

Nutritional Assessment of *Hetero-clarias* and *Oreochromis niloticus* under Two Drying Preservation Methods

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Abstract This study was conducted to compare the effect of Sun drying and Oven drying on the nutritional composition of two fish species (*Hetero-clarias* and *Oreochromis niloticus*). Ten freshly harvested catfish (*Hetero-clarias*) and Tilapia (*Oreochromis niloticus*) were shared into two parts; a part was sun - dried for 12 days (7 hours daily) between the hours of 9 a.m – 4 p.m at an average temperature range of 23 – 35.9⁰C, temperature range in Iworoko Ekiti between February – March (According to Norwegian Met Institute) and the other part was dried using laboratory electric oven at a temperature range of 80⁰C for 5 days (4 hours daily). Each part was in three (3) replicates. The proximate compositions of the dried samples (Mean moisture, protein, lipid, ash, fibre, carbohydrate) were determined. The changes in moisture, protein and carbohydrate contents including energy value were found to be significant ($P < 0.05$) for the two processing (drying) methods. Ash and lipid contents showed no significant differences ($P > 0.05$) for the two drying methods used in this study. The changes in the fibre contents was found to be significant ($P < 0.05$) in the *Hetero-clarias* species for both processing methods while it was not significant ($P > 0.05$) in the *Oreochromis niloticus* species for both processing methods. This result indicates that drying methods have effects on the proximate compositions of fish species (*Hetero-clarias* and *Oreochromis niloticus*). The overall assessment showed that; for taste; the highest mean value recorded was 6.0 ± 0.0 and 5.3 ± 0.6 in Oven dried *Hetero-clarias* and Oven dried *Oreochromis niloticus* respectively. The least mean value 3.0 ± 0.5 was recorded in the sun dried *Oreochromis niloticus* followed by 3.4 ± 0.6 in sun dried *Hetero-clarias*. The result further indicated that there is significant difference between organoleptic qualities of oven dried and sun dried samples of the same fish species.

Keywords Sun Drying, Oven Drying, Nutritional

Composition, *Hetero-clarias*, *Oreochromis niloticus*

1. Introduction

Today food security is a major concern in Nigeria because of the increasing gap between population and rate of food production. Fish production remains a vital tool to promote food and nutritional security in Nigeria. Fish is a major source of protein and its harvesting, handling, processing and distribution provide livelihood for millions of people as well as is source of foreign exchange for many countries (Al-Jufaili and Opara, 2006). Fish is one of the most important sources of animal protein available in the tropics and has been widely accepted as a good source of protein and other elements for the maintenance of health of human beings (Andrew, 2001). Fish constitutes about 69.6% of the total supply of protein available to Nigeria. Consumption of fish provides an important nutrient to a large number of people worldwide and thus makes a very significant contribution to nutrition.

Fish is an extremely perishable food item (Agbo *et al.*, 2002). Soon after death, fish begins to spoil. In the healthy live fish, all the complex biochemical reactions are balanced and the fish flesh is sterile. After death however, irreversible change that results in fish spoilage begins to occur. The resultant effect is the decomposition of the fish (Akinola *et al.*, 2006). Various factors are responsible for fish spoilage. The quality of fish at capture is important in determining the rate of spoilage. Notably are the fish health status, the presence of parasites, bruises and wounds on the skin and the mode by which the fish was captured. The caught fish quality depends on the handling and preservation of the fish as received from the hands of the fishers after capture. The handling and the preservation

practice after capture affects the degree of spoilage of the fish (Akinneye *et al.*, 2007).

The methods that are commonly employed are the traditional techniques such as salting/brining, sun-drying and smoking which also increase fish availability to the consumers (Abolagba *et al.*, 1996). The salting prior to drying, involves the removal of moisture and the introduction of salt until the attainment of the right texture, flavor and colour. Preservation is through moisture removal and the presence of salt which at the right level inhibits chemical, microbial and enzymatic activities and also attack harmful biological agents (Abraham and Oramadike, 2011).

Akinola *et al.* (2006) reported that despite the rudimentary nature of process of traditional methods, lack of control over the drying rate, sometimes results in under-drying or over-drying. During this process exposure of fish to unexpected winds, dust, dirt, insect infestation, and contaminants such as flies are some other problems encountered. These methods are still predominant in Nigeria. To reduce post-harvest losses and to improve the quality of fish and fishery products, traditional processing technology must be improved upon in Nigeria. This includes upgrading the traditional fish processing technology and adoption of solar dryer. Artificial dryers such as solar dryer, kiln, oven, etc, have long been in existence, some of them are powered electrically, by sun, gas or natural fuel such as firewood, charcoal, wood and saw dust (Bolaji, 2005).

The drying of fish in an oven consists of a period of several hours in which the fish is cooked and dried with low burning fire for a certain period with the production of moderate amount of smoke. The length of this latter period varies with the required keeping quality. The moisture of the dried products varies between an estimated 40% in the higher ranges and 10-20% in lower ranges. The quality of the product is judged on degree of drying, appearance, damages and insect infestation which influences the fish price.

There is a need to adopt an adequate preservation method for fish, so that at the cost of preserving fish, the nutritional composition of the fish is not altered unconsciously. This study is aimed at comparing the nutritional composition of *Hetero-clarias* and *Oreochromis niloticus* after processing with different processing techniques (oven – drying and sun - drying).

The main focus of this study was to investigate the effects of drying (oven-drying and sun-drying) on the nutritional composition of *Hetero-clarias* and *Oreochromis niloticus*. The proximate composition of dried fishes was determined when preserved by two different drying methods. The knowledge obtained from this study will improve the capacity of local fishing and aqua - cultural communities on appropriate handling and processing of fish therefore reducing the rate of spoilage,

wastage and nutritional loss during processing. This study is essential because about 75% of artisanal catch and 20% of industrial catch is dried/smoked and distributed traditionally and that there is inadequate information relating to losses due to traditional and modern processing of fish.

2. Materials and Methods

2.1. Experimental Fishes

Ten freshly harvested catfish (*Hetero-clarias*) and Tilapia (*Oreochromis niloticus*) were obtained from Durante fish farms, Ibadan, Oyo – State. The average weight of catfish (*Hetero-clarias*) was 400g while that of Tilapia (*Oreochromis niloticus*) was 300g. The twenty fishes of both species were shared into two equal portions; ten was used for oven drying and the other ten for sun drying.

2.2. Methods of Processing

The major processing methods employed were; gutting, washing, cutting, brining, hanging and drying (Oven drying and Sun drying).

Drying: The fish samples were dried using two different methods (sun-drying and oven-drying) and fish samples for each treatment were in triplicates.

Sun-drying: A portion of the fish samples was sun-dried for 12days (7 hours/day) in broad day sunlight. The fish samples were placed in a rectangular clean plastic tray that was covered with a mosquito net to prevent access by flies and other insects. Samples were sun dried from 9.00 am to 4.00 pm daily. The temperature ranges in Iworoko Ekiti in which the samples were sundried was within the range of 23 – 35.9⁰C, according to the Norwegian Met Institute. The tray was always kept indoors after 4.00 pm for 12 days after which they were taken to the laboratory for proximate analysis.

Oven-drying: The other portion of the fish samples was dried using laboratory electric oven (DHG – 9101. ISA). The well drained fish samples were oven dried at a temperature of 80⁰C for 5 days (4 hours daily) after which the proximate analysis was carried out.

2.3. Proximate Analysis of the Fish Samples

The nutritional analysis was carried out in the Biochemistry Laboratory of Ekiti State University (EKSU), Ado Ekiti. The proximate compositions were assayed as described by AOAC, 2005. The fish samples were analyzed for crude protein, lipids, carbohydrate, moisture and ash contents, after the drying process. Each analysis was carried out in triplicate. The fish samples were crushed and blended using a domestic blender (Model MGB 1212).

2.4. Determination of Protein Content

The Microkjelahl method was used in the determination of the crude protein content.

The percentage Nitrogen in the sample was determined using the following formula.

$$100 = \frac{[(A \times B) 0.14]}{C}$$

Percentage crude protein = Nitrogen in sample x 6.25
where;

A = Hydrochloric acid used in titration (ml)

B = Normality of standard acid

C = Weight of sample (g)

2.5. Determination of Ash Content

1.0g of dry matter was weighed into a crucible, incinerated in a muffle furnace at temperature of 500°C for a period of between 24 and 48 hours. After complete ashing, samples were cooled in a desiccator and weighed afterward to give the Total Organic Matter (TOM) otherwise called the ash using the expression below:

$$\% \text{ Ash} = \frac{(\text{Weight of crucible} + \text{TOM}) - (\text{Weight of crucible})}{\times 100}$$

2.6. Determination of Lipid Content

Lipid extraction was carried out using Soxhlet extraction method.

The percentage of extracted lipid was calculated as:

$$\% \text{ Lipid} = \frac{W4 - W3}{W2 - W1} \times 100$$

2.7. Determination of Moisture Content

The hot oven method was adopted.

The percentage moisture was calculated as follows:

$$\% \text{ Moisture} = \frac{W2 - W3}{W1} \times 100$$

2.8. Determination of Crude Fibre

3.00 g of the defatted sample was added to 200 ml H₂SO₄ in a boiling solution and was boiled gently for 30 minutes, stirring occasionally. Titration was done in a vacuum flask. The filter paper was washed with boiling water and the residue was transferred into a flask. 200 ml NaOH boiling solution was allowed to boil for 30 minutes in a filter vacuum and the residue was washed with boiling water, HCl solution and again with boiling water. Fat was removed by washing with petroleum ether. The dry

crucible was set at 105°C and allowed to cool in a dryer. The crucible was left with the residue in the furnace at 550°C for 3 hours. It was removed after this period and allowed to cool in a desiccator.

$$\text{The percentage crude fiber} = \frac{A - B}{C}$$

Where:

A=Weight of crucible with dry residue (g)

B=Weight of crucible with Ash (g)

C=Weight of Sample (g)

2.9. Carbohydrate Determination

Only traces of carbohydrates are contained in fish muscles, in the form of sugars, phosphates and glycogen. Other tissues like liver contain larger amount as glycogen. Carbohydrate was estimated by difference.

$$\text{The percentage carbohydrate} = (100 - P - M - F - A)$$

Where;

P=Percentage protein

M=Percentage moisture

F=Percentage fat

A=Percentage ash

2.10. Organoleptic Analysis

Organoleptic qualities of the dried fish samples were evaluated by setting up a 4 – member panel familiar with the qualities of dried fish. The panelist rated the samples for parameters like flavor, texture, appearance, and palatability based on a 5 – point hedonic scale after being trained on how to apportion mark to each parameter. Dried fish samples were issued out in conjunction with questionnaires. The fish samples were given out with questionnaires for the panel members to feel and taste the fish products and score was based on how it appealed to the taste, texture, palatability and flavor to the panel. The questionnaires were returned and marks were appropriately apportioned to each parameter Panelists are to use the modified 5- point hedonic scale described by Eyo (2001) which is as follows:

2.11. Modified Scores Remark

1-1.9 Unacceptable

2-2.9 Fair

3-3.9 Medium

4-4.9 Good

5-6.0 Very good

2.12. Statistical Analysis

The Independent Samples T - Test was employed to compare the differences between the means of the two

treatment groups (Sun – drying and Oven – drying).

3. Results and Discussion

The moisture contents in oven-dried fish products from different fish species: *Hetero-clarias* and *Oreochromis niloticus* were 8.60 ± 0.2 and 8.4 ± 0.6 respectively while the sun dried samples had 14.88 ± 0.7 and 12.64 ± 2.0 respectively. In this study, more water contents were rapidly removed in the fish exposed to oven-drying than sun-drying. This observation is in agreement with Omafuvbe and Kolawole, (2004), who reported that oven-drying generally, achieved the required moisture content in food earlier and more uniformly than sun-drying. According to Silver *et al*, (2008), the water content in fish affects the microbiological and chemical stability, physical properties, processing, storage and distribution of fish. A safe moisture level of 6 to 8% in dried fish has been recommended in order to prevent spoilage due to microbe and pest proliferation (Effiong and Mohammed, 2008).

The results in this study show that the ash content in the oven dried *Hetero-clarias* (15.57 ± 0.6) was higher than that of sun dried *Hetero-clarias* (15.08 ± 1.0), and also the ash content in oven dried *Oreochromis niloticus* (17.34 ± 1.5) was higher than the sun dried *Oreochromis niloticus* (17.04 ± 0.1). Owaga *et al.*, (2009) reported that total ash value is an indicator of the total mineral element contents in fish; this shows that oven dried fish samples had more mineral content than sun dried samples.

The fiber contents were low in all the treatments. The highest was recorded in the sun dried *Oreochromis niloticus* (1.6 ± 0.6). Akinneye *et al*, (2010), did not detect any fiber in the three species (*Heterotis niloticus*, *Sardinella spp*, *Bonga spp*) that were subjected to oven and sun drying. Although, a diet high in soluble fiber can reduce total serum cholesterol by as much as 15% in man, Fusco, (2011) reported that there is a meager or no fiber in animal products such as meat, fish, eggs or dairy products.

In this study, the highest fat content was recorded in oven dried *Hetero-clarias* (28.26 ± 1.9) compared to sun dried *Hetero-clarias*. Oven dried *Oreochromis niloticus*,

sun dried *Oreochromis niloticus* and which are 26.77 ± 2.1 , 20.05 ± 1.0 and 19.70 ± 0.5 respectively. Studies revealed that lipid contents fluctuate considerably with age, feed and sexual cycle of fish, Jorkan *et al*, (2008). Based on the 5% fat composition criteria for discriminating lean fish from fatty species, Ackman, (1989), it was apparent that *Hetero-clarias* and *Oreochromis niloticus* could be regarded as fatty fish species. According to Puwustien *et al*, (1999), the fats exuded with moisture evaporation and the extended heat treatment during drying could increase the fat contents in fish. Augustsson, (2003) reported that fish with moderate fat contain low cholesterol and are good sources of Omega – 3 fatty acids which protect against heart rhythm disorders and has benefits for blood clotting and blood vessel function.

The crude protein level in the sun dried *Hetero-clarias* and *Oreochromis niloticus* fish samples were 35.12 ± 1.7 and 33.33 ± 1.0 respectively. The oven dried fish samples have the higher crude protein content; 43.02 ± 2.6 and 40.73 ± 1.1 for *Hetero-clarias* and *Oreochromis niloticus* respectively. The highest crude protein content was recorded in the oven dried *Hetero-clarias* (43.02 ± 2.6). The high level of protein of the oven dried fish samples insinuates that protein Nitrogen was not lost during dehydration at a temperature of 80°C; this is in accordance to the findings of Gokoglu *et al*, (2004), Tao and Linchun, (2008). The authors are of the view that the high level of protein in the oven dried products may be due to of dehydration of fish which concentrated the proteins during the heat treatment, thus enhancing the nutritional value of the oven dried fish.

The highest carbohydrate content was remarkable in sun dried *Oreochromis niloticus* with 15.34 ± 0.6 compared to others; 12.48 ± 0.5 , 4.02 ± 1.0 and 7.95 ± 1.1 for oven dried *Oreochromis niloticus*, oven dried *Hetero-clarias*, and sun dried *Hetero-clarias* respectively. The main function of carbohydrate is to supply energy to the body and to perform various physiological functions. Low carbohydrate diets have been reported to lower blood pressure by causing weight loss and improving the insulin sensitivity in diabetics (Arora and McFarlane, 2005).

Table 1. Proximate Composition of Oven-dried and Sun- dried *Hetero-clarias*

Fish species	Moisture %	Ash %	Fat %	Fibre %	Protein %	CHO %	Energy value (Kj/g)
Ovendried	8.60 ± 0.2	15.57 ± 0.6	28.26 ± 1.9	0.57 ± 0.1	43.02 ± 2.6	4.02 ± 1.0	$1,845.36 \pm 37.8$
Sundried	14.88 ± 0.7	15.08 ± 1.02	77.21 ± 1.0	0.20 ± 0.1	35.12 ± 1.7	7.95 ± 1.1	$1,722.68 \pm 79.3$

Table 2. Proximate Composition of Oven dried and Sun dried *Oreochromis niloticus*

Fish species	Moisture %	Ash %	Fat %	Fibre %	Protein %	CHO %	Energy value (Kj/g)
Ovendried	8.4 ± 0.6	17.34 ± 1.5	20.05 ± 1.0	1.0 ± 0.1	40.73 ± 1.1	12.48 ± 0.5	$1,646.42 \pm 31.7$
Sundried	12.64 ± 2.0	17.04 ± 0.1	70.05 ± 1.0	1.6 ± 0.6	33.33 ± 1.0	15.34 ± 0.6	$1,556.29 \pm 19.2$

4. The Organoleptic Properties

The organoleptic properties of Oven dried and Sun dried fish species are shown in Tables 3 and 4. The overall assessment shows that; for taste; the highest mean value recorded was 6.0 ± 0.0 and 5.3 ± 0.6 in Oven dried *Hetero-clarias* and Oven dried *Oreochromis niloticus* respectively. The least mean value 3.0 ± 0.5 was recorded in the sun dried *Oreochromis niloticus* followed by 3.4 ± 0.6 in sun dried *Hetero-clarias*. For the texture; the highest mean value recorded was 5.3 ± 0.6 in oven dried *Hetero-clarias* which is followed by 3.8 ± 0.1 in oven dried *Oreochromis niloticus* and sun dried *Hetero-clarias*. The least mean value 2.5 ± 0.5 was found in sun dried *Oreochromis niloticus*.

Table 3. Organoleptic Properties of the Oven - dried and Sun - dried *Hetero-clarias*

Fish species	Taste	Texture	Palatability	Flavour
Oven-dried	6.0 ± 0.0	5.3 ± 0.6	5.7 ± 0.4	5.6 ± 0.6
Sundried	3.4 ± 0.6	3.7 ± 0.8	2.9 ± 0.7	3.1 ± 0.5

Table 4. Organoleptic Properties of Oven – dried and Sun - dried *Oreochromis niloticus*

Fish species	Taste	Texture	Palatability	Flavour
Oven-dried	5.3 ± 0.6	3.8 ± 0.1	4.5 ± 0.0	4.5 ± 0.1
Sundried	3.0 ± 0.6	2.5 ± 0.5	2.1 ± 0.0	3.1 ± 0.6

The oven dried fish species has the highest value of palatability 5.7 ± 0.4 and 4.5 ± 0.0 in *Hetero-clarias* and *Oreochromis niloticus* respectively. The lowest mean value 2.1 ± 0.5 was recorded in sun dried *Oreochromis niloticus*. For flavor; the oven dried fish species (*Hetero-clarias* and *Oreochromis niloticus*) has the highest mean value of 5.6 ± 0.6 and 4.5 ± 0.1 respectively. The least mean value was recorded in sun dried *Oreochromis niloticus* and sun dried *Hetero-clarias*. This result further indicates that there is a significant difference between the organoleptic qualities of Oven dried and Sun dried fish species.

5. Conclusions

It can therefore be concluded that, the quality of the oven dried products is better than that of the sun dried products; this might be as a result of the elevated and uniform temperature in the oven, which brought about a quick removal of moisture than the sun dried products. The quick removal of moisture helps in retarding spoilage activities and insect infestation as well as microbial contamination on the products and this brings a better output than the sun dried products. The most remarkable organoleptic characteristics is the taste. The taste of the oven dried *Hetero-clarias* sample is the most pleasant while the sun dried *Oreochromis niloticus* had the least pleasant taste.

6. Recommendations

In order to reduce post-harvest losses and increase nutritional security, the method of fish preservation in Nigeria need to be improved upon as a strategy to promote agricultural resilience. It is recommended that protein deficient patients can build up their muscles from the consumption of oven dried fish species (such as *Hetero-clarias* and *Oreochromis niloticus*). Also, improved technologies should be developed and made available for oven drying fish products in order to reduce post-harvest spoilage. Finally, the government should help small scale fish processors by constructing large community ovens/kilns which they could rent and use for processing, thus creating a source of revenue for the government through fish processing. This study thereby supports the application of electric oven drying as an efficient drying method for fish processing nationwide.

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