NUTRITIVE EVALUATION OF ENCLOSED SALTED-SOLAR DRIED *Oreochromis niloticus*

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ABSTRACT ✓

This study investigated the effect of enclosed solar drying on the nutritive quality of unsalted and salted *Oreochromis niloticus.* Sensory and proximate evaluations were carried out on the salted and unsalted fish after drying. Acceptability, appearance, colour, odour, taste and texture of salted and unsalted fish differed significantly ($P<0.05$). The moisture, protein lipid and ash contents differed significantly ($P<0.05$). All dried fish samples from the enclosed dryers showed high levels of acceptability and protein content. However, fish samples brined at 25% and dried using Solar Tent Dryer had the highest acceptability and protein content.

INTRODUCTION

Open air sun-drying of fish has many limitations. These include the fact that long periods of sunshine without rain are required, drying rates are low and in areas of high humidity, and it is often difficult to dry the fish sufficiently. The quality of open-air dried fish is likely to be low due to slow drying, insect damage and contamination from air-borne dust, and it is difficult to obtain a uniform product (Eyo, 2001). Thus, in the search for improved drying techniques using naturally abundant solar energy, the use of enclosed solar drying systems have recently been investigated as an alternative to traditional open-air sun drying. These enclosed systems are called solar dryers. Solar dryers employ some means of collecting or concentrating solar radiation with the result that elevated temperatures and, in turn, lower relative humidities are achieved for drying. When using solar dryers, the drying rate can be increased, lower moisture contents can be attained and product quality is higher. The dryers are less susceptible to variations in weather, although drying is obviously slower during inclement weather, and they do provide shelter from the rain. The high internal temperatures discourage the entry of pests into the dryer and can be lethal to those that enter (Trim and Curran, 1983). Many forms of solar dryer for use with agricultural and fisheries products have been developed in Nigeria. However, only a few of these have been developed specifically for fish. Few workers (Olokor *et al.*, 1997 and Ogali ; Eyo, 1998) have reported respectively on some aspects of biochemical changes in fish dried using tent and box types of solar dryers. In order to improve the quality of open-air dried fish and to provide information on the nutritive and keeping qualities of solar dried fish, this experiment was conducted to assess the effects of enclosed solar drying in the quality of fresh and differently salted *O.niloticus*.

MATERIALS AND METHODS

Three Enclosed Solar Drying Systems (EDS) were used. These were: Solar Tent Dryer, Natural Airflow Solar Cabinet Dryer and Forced Airflow Solar Cabinet Dryer. The Solar Tent Dryer (STD) was made up of polythene sheet stretched over a wooden framework (1.1m wide x 1.1m long x 1.5m high) with side and top vent of (0.25m x 0.25m). A framed wire gauzed rack (1m x 0.54m) with a drying area of $0.54m^2$ was suspended at about 60cm off the ground. Underneath the rack was the heat collector made up of a spread of irregularly shaped granite stones painted black. The Natural Airflow Solar Cabinet Dryer (NACD) has a drying chamber that was painted black both inside and outside. Inside the drying chamber was a framed wire gauzed drying rack (1m x 0.54m) with a drying area of $0.54m^2$ (2).A solar collector made of glass was connected to the drying chamber to produce the drying energy required. Airflow was generated by natural convection through the collector through the drying chamber and moist air leaves the dryer through the upper chimney-like opening. The Forced Airflow Solar Cabinet Dryer (FACD) has drying chamber that was painted black both inside and outside. Inside the drying chamber were a framed wire gauzed drying rack (1m x 0.54m) with a drying area of $0.54m^2$ and an electric powered two blade fan fixed to the ceiling of the drying chamber to force out the moist air. A solar collector made of glass was connected to the drying chamber to produce the drying energy required. Airflow was generated by natural convection through the collector through the drying chamber and moist air leaves the dryer through the upper chimney-like opening. The solar drying was carried out in each EDS simultaneously. Sixty (60) fresh *O. niloticus* were dried in each EDS used for the experiment. In each EDS the fish were divided into five groups and were salted using NaCl at different levels as described by Oyero, (2006). First Level -

Unsalted treatment (US) - The fish were not salted. Second Level – 25% brined treatment (25B) – the fish were immersed in 25% brine for one hour. The brine was prepared by dissolving 250g of NaCl in 1 litre of water. Third Level - 50% brined treatment (50% B) – the fish were immersed in 50 per cent brine for one hour. The brine was prepared by dissolving 500g of NaCl in 1 litre of water. Fourth Level – 75% brined treatment (75B) – the fish were immersed in 75 per cent brine for one hour. The brine was prepared by dissolving 750g of NaCl in 1 litre of water. Fifth Level – 100% Dry Salted treatment (DS) – the fish were rubbed on the surface and inside of the fish. Each level of salting represented a treatment. The drying took place at the Federal University of Technology, Minna. The fish were solar dried for one week. The sensory evaluation of the dried fish samples were evaluated weekly for four weeks by a trained panel of five evaluators. The evaluation was done on Hedonic scale of 5 based on the method of Doe and Olley, (1990). The parameters evaluated were taste, colour, odour/smell, texture, appearance and acceptability. The chemical analyses of proximate composition of the dried samples of *O. niloticus* were carried out using the methods of Association of Analytical Chemists (AOAC, 1990). The parameters analyzed include moisture, crude protein, lipid and ash.

RESULTS AND DISCUSSION

Figure 1 shows the acceptability of the sensory evaluation of differently salted *O. niloticus* dried using Enclosed Solar Drying Systems (EDS). Acceptability, appearance, colour, odour, taste and texture differed significantly ($P<0.05$). There was a direct relationship between the various parameters (appearance, colour, odour, taste texture and acceptability) of the dried *O. niloticus* products from the three solar dryers (STD, NACD and FACD). Dried samples from STD and NACD showed high levels of acceptability especially STD 25 NACD 25 treatments. None of the dried products in these two enclosed drying systems had a value less than 2.5 on the 5 point hedonic scale of measurement. This indicated that all the dried products from the two systems were widely accepted. However, despite this acceptability the unsalted treatment dried products in the STD and NACD showed the least values. The reverse was the case in the FACD. Only the unsalted treatment dried product in FACD showed a high value of 3.80 on 5 point hedonic scale of measurement. This could be attributed to the fact that the initial rate of drying is governed by heat and mass transfer processes external to the fish relative to the air speed all have direct effect on the drying rate. Thus in the early stages of drying the rate can be increased by increasing the air speed and temperature and reducing the air relative humidity. However, according to Doe and Olley (1990), there is a limit; if dried too fast a relatively impermeable layer can develop on the surface of the fish (case hardening) and at temperatures above 40^0C (depending on the fish species) This could be the situation here as it could be deduced that the forced airflow and the salting levels contributed to fast drying of the products.

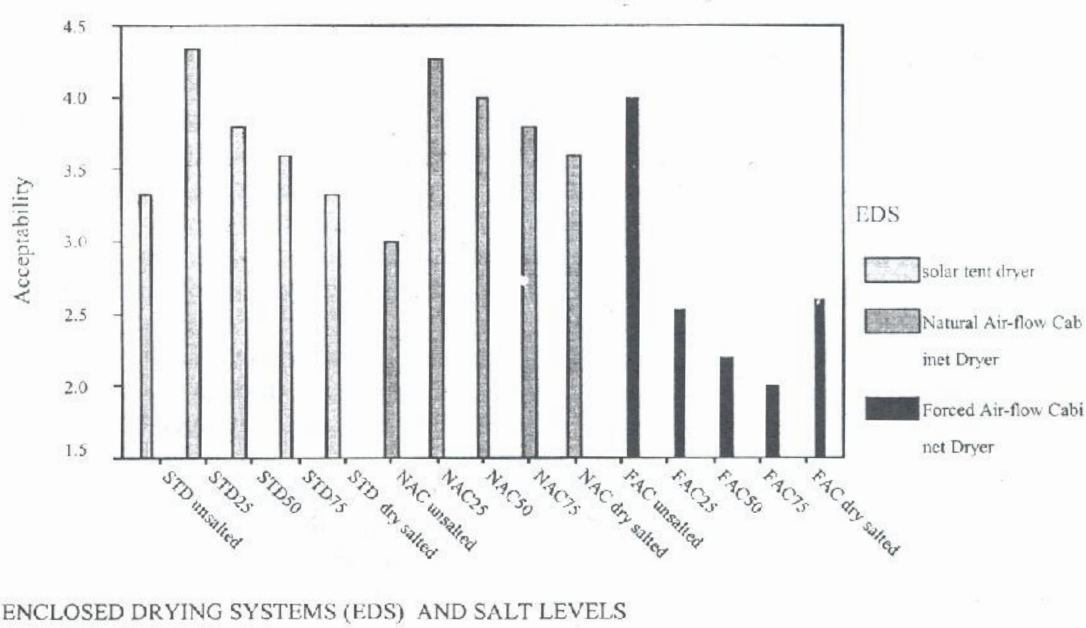

Figure 1 Mean values of acceptability of *O. niloticus* differently salted and dried using enclosed drying systems (EDS)

Table 1 shows the moisture, crude protein, crude lipid and ash contents of differently salted O. *niloticus* dried using Enclosed Solar Drying Systems. Moisture, crude protein, crude lipid and ash contents differed significantly ($P<0.05$). All the treatments had moisture content values below 10%. The moisture contents obtained were lower than those obtained by Trim and Curran (1983). Moisture content was 25% was in the brined products and 25-40% moisture content in dry salted products. This low moisture content indicated that the dried fish products have the tendency to be very stable. From Trim and Curran (1983) results, the brined and dry salted products had a shelf life of approximately 100 days. In all the three drying methods, FACD showed the least of the moisture content when compared at different levels of salting. The moisture content decreased respectively in the brined dried products, of 25% brined, 50% brined and 75% brined treatments, according to the level of salting. It was observed that the higher the level of salting of the fish, the lower the moisture content. As expected, the unsalted dried products had the highest moisture contents in all the three drying methods. This was in line with Horner (1994) that the objective of dehydration is to remove water from the deepest part of the flesh quickly enough to reduce water activity below the minimum for microbial growth before significant spoilage takes place, the objective of salting is to ensure that salt penetration is rapid enough to similarly lower the water activity in the deepest parts of the flesh.

Table 1 Mean values of moisture, protein, lipid and ash contents of *O. niloticus* differently salted and dried using enclosed drying systems (EDS)

	SALT LEVELS	MOISTURE %	PROTEIN %	LIPID %	ASH %
STD	UNSALTED	10.01^{k}	58.86^{a}	13.40^{k}	18.09^{k}
	25% BRINED	8.91^{e}	65.47^{i}	13.49^{e}	13.06^{g}
	50% BRINED	8.81^{d}	64.71^{f}	14.22^{i}	12.52^{e}
	75% BRINED	8.65^{c}	64.20^{e}	14.03^{h}	13.10^{g}
	DRY SALTED	9.62^{g}	63.45^{d}	12.35^{b}	13.63^{i}
NACD	UNSALTED	10.03^{k}	59.03^{b}	15.55^{m}	15.44^{j}
	25% BRINED	9.04^{f}	65.95^{k}	12.00^{f}	12.04^{c}
	50% BRINED	8.53^{b}	65.03^{g}	14.42^{k}	12.03^{c}
	75% BRINED	8.52^{b}	64.98^{g}	14.35^{j}	12.23^{d}
	DRY SALTED	9.73^{i}	63.50^{d}	14.35^{j}	12.63^{f}
FACD	UNSALTED	9.80^{j}	60.25^{c}	20.87^{n}	9.03^{a}
	25% BRINED	8.81^{d}	65.99^{k}	13.53^{d}	11.65^{b}
	50% BRINED	8.45^{a}	65.55^{j}	13.95^{g}	12.06^{c}
	75% BRINED	8.44^{a}	65.26^{h}	12.87^{c}	13.43^{h}
	DRY SALTED	9.68^{h}	64.15^{e}	14.49^{l}	11.65^{b}

Data in the same column carrying the same superscript do not differ significantly from each other ($P>0.05$)

There was a strong inverse relationship between the moisture and crude protein contents. The three unsalted dried products had the highest moisture contents. This same trend was observed for all other products. After four weeks of storage, all the dried products showed crude protein contents well above 50% with the highest being that of FACD which was 65.99% and was not significant at $P<0.05$ from NACD 25 treatment which was 65.95%. All the dried products had low levels of crude lipid content apart from FACD unsalted treatment which was 20.87% and could be attributed to the nature of *O. niloticus*, which is classified as a lean fish (ILO-WEP, 1982). The reason for the exceptionally high crude protein content in the FACD unsalted treatment could not be adduced.

There was no consistency in the ash contents of the dried products and could be due to the possible inconsistency in the bone removal of the dried products before milling for analysis. However, the ash contents of all the dried products showed appreciable levels to indicate the dried fish products as good sources of mineral contents. All the salted-dried products from the three enclosed solar dryers showed higher levels of acceptability and nutritive quality in terms of protein content when compared to the outcome of Oyero *et al.* (2006). It is thus recommended that any of the EDS should be used as an alternative to open-air solar drying.

REFERENCES

A.O.A.C. (1990). Official Methods of Analysis (15th edn.) – Heldrich. Association of Official Analytical Chemists, Virginia, U.S.A. 1298pp.

Doe, P. and Olley, J. (1990). Drying and dried fish products. In Seafood: Resources, Nutritional Composition and Preservation. CRC Press Boca Ranton, Florida. Chapter 8 p125-46.

Eyo, A.A. (2001). Fish Processing Technology in the Tropics. A publication of National Institute for Freshwater Fisheries Research (NIFFR). New Bussa, Nigeria 403pp.

Horner, W.F.A. (1994). Preservation of fish by curing (drying, salting and smoking). In Fish Processing Technology. Ed. George M. Hall. BlackAcademic & Professional USA and Canada: VCH Publishers, Inc., New York pp 31-71

ILO - WEP, (1982). Small-scale processing of fish. TECHNOLOGY SERIES. Technical Memorandum No. 3. ILO's World Employment Programme (WEP) Prepared under the joint auspices of the International Labour Office(ILO), the Food and Agriculture Organisation and the United Nations Environment Programme. International Labour Office Geneva 140pp.

Ogali, E.L. and Eyo A.A. (1998). Evaluation of the effectiveness of a box type solar dryer in drying fish in Kainji Lake Area, Nigeria. FAO Fisheries Report. No. 574. Pp 100-102

Olokor, J.O., A.A. Eyo, M. Mdaihili, J.K. Okomoda and Ayanda J.O. (1997). Promotion of fish drying using solar energy in villages around Lake Kainji. In: Proceedings of the 10th Annual Conference of the Biotechnology Society of Nigeria Ed. Mdaihili M., pp. 221-229.

Oyero, J. O. (2006) Effects of different processing techniques on the nutritional quality of salted Nile Tilapia *Oreochromis niloticus*. Ph.D Thesis, Federal University of Technology, Minna, Nigeria.

Oyero, J. O., Sadiku, S. O. E., Ajisegiri, E. S. A. and Eyo, A. A. (2006). Effect of open air drying on the quality of unsalted and salted *Oreochromis niloticus*. *Journal of Sustainable Tropical Agricultural Research*. Volume 18 pp 6-12.

Trim, D.S. and Curran, C.A. (1983). A comparative study of solar and sun drying of fish in Ecuador, Report of the tropical Products Institute, London, L60 pp38