PROXIMATE COMPOSITION OF *Oreochromis niloticus* SUBJECTED TO DIFFERENT PRESERVATION METHODS

NWAMBA, Helen Ogochukwu
Department of Applied Biology, Enugu State University of Science and Technology, Enugu State, Nigeria. **Email:** nwambahelen@yahoo.com **Phone:** +234 8036731557

ABSTRACT

Twenty one (21) specimens of Oreochromis niloticus (total weight 400g) were collected from a market in Enugu metropolis and used to assess the effects of different preservation methods on proximate composition. The fish samples were stored for 28 days. Preservation and processing methods adopted were: refrigeration, deep-freezing, oven-drying, straight-smoking and salted smoking. The oven-dried, straight-smoked, and salted-smoked samples were stored in polythene bags at room temperature in the laboratory. Moisture, protein, fat, fiber and ash contents of all the sample were determined according to the Association of Official Analytical Chemists procedures. Free preservation on storage led to significant decrease (P<0.05) in the percentage ash, crude protein and fat contents of fish samples. The greatest reduction was observed in refrigerated samples while salted-smoked samples were the least affected. There was a significant difference (P<0.05) between the storage period and the free-fatty acid of the samples. The refrigerated samples showed the highest levels of rancidity while the salted-smoked method gave the highest level of stabilizing in the proximate composition on storage for 28 days.

Keywords: *Oreochromis niloticus*, Preservation methods, Proximate status

INTRODUCTION

In view of the increasing importance of tilapia (*Oreochromis niloticus*) as a cheap and affordable source of animal protein, the need to improve its handling, preservation and storage becomes necessary. Nigeria's annual demand for fish is rising astronomically and in order to meet this demand, measures must be taken to reduce heavy post-harvest losses through deliberate and conscious application of science and technology (Jones and Disney, 1967; Talabi 1977; Okpanefe, 1982).

The artisanal sector of Nigeria's fishery industry is faced with problems of spoilage and contamination of harvested fish. This is attributed to the fisher-folks' pattern of handling, processing and storage. Talabi and Igbinosun (1984) had estimated losses by weight of fish produced to be up to 45 %. The agents of spoilage (bacterial and autolytic enzymes) operate under optimum conditions. Bacteria require water to exist and are sensitive to heat, salt concentration and pH (Tobor, 1984). In Nigeria, temperature is very ambient for fish to get spoilt rapidly within 24 hours. This confirms Jones and Disney (1967) view that fish is a notorious perishable commodity. Microbial species primarily associated with fish spoilage belong to the genera *Pseudomonas, Micrococcus, Staphylococcus, Salmonella, Bacillus* and *Clostridium* (Ejike and Mohammed, 1982). Aribisalla (1978) noted that fish muscles are generally considered sterile when freshly caught, but when dead, the bacteria at the surface of the body, in the gills and intestines gradually penetrate into the sterile muscle. Ejike and Ezebialu (1983) investigated the effect of tissue water and temperature on bacteria load of deteriorating *Sarotherodon niloticus* and found that *Pseudomonas* and *Micrococcus* were the dominant organisms associated with

spoilage. When fish dies, a number of physical and chemical changes leading to spoilage take place in its body. Majority of quality changes that occur in fish result from protein denaturation and rancidity (Frazier and Westhoff, 1986).

Frazier and Westhoff maintained that fish oils seem to be susceptible to quick oxidative deterioration than most animal fats. Fatty fish is known to spoil quickly due to oxidation of fatty acids and lipid oxidation leading to rancidity. Reay *et al.* (1943) described the succession of external changes, in fish as it spoils and finally becomes putrid. They maintained that the bright characteristic colour of fish, fades giving rise to dirty-yellow or brownish discoloration. The most remarkable is the softening of the flesh and the exudation of juices when squeezed.

Owing to the prevailing temperature in Nigeria, fish preservation becomes a crucial aspect of fisheries commerce. Ikeme (1985) considered this problem and stipulated that only a negligible proportion of fish caught in the Nigerian rivers and lakes can be described as fresh since out of all flesh foods, fish is considered the most susceptible to autolysis. Oxidation and hydrolysis of fats as well as microbial spoilage, it becomes imperative that its preservation strategies must be prompt. Sorinmade *et al.* (1982) reported that refrigerated sea water at 4^{o}C extended the storage life of *O. niloticus* for 18 – 28 days and maintained that all chemical parameters increased: thus minimizing the probability of nutrient losses during storage. Improvement of refrigeration facilities in both developed and developing countries has made refrigeration systems become more reliable and easier to use. Although some of the contaminating micro-organisms are killed in the process of freezing of fish (Cutting and Spencer 1968). Most of the psychrophilic micro-organisms associated with fish grow below 0°C.

Graham (1982) noted that when fish are correctly frozen after catch and stored in proper manner at the recommended temperature of 30°C, they do not keep indefinitely. Moisture control, primarily by drying provides an opportunity to prevent losses, which occur during harvesting, 'handling and storage. During smoking of fish, two distinct processes occur: i.e. drying which result in the characteristic texture and addition of smoke constitutes which results in the appropriate flavour in the product apart from its preservative effects (Foster and Simpson, 1961). The important aspects in the quality of smoked *O. niloticus* are concerned with freshness and manner of preparation of the raw material, the smoking process, the post-processing storage, transportation and retailing. Against this background, this study was aimed at evaluating the nutritional characteristics of *O. niloticus* preserved and stored under various conditions for a period of 28 days. The main focus was on the loss of nutrients arising from poor preservation and handling. Hence proximate composition of fish samples under various preservation methods were determined and compared. Assessments were made of the physico-chemical and fatty acid values of the fish samples.

MATERIALS AND METHODS

Fish: A total of twenty-one live specimens of *O. niloticus* (total weight 400g) used for this experiment were collected from the Artisan market, Ogui Road, Enugu, Nigeria. The fishes were descaled, degutted and thoroughly washed in clean water. Immediately after degutting, parts of the muscles of the fish samples were removed and divided into six sub-groups (15 g each). One group which served as the control was immediately taken for proximate chemical analysis, while the remaining five groups were subjected to five modes of processing and preservation viz: refrigeration, deep freezing, oven drying, straight smoking and salted smoking.

Processing and Preservation Techniques: Fish samples for the first group subjected to refrigeration were put in polythene bag, labeled and stored in a refrigerator at 0°C for 28 days, while the second group was wrapped in polythene bag, labelled and stored in a deep freezer at -10°C for 28 days. The third group was as well placed in a clean aluminum tray and

introduced into an isothermal oven pre-set at 105°C ± 5°C and dried for 4 hours. This was allowed to cool and transferred into a labeled polythene bag and stored at room temperature (25°C±4°C) in the laboratory for 28 days. A smoking Kiln (temperature 80°C – 85°C) was used to smoked another sample for 8 hours, after this the sample was allowed to cool at room temperature and packed in a labelled polythene bag and stored in the laboratory at room temperature (25°C ± 4°C) for 28 days. The last group of fish sample was soaked in 5 percent sodium chloride solution for an hour. The sample was smoked for 48 hours at 95°C ± 5°C, cooled at room temperature and stored at 25°C ± 4°C in a labelled polythene bag for 28 days.

Chemical Analysis: Proximate composition of each experimental fish sample was carried out to analyse protein, crude fibre, ash, moisture and fat composition using AOAC (1990). Metabolisable energy was determined using the bomb calorimetric method and carbohydrate by difference (AOAC, 1990). Free fatty acids were estimated using the lipid chromatographic method of Marrinetti (1967). Chemical analyses were done at day 0, 14 and 28.

Statistical Analysis: Data collected were analysed using analysis of variance (ANOVA) (Steel and Torrie, 1980) at 5% level of significance.

RESULTS AND DISCUSSION

The oven-dried, straight-smoked and salted-smoked samples showed significant differences ($P > 0.05$) from the refrigerated and deep-froze samples. The values for the various parameters also showed that the wet samples (control) had high moisture content and corresponding low fat values. The dried samples did not show very significant variations except the ash of salted-smoked treatment.

The pattern of distribution of values indicated that the percentage crude protein level of the treated samples and storage periods were significantly lower than those immediately after treatment at day 0. In all methods of preservation, the salted-smoked sample gave the highest crude protein on day 28 although straight-smoked sample had higher values on day 14 (Table 1).

The percentage fat content of fish muscles for the various storage methods showed that the refrigerated sample had the highest level of fat during storage, while the oven-dried and salted-smoked samples had the lowest level of fat, respectively (Table 1).

The changes in mineral composition as indicated by the ash values at day 0 were significantly higher ($P>0.05$) than values obtained at day 28. The salted-smoked sample had the lowest percentage of degradation in nutrients while the refrigerated sample had the highest nutrient loss.

The free fatty acid content of fish oil obtained during the various preservation methods showed progressive increase in free fatty values of each treatment up to day 14 followed by a decline in day 28, though at varying degrees (Table 1).

Fish undergoes appreciable deterioration in time not only at ambient temperature but even at cold storage temperatures of down to -30 °C. The quality of fish during storage is affected by the method of preservation. The observations of this research are in agreement with this view.

Results obtained from this study indicated that the different methods of preservation caused significant changes ($P<0.05$) in the proximate composition of the muscle tissues of *O. niloticus.*

All the fish wet preserved had high moisture content, while the dried samples had lower moisture values. This loss of moisture led to the different concentrations of the various nutrients in the resultant dried fish.

Estimation of ash indicated loss of nutrients during storage as shown by the decline in the percentage ash with highest losses obtained for samples under refrigeration. The salted-smoked and oven-dried fish samples produced the least variation in loss of minerals (ash) as compared to smoked, frozen and refrigerated samples.

Table 1: Some nutrient composition of *Oreochromis niloticus* subjected to various methods of preservation after 0, 14 and 28 days post preservation

Parameters	**Proximate composition (%)**								
Preservation methods	**Fresh sample**			**Refrigeration**			**Deep Freezing**		
Days	**0**	**14**	**28**	**0**	**14**	**28**	**0**	**14**	**28**
Carbohydrate	0.40	0.39	0.39	0.40	0.43	0.44	0.42	0.41	0.42
Moisture	70.59	70.60	77.61	76.82	76.84	76.80	77.10	77.21	77.18
Fibre	0.46	0.45	0.49	0.45	0.46	0.48	0.45	0.44	0.60
Protein	17.74	17.72	17.71	17.73	16.43	14.90	17.83	16.83	15.89
Fat	1.60	1.61	1.60	1.59	1.42	1.13	1.52	1.40	1.18
Ash	3.80	3.79	3.81	3.78	2.98	2.23	4.06	3.63	2.88
Fatty acids	3.70	3.71	3.66	3.65	5.34	4.56	3.58	4.81	4.39
	Straight Smoking			**Salted Smoking**			**Oven Drying**		
Carbohydrate	0.44	0.41	0.39	0.41	0.42	0.43	0.41	0.42	0.43
Moisture	18.60	18.62	18.62	21.60	21.59	21.60	17.58	17.60	17.62
Fibre	0.95	0.92	0.94	0.71	0.72	0.72	0.65	0.65	0.66
Protein	19.41	19.02	18.37	19.65	18.60	19.48	19.48	18.46	17.96
Fat	3.12	2.83	2.56	3.86	3.55	3.42	3.36	3.15	2.97
Ash	7.73	6.94	5.84	10.73	9.65	8.96	6.07	5.44	4.93
Fatty acids	4.23	5.85	5.42	4.57	5.76	5.42	4.46	5.24	4.50

This could be attributed to earlier observation made by Burges and Bannerman (1963) that drying and salting reduce the amount of water in the tissues available to spoilage by micro-organisms. This can further be explained by the findings of Igene (1983) that fish during smoking becomes impregnated with wood smoke and is thus given a distinctive flavour and becomes less liable to spoilage, since many components of the wood smoke act as antiseptic.

From the nutritional point of view, the most important quality parameter for fish is its protein content. Results obtained from this experiment indicated that the different methods of preservation led to significant decrease ($P<0.05$) in the percentage protein content of the muscle tissues of *O. niloticus.* Similarly decrease in crude protein was observed by Ufodike and Obureke (1989) when the effect of preservation techniques on quality of *O. niloticus* muscle was investigated. The workers reported that the gradual decrease in percentage protein level with storage time was probably due to hydrolysis of protein during autolysis in the fish tissue.

Ojobe *et al.* (1992) had made similar observations while working on crude protein levels of *Clarias gariepinus.* Reduction in crude protein level could be due to trimeihylamine and formaldehyde present in varying amounts in fish flesh (Dingle and Hynes, 1975). They stated that the amounts of these compounds sometimes increase during storage while protein content decreases.

It was evident from the results obtained that crude protein deterioration was most pronounced in fish preserved by refrigeration (17.73 – 14.90). This was followed by deep-freezing (17.80 – 15.89) and oven-dried sample. Least reduction in crude protein were observed in straight-smoked (19.41 – 18.37) and salted-smoked sample (19.65 – 18.60). This suggested that salt-smoking is the best method for preserving *O. niloticus.*

Results obtained showec[1] variations in the fat content of the various methods of preservation. There were higher fat values in the dried samples, due to the loss of moisture in processing the fish muscle by drying. This trend was observed by Talabi and Igbinosun (1984) who contended that fish has inverse high or low water content depending on the fat content. It

is evident from this study that the refrigerated sample had the highest variation in value followed by deep-freezing samples.

Oven dried, straight and salted smoked samples had the least decline in percentage fat on storage. Similarly, the values for free fatty acids showed marked variations; with all the samples increasing in free fatty acids in the first two weeks and showing varying degrees of decline after four weeks. This may be explained by the observation made by Cutting and Spencer (1968) that the development of rancidity in fish during storage is due chiefly to the atmospheric oxidation assisted by certain tissue enzymes activated by the large proportion of highly unsaturated fat in fish

Conclusion: The authors wish to mention that results obtained from this research showed that salted-smoked fish gave least variation in proximate composition. It should therefore be employed as the best method for preserving fish among others. This becomes more appropriate because apart from the preservative effect of the method on the product, it adds flavour to fish tissue. Further research is recommended on the refrigeration of salted-smoked fish in order to compare its effectiveness in sustaining the nutritional quality of fish during storage.

REFERENCES

ARIBISALLA, O. A. (1978). Microflora associated with dried and smoked fish in Lagos area. *1978/97 Annual Report of Nigerian Institute of Oceanographic and Marine Research (NIOMR),* Lagos.

AOAC (1990). *Official Methods of Analysis.* 12th Edition, Association of Official Analytical Chemists (AOAC), Washington DC, USA.

BURGES, G. H. and BANNERMAN, A. M. (1963). *Fish Smoking, A Tom Kiln Operator's Hand Book,* Company Inc. Westport.

CUTTING, C. L. and SPENCER, R. (1968). Fish and fish products. *In: Quantity Control in the Food Industry,* Academic Press, London.

DINGLE, J. R. and HYNES. J. A. (1975). Protein instability in minced flesh from fillets and frames of several commercial Atlantic fishes during storage at 5^0C. *Fishery Research Board of Canada,* 32: 775 – 783.

EZIKE, C. and EZEBIALU, M. C. (1983). Some aspects of the influence of temperature and tissue waste on bacterial load in deteriorating *Sarotherodon niloticus* L. *Paper Presented at the 3rd Annual Conference of Fisheries Society of Nigeria* (FISON), 22nd – 25th February 1983, Maiduguri, Nigeria.

EJIKE, C. and MOHAMMED, B. I. (1982). The effect of temperature and tissue water level on microbial load, extractable protein and lipids in deteriorating *Sarotherodon niloticus*: Pages 347 – 532. *In: International Symposium on Food Industry and the Environment, House of Technics,* Budapest.

FRAZIER, W. C. and WESTHOFF, D. C. (1986). *Food Microbiology.* McGraw-Hill, New Delhi.

GRAHAM, J. (1982). Freezing. *In:* AITKEN, A., MACKIE, I., MERRITT, J. and WINDSOR, M. (Eds.), *Fish Handling and Processing,* Torry Research Station, Edinburgh.

IGENE, J. O. (1983). Drying of fish - Factors to consider. *Paper Presented at the 3rd Annual Conference of Fisheries Society of Nigeria* (FISON), 22nd – 25th February 1983, Maiduguri, Nigeria.

IKEME, A. I. (1985). Extending the shelf-life of smoked mackerel. Pages 144 – 148. *In: Proceeding of the FAO Expert Consultation on Fish Technology in Africa.* Lusaka, Zambia, 21 – 25 January, 1985.

JONES, N. R. and DISNEY, J. G. (1967). Technology in fisheries development in the tropics. *Tropical Products Institute,* 5(3): 57 – 62.

MARRINETTI, G. V. (1967). *Lipid Chromatographic Analysis.* Marcel Dekker Incorporated, New York.

OJOBE, T. O., OMOREGIE, E. and OFOJEKWU, P. C. (1992). Effects of salt curing preservation on the protein and amino

acid contents of preserved *Clarias gariepinus* muscle. *Journal of Inland Fisheries Society of India,* 24(2): 15 – 19.

OKPANEFE, M. O. (1982). Demand analysis for Nigerian fisheries. Pages 193 – 206. *In:* ITA, E. O. (Editor), *Proceedings of the Second Annual Conference of the Fisheries Society of Nigeria (FISON).* 25th – 27th January, 1982, Calabar, Nigeria.

REAY, G. A., CUTTING. C. L. and SHEWAN. J. M. (1943). The nation's food. VI. Fish as food. 2. The chemical composition of fish. *Journal* of *the Society of Chemical Industry,* 62: 77 – 85.

SORINMADE, S. O., TALABI. S. O., AYINLA. A. O. and BANWO, A. (1982). Studies on low temperature characteristics of Nigeria fish species. *1982 Annual Report of Nigerian Institute of Oceanographic and Marine Research (NIOMR),* Lagos.

STEEL, R. G. O. and TORRIE, J. H. (1980). *Principles and Procedures of Statistics.* McGraw-Hill Book Company, Incorporated, New York.

TALABI, S. O. (1977). Improving fish utilization through medium scale integrated fishery industries. *Proceedings of NIFES,* 1: 108 – 116.

TALABI, S. O. and IGBINOSUN, I. E. (1984). A new equipment for smoke drying of fish in Nigeria. *Nigerian Institute of Oceanographic and Marine Research (NIOMR) Occasional Paper,* 33: 3 – 4.

TOBOR, J. G. (1984). A review of the fishing industry in Nigeria and status of fish preservation methods and future growth prerequisites to cope with anticipated growth in production. *Nigerian Institute of Oceanographic and Marine Research (NIOMR) Technical Paper,* No. 17.

UFODIKE, E. B. C. and OBUREKE, J. U. (1989). Effect of preservation technique on quality of *Oreochromis niloticus* muscle. *Journal of Agricultural Science,* 4: 1 – 5.