p<0.05$). Fatty acid profiles of *O. niloticus* were determined using Gas chromatography-mass spectrometry (GC-MS) method. The percentage of saturated and unsaturated fatty acids was higher (50.08%, 21.22%) in earthen pond cultured *O. niloticus* than the plastic and sandcrete tanks. The study revealed that *O. niloticus* raised in earthen pond possess some nutritional advantages over the plastic and sandcrete tanks.

Keywords: Organoleptic assessment, Fatty acids, Culture facilities, *Oreochromis niloticus*.

INTRODUCTION
Fisheries products are recommended for human consumption because they reduce the risk of cardiovascular diseases in human beings (Kang and Leaf, 1996). Fish are an essential constituent of human diet and the benefit of this adequate matter is highly linked to the quality of their lipid content, a source of essential polyunsaturated fatty acids (PUFA), mainly eicosapentaenoic acid (EPA), docosahexaenoic acid and linoleic acid (DHA) (Harris, *et al*., 2008, Baum, *et al*., 2012). Fish, a major product of aquaculture is an important source of protein for the teeming population in developing nations (FAO, 2018). Fish and fishery products play a critical role in global food security and the nutritional needs of humans' health (FAO, 2018).

Aquaculture is one of the fastest growing food-producing sectors in aquatic field and is set to play a key role in meeting the rising demand for fishery products due to increase in human population and decline natural fisheries resources (FAO, 2018). One of the priorities of aquaculture is the increase in the production of fish because the amount of fish capture from natural resources is no longer capable to meet the demand of the increasing population due to the almost stabilized catch yields since 2011 according to FAO (2016).

Nile tilapia (*Oreochromis niloticus*) (Trewavas, 1983) is a cichlid fish native to Africa. It has been successfully farmed under a wide range of environmental conditions and is an important aquaculture fish species in many parts of the world, particularly in tropical and sub-tropical

countries (El-Sayed, 2006; Dagne *et al*., 2013). It is considered to be one of the most productive and internationally traded food fishes in the world (Chakraborty and Benerjee, 2012; Hernandez *et al*., 2013; Siddik *et al*., 2014). Today, *O. niloticus* has become the shining star of aquaculture with many farms beginning and others expanding as consumption rate increases across the globe (Fitzsimmons, 2005; Ogello *et al*., 2014). The success of *O. niloticus* is related to the fact that it grows and reproduces in a wide range of environmental conditions, has a low trophic level for feeding and tolerates stress induced by handling and poor water quality (Liti *et al*., 2005; Tsadik and Bart, 2007; Dagne *et al*., 2013).

The acceptance of fish or fisheries products by the consumer depends on several attributes of fish quality. They are nutrient content, microbial load with biochemical and physiochemical properties like flavor, texture, odour and colour (Alam, *et al*., 2012). Factors that affect the sensory properties of both wild and cultured fish are grouped to be endogenous and exogenous factors. Species, sex, size, age and strain of the fish are the major endogenous factors of the fish while feeding, nutrition, seasonal variation, environmental factors, culture practices and processing conditions are exogenous factors (Huss, 1995).

Thus, the aim of the present study is to determine the influence of the environment on the fatty acid profiles and organoleptic characteristics of *Oreochromis niloticus* from different culture facilities (plastic, sandcrete tanks and earthen ponds), with the view of finding out if there is any difference in their nutritional status, which will help the consumers to make a good choice in tilapia consumption.

MATERIALS AND METHODS

Samples Collection

Nile tilapia (*Oreochromis niloticus*) used for this study was obtained from different culture enclosures (plastic, sandcrete tanks and earthen ponds), at the Teaching and Research Farm of the Department of Fisheries and Aquaculture Technology, the Federal University of Technology, Akure, Ondo State. Twelve fish samples of average weight 127±2.03g from each facility were selected for fatty acid composition and sensory profile.

Sensory Evaluation

This was undertaken to determine the taste, odour, mouth feel (texture) and general appearance (colour) of the smoked experimental fish product (Plastic, Sandcrete and Earthen). The organoleptic assessment was evaluated by ten trained panel of judges selected from the Teaching and Research Farm of The Department of Fisheries and Aquaculture Technology, Federal University of Technology, Akure, Ondo State, Nigeria. Questionnaires for the panelists score were prepared using hedonic scale described by Eyo (2001) as follows: 7-6 very good; 6-5 good; 4-3 fair; 2-1 poor and 0 - Bad

Fatty Acid profile determination

The oil used for the fatty acids was extracted from three representative samples from each source using hexane extraction method (AOAC, 1995). The fatty acids composition of tissue of *Oreochromis niloticus* was determined using methyl-esters, prepared by standard method on Gas Chromatography/ Mass spectrometer (GCMS) with model number GCMS-QP2010 Shimadzu, Japan with flame ionization detector. The injection and detection temperature were 250^0C and 250 ^{o}C respectively. The carrier gas used was Nitrogen at the flow rate of 3ml/min.

Data analyses

The data collected were analysed by one-way analysis of Variance (ANOVA) at 95% confidence level using SPSS (version 22) as described by Steel and Torrie (1980). Comparisons among means were separated using Duncan Multiple Range Test (DMRT) at $p<0.05$.

RESULTS

The organoleptic parameters (appearance, texture, odour and taste) of *Oreochromis niloticus* obtained from the three culture facilities, (Plastic, Sandcrete tanks and Earthen pond) are presented in Figure 1. There was no significant difference ($p>0.05$) in the mean values of appearance, texture and odour. However, the means value of taste shows significant difference ($p<0.05$) in the three culture facilities. Result reveals that the panelist takes preferences in the taste of earthen *O. niloticus*. However, the taste of *O. niloticus* reared in earthen pond had the highest score of (6.60± 0.16) while *O. niloticus* reared in sandcrete and plastic had the lowest value of 5.80± 0.13 and 5.80± 0.13, respectively. However, texture analysis determined higher firmness value for sandcrete tank and earthen pond (4.50±0.17 and 4.50±0.17) when compared to plastic tank (4.40±0.16).

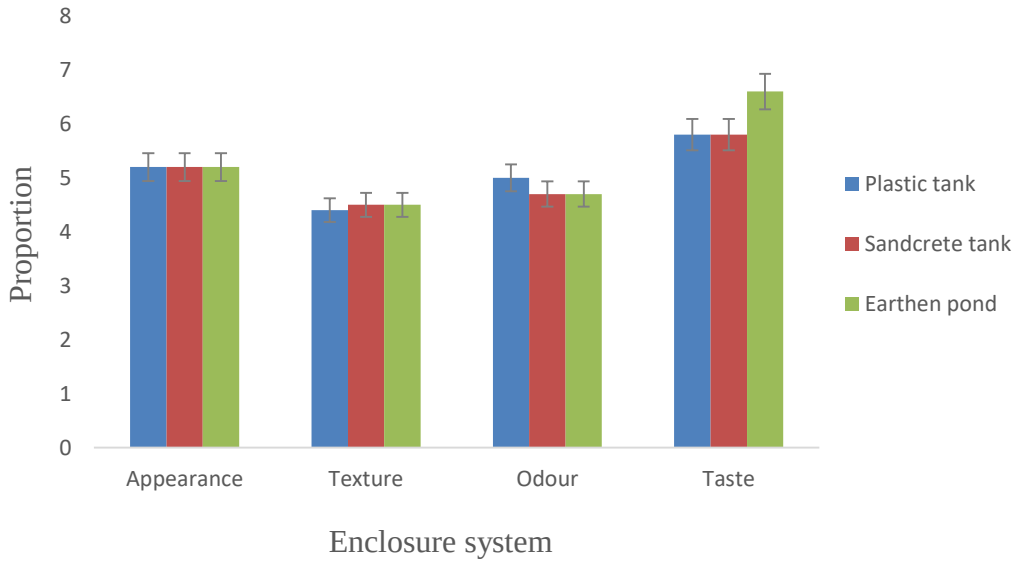

Figure 1. Organoleptic assessment of *Oreochromis niloticus* reared under different culture facilities (plastic tank, sandcrete tank and earthen pond)

The result of the fatty acids profile of *Oreochromis niloticus* from this present study showed the occurrence and proportion of saturated and unsaturated fatty acids in the three culture facilities (plastic, sandcrete tanks and earthen ponds) respectively as shown in Table 1 was significantly difference ($p<0.05$). However, the occurrence of C12:0, C14:0, C16:0, C18:0, C20:0, C22:0, C16:1, C18:1, C20:1 and C22:1 were noticed in *O. niloticus* from the three culture enclosures. It was observed that the percentage of saturated and unsaturated fatty acid was higher in *O. niloticus* reared in earthen pond than sandcrete and plastic tanks.

The following range of values 0.08-0.10 %, 4.42-4.68 %, 33.8-36.8 %, 9.22-10.4 %, 0.35-0.43 %, 0.61-0.68 %, 8.36-9.40 %, 10.45-11.31 %, 0.22-0.27%, 0.20-0.24% was obtained for lauric acid, myristic acid, palmitic acid, stearic acid, arachidic acid, behenic acid, palmitoleic acid, oleic acid, gadoleic acid, cetoleic acid concentration respectively.

Table 1. Fatty acid composition of *Oreochromis niloticus* from the Three Culture Facilities (Plastic, Sandcrete Tanks and Earthen Pond)

Saturated Fatty Acid	Plastic Tank	Sandcrete Tank	Earthen Pond	Unsaturated Fatty Acid	Plastic Tank	Sandcrete Tank	Earthen Pond
C12:0 Lauric Acid	0.08±0.01^{a}	0.09±0.01^{ab}	0.10±0.00^{c}	C16:1 Palmitoleic Acid	8.34±0.01^{a}	8.36±0.01^{b}	9.40±0.00^{c}
C14:0 Myristic Acid	4.42±0.01^{a}	4.43±0.01^{a}	4.68±0.04^{c}	C18:1 Oleic Acid	10.45±0.01^{a}	10.52±0.01^{b}	11.31±0.06^{c}
C16:0 Palmtic Acid	33.8±0.01^{a}	34.1±0.01^{b}	36.8±0.06^{c}	C20:1 Gadoleic Acid	0.22±0.01^{a}	0.23±0.01^{a}	0.27±0.01^{b}
C 18:0 Stearics Acid	9.52±0.01^{a}	9.55±0.03^{a}	10.4±0.06^{c}	C22:1 Cetoleic Acid	0.20±0.00^{a}	0.21±0.00^{a}	0.24±0.00^{b}
C 20:0 Arachidi Acid	0.35±0.01^{a}	0.38±0.01^{b}	0.43±0.01^{c}				
C22:0 Behenic Acid	0.61±0.01^{a}	0.64±0.01^{b}	0.68±0.01^{c}				
Total	**48.6**	**49.19**	**53.08**		**19.21**	**19.27**	**21.22**

Means in the same row with different superscripts are significantly different at ($p<0.05$)

DISCUSSION

Organoleptic assessment in this study revealed that the score of graded parameters of *O. niloticus* such as: appearance, texture and odour show no significant difference ($p>0.05$) from the three culture facilities. However, the result revealed that there was significant difference in the taste of *O. niloticus* reared in earthen pond with higher value of (6.60) than sandcrete/plastic tank value of (5.80 and 5.80). The sensory attributes as observed by the response of the ten (10) member evaluator panel showed that people preferred *O. niloticus* reared in earthen pond than sandcrete and plastic tank. The present study report was in agreement with the observation reported by Adetuyi *et al.* (2011), on proximate composition and sensory analysis of African Catfish (*Clarias gariepinus*) harvested from different sources in Ondo State, Nigeria.

From a human consumer point of view, all fish are considered to be of similar nutritional value, and selection is chiefly based on availability, freshness, flavour and similar factors (Hearn and Sgoutas 1987). On the other hand, results of clinical and epidemiological research suggest that fat composition is very important because of their beneficial effects on human health (Simopoulos, 2002). Therefore, when fish are suggested as a means of improving health, fat quality must be considered (Roche, 1999). The quality of fat has been described using different fatty acids groups such as PUFA/SFA, n-3/n-6 and n-3 HUFAS distribution (Ahlgren *et al*., 1994; Muller-Navarra *et al*., 2000).

The fatty acid profile values obtained in the present study, showed variations in the composition and proportion in *O. niloticus* reared in the three culture enclosures. The range of the values recorded for Palmitic acid (33.8-36.8), Stearic acid (9.22-10.4), Palmitoleic acid (8.36-9.40) and Oleic acid (10.45-11.31) in the present study agreed with the value range recorded by Ashraf *et al.* (2008) on fatty acid composition of Nile tilapia *oreochromis niloticus* muscles: a comparative study with commercially important tropical freshwater fish in Philippines. However, the value of Lauric acid, Myristic acid, Arachidic acid, Behenic acid, Gadoleic acid and Cetoleic acid gotten from the three facilities from this present study was lower than the values recorded by Osibona *et al.* (2009) on fatty acid composition and amino acid profile of two freshwater species, African catfish (*Clarias gariepinus*) and Tilapia (*Tilapia zillii*).

The occurrence of these compounds varied with culture facilities. Palmitic acid which is known to increase blood cholesterol was the dominant saturated fatty acids in *O. niloticus* from the three culture facilities. This was similar to the report of Ibhadon *et al*. (2015) who observed that palmitic acid was a key metabolite in fish.

CONCLUSION

From the experiment carried out, it was generally found out that the results of this research has established a reference value regarding the selected fatty acids profile and organoleptic assessment of the Nile Tilapia, *Oreochromis niloticus* under different culture facilities (plastic, sandcrete tanks and earthen pond) employed in this study.

REFERENCES

Adetuyi, F. O., Osagie A. U., and Adekunle A. T. (2011). Proximate composition and sensory analysis of African Catfish (Clarias gariepinus) harvested from different sources in Ondo State, Nigeria. Journal of Food Nutrition. 1:49–54.

Ahlgren, G., Blomqvist, P., Bobserg, M. and Gustafsson, I. B. (1994). Fatty acid content of the dorsal muscle an indicator of fat quality in freshwater fish. Journal of Fish Biology. 45: 131–157.

Alam, S., Khan, N., Nasir, M., Javid, A., Khan, T and Tayyab, A (2012). Chemical and sensory quality changes in wild and farmed fish flesh (Labeorohita) at frozen storage (-180C). The Journal of Animal and plant Sciences. 22(3):614-618.

AOAC, (Association of Official Analytical Chemist) (1995). Official methods of analysis of Association of Official Analytical Chemist. 11th edition. Arlington, Virginia. 1(2):10

Ashraf, S., Hiroshi, Y.O, Esteban S.G., Denny R.C and Ehab R.E. (2008). Fatty acid composition of Nile Tilapia Oreochromis niloticus muscles: A comparative study with commercially important tropical freshwater fish in Philippines. 8th International symposium on Tilapia In Aquaculture. pp 921-932.

Baum, S.J., Kris-Etherton, P.M., Willett, W.C., Lichtenstein, A.H., Rudel, L.L and Maki, K.C (2012). Fatty acids in cardiovascular health and disease: A comprehensive update. Journal of Clinical Lipidology. 6:216-234. pmid:22658146.

Chakraborty, S. B. and Banerjee, S. (2012). Comparative growth performance of mixed-sex and monosex Nile tilapia at various stocking densities during cage culture. Recent Research in Science and Technology. 4: 46-50.

Dagne, A., Degefu, F., & Lakew, A. (2013). Comparative growth performance of mono-sex and mixed-sex Nile tilapia (Oreochromis niloticus L.) in pond culture system at Sebeta, Ethiopia. International Journal of Aquaculture. 3: 30-34.

El-Sayed, A. F. M. (2006). Tilapia culture. Wallingford, Oxfordshire, UK, CABI Publishing. pp. 1- 45.

Eyo, A.A., (2001). Fish processing technology in the tropics, National Institute for Freshwater Fisheries Research. University of Ilorin press. pp 66-70

FAO, (2016). State of World Fisheries and Aquaculture Report. 2016 edition, Food and Agriculture Organization of the United Nations, Rome, Italy. pp 10-14

FAO, (2018). State of World Fisheries and Aquaculture Report. 2018 edition, Food and Agriculture Organization of the United Nations, Rome, Italy. pp 14

Fitzsimmons, K. (2005). Tilapia culture. In: Kelly, A. M., Silverstein, J. (eds), Aquaculture in the 21st Century: American Fisheries Society; Symposium 46, Bethesda, Maryland, pp. 563-590.

Harris, W.S., Miller, M., Tighe, A.P., Davidson, M.H and Schaefer, E.J (2008). Omega-3 fatty acids and coronary heart disease risk: Clinical and mechanistic perspectives. Atherosclerosis. 197:12-24. pmid:18160071

Hearn, T. L., Sgoutas, S. A., Hearn, J. A and Sgoutas, D. S. (1987). Polyunsaturated fatty acids and fat in fish flesh for selecting species for health benefits. Journal of Food Sciences. 53: 1209–1211.

Hernandez, M., Gasca-Leyva, E., and Milstein, A. (2013). Polyculture of mixed-sex and male populations of Nile tilapia (Oreochromis niloticus) with the Mayan cichlid (Cichlasoma urophthalmus). Aquaculture. 1: 418 – 419.

Huss, H.H (Ed.). (1995). Quality and quality changes in fresh fish. FAO Fisheries Technical Food and Agriculture Organization (FAO) of the United Nations, Rome, Italy, 348.

Kang, J. X. and A. Leaf. 1996. The cardiac antiarrhytmic effects of polyunsaturated fatty acid. Lipids. 31: 41-44.

Liti, D., Cherop, L., Mungitti, J., & Chhorn, L. (2005). Growth and economic performance of Nile tilapia (Oreochromis niloticus) fed on two formulated diets and two locally available feeds in fertilized ponds. Aquaculture Resource. 36: 746-752.

Muller-Navarra, D. C., Brett, M. T., Liston, A. M and Goldman, C.R. (2000). A highly unsaturated fatty acid predicts carbon transfer between primary producers and consumers. Nature. 403: 74–77.

Ogello, E.O., Musa, S., Aura, C. M., Abwao, J. O. & Munguti, J. (2014). A critical appraisal of feasibility of tilapia production in earthen ponds using biofloc technology, a review. International Journal of aquatic sciences. 5: 21-39.

Osibona, A. O., Kusemiju, K., & Akande, G. R. (2009). Fatty acid composition and amino acid profile of two freshwater species, African catfish (Clarias gariepinus) and Tilapia (Tilapia zillii). African Journal of Food, Agriculture. Nutrition and Development. 9: 608-621.

Roche, H. M. (1999). Unsaturated fatty acids. Proceedings of the Nutrition Society. 58: 397–401.

Siddik, M. A. B., Nahar, A., Ahamed, F., and Hossain, M.Y. (2014). Over-wintering growth performance of mixed-sex and mono-sex Nile tilapia Oreochromis niloticus in Northeastern Bangladesh. Croatian Journal of Fisheries. 72: 70 – 76.

Simopoulos, A. P. (2002). The importance of the ratio of omega-6/omega-3essential fatty acids. Biomedicine and Pharmacotherapy. 56: 365–379.

Steel, R. G. D. and Torrie, J. H. (1980). Principles and procedures of statistics: A biometrical approach. McGraw Hill Book Company, New York. pp. 101-123.

Tsadik, G. G. and Bart, A. N. (2007). Effects of feeding, stocking density and water-flow rate on fecundity, spawning frequency and egg quality of Nile tilapia, Oreochromis niloticus (L.). Aquaculture. 272: 380-388.