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Effect of Moisture content on the drying rate using traditional open sun and shade drying of fish from Njuwa Lake in North-Eastern Nigeria

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Abstract: *In this study, fish samples namely, Tilapia zilli, Clarias geriepinus, Synodontis ocellifer and Alestes baremose were obtained from Njuwa Lake, Yola Adamawa State. Moisture content and other proximate composition was analyzed using methods of open sun drying (40-42^{0}c) and shade drying 30-32^{0}c respectively. Results showed that the values reported for moisture, crude fibre, crude lipid, crude protein, ash and carbohydrate were ranged between 4.72-7.63, 3.02 ± 0.23, 7.13 ± 0.23, 59.26 ± 0.35, 1.61 ± 0.01 and 0.3 for Tilapia zilli, while values of 4.39-8.21, 2.61 ± 0.06, 7.24 ± 0.06, 64.32 ± 1.25, 1.86 ± 0.03 and 0.08 are for dried Clarias geriepinus respectively. Also values of Synodontis ocellifer were 3.90-7.10, 3.62 ± 0.05, 6.52 ± 0.13, 55.99 ± 0.33, 0.99 ± 0.01 and 0.1 respectively. While values of 4.41-7.32, 2.91 ± 0.04, 8.23 ± 0.05, 55.31 ± 0.25, 1.96 ± 0.04 and 0.2 are for Alestes baremose fish species. Moisture content observed is as follows: Clarias geriepinus > Tilapia zilli > Alestes baremose > Synodontis ocellifer.*
Key words*: Fish, moisture, open sun drying, shade drying, Tilapia zilli*

I. Introduction

Fishes form one of the most important groups of vertebrates for man, influencing his life in various ways. Millions of human beings suffer due to hunger and malnutrition, and fishes form a rich source of food and provide a means to tide over the nutritional difficulties of man. Fish flesh contains up 15 – 25% protein, 80% water, 1 – 2% minerals matter [1, 2] reported that, fish is a highly perishable food materials because of its high moisture and nutrient contents and spoilage begins as soon as fish dies. It has also been reported by [3] that immediately the fish dies, a number of physiological and microbial deteriorations set in and thereby degrade the fish. The relative high moisture content and high degree of unsaturated fatty acids in fish accounts for its perishability either during processing or storage [4]. Therefore, there is need for sun drying method by this; preservation is achieved by lowering water content in fish, thereby retarding activity of bacteria and fungi [5].
Drying or dehydration removes active water and stops microorganism growth. It also reduces rate of enzymes activity and chemical reactions. While drying, there is moisture loss, and fish protein and other substances tend to be concentrated and product becomes hard [6]. During drying moisture content and water activity are reduced and hence microorganisms cannot grow and multiply to spoil fish. This will help in preserving fish for a long time [7].

Simple sun-drying is the widely practiced traditional method of fish preservation and that sun drying depends heavily on the natural weather, since the fish dries by heat from sun and the air current carries water away. Rack drying has been used as the most hygienic method for sun-drying. Here fishes are dried on raised racks above ground. This can be made by tying old webbings to poles made of locally available materials, which are fixed at fixed distances from each other, this ensures circulation of air from both top and bottom, and contamination of the product with sand or dust is almost avoided and quality product is assured. Here, racks can be sloping type where there is a drain of water, or it can be multi-deck racks that consist of two layers or more [2]. Because the importance of fish drying is growing among all classes of consumers that some are consumed inside the country and a smaller portion is exported.

The objective of the present work was to study the effect of open sun-drying and shade drying on some fish species from Njuwa Lake, and to assess the moisture loss of the different fish samples in Lake Njuwa based on the expected standard set by the public health department [8].

II. Materials And Methods Study Area

Njuwa lake is located in Rugange village of Yola South Local government Area, Adamawa State. It lies between lattitude 8^0 N and 11^0 N, and longitude 11.5^0 E and 13.5^0 E. It is a small lake of ($2.8km^{2)}$, shallow (average depth 3m; maximum depth 5m). It was formed naturally and specifically used for annual fishing festival during the months of March annually for duration of two days and for farming irrigation.

Sampling process

Four samples (*Tilapia zilli, Clarias gariepinus, Synodontis ocellifer and Alestes baremose*) were used for the analysis of the moisture content using open-sun drying and shade drying methods respectively. The aforementioned fish were caught from Njuwa Lake. The fish samples were cleaned and gutted. Fish sample was cut and prepared for drying. The samples were then dried under the open-sun and shade and moisture content for each sample were measured at interval of 30 minutes each, until equilibrium is maintained.

Analytical Process

Determination of Moisture Content: open sun and shade drying methods was used in the determination of moisture content. 11.87g of fresh fish samples were weighed at the initial of the experiment and the drying temperatures of the aforementioned methods of the time of conducting the experiment are at (40-42^{0}C) and (30 – 32^{0}C) respectively. The measured samples were placed until a constant weight for 7h and 30 min was obtained according to the official methods of analysis [9]. The percentage moisture content (% MC) was computed as follows:

Moisture (%) = Loss in weight on drying (g) / Initial sample weight X 100…….(1.0)

Determination of Ash Content: The standard test method for ash content-ASTM D2866-94 was used. A crucible was pre-heated in muffler furnace to about 500^{0}C for 3 hours. It was then cooled in desiccators and weighed. 1.0g of each dried fish sample was transferred into the crucibles and re weighed. The crucibles containing the samples were then placed in a cold muffler furnace and the temperature was allowed to rise to 500^{0}C. It was removed and allowed to cool in a desiccator to room temperature (30^{0}C) and re weighed again. The ash content was calculated using the equation: Ash (%) = ash weight (g)/Oven dry weight (g) X 100…….. (1.1)

Determination of Crude Fiber: 1.0 g of each fish sample was boiled in 30 ml of 0.3N sulphuric acid for 15 minutes, then 40mls of 1.5N sodium hydroxide was added, the boiling was continued for another 15 minutes and then allowed to cool. The mixture was then filtered and washed several times with distilled water. The residue was then treated with 0.3N hydrochloric acid, filtered and washed with distilled water to neutrality and then with acetone. The residue was then dried in an oven at 105^{0}C then weighed into a clean crucible and ash for 3 hours at 500^{0}C. Crude fibre was calculated using the equation:

Crude fibre (%) weight of sample before using – weight of sample after using / weight of sample after using X 100 …….(1.2)

Determination of crude Lipid (Ether Extract): 2g of the sample for each fish sample was weighed into a 250 ml conical flask and 50 ml of diethyl ether was added, shook and allowed to stand overnight. The mixture was then filtered over a gravity filtration set and washed down with the same solvent. The ether was removed by evaporation on a water bath and then dried at 105^{0}C in the oven for 1 hour and weighed. Percentage oil was calculated using the equation

Crude Lipid (%) = weight of oil / weight of sample X 100…… (1.3)

Determination of crude protein and carbohydrate was carried out according to the official methods of analysis [9].

III. Results And Discussion

Table 1: Moisture Content for open-sun and shade-drying at varied temperature of 40- 42^{0}c and 30-32^{0}c respectively

Fish Sample	Drying method	Initial weight(g)	Final weight (g)	%Moisture
Tilapia zilli	F-OS/drying	11.17	4.72	42
	F-S/drying	11.17	6.85	61
	H-OS/drying	11.17	6.51	58
	H-S/drying	11.17	7.63	68
Clarias geriepinus	F-OS/drying	11.17	4.65	42
	F-S/drying	11.17	6.61	59
	H-OS/drying	11.17	4.39	39

	H-S/drying	11.17	8.21	74
Synodontis ocellifer	F-OS/drying	11.17	4.23	38
	F-S/drying	11.17	6.04	54
	H-OS/drying	11.17	3.90	35
	H-S/drying	11.17	7.10	64
Alestes baremose	F-OS/drying	11.17	4.79	43
	F-S/drying	11.17	6.34	57
	H-OS/drying	11.17	4.41	39
	H-S/drying	11.17	7.32	66

Key: F-OS, flesh open sun; F-S, flesh shade; H-OS, head open sun; H-S, head shade.

Table 2: proximate composition of fish[a]

Fish sample	Moisture content (range)	Crude fiber	Crude Lipid	Crude protein	Ash	Carbohydrate (without fiber)
Tilapia zilli	4.72-7.63	3.02±0.03	7.13±0.23	59.26±0.35	1.61±0.01	0.3
Clarias geriepinus	4.39-8.21	2.61±0.06	7.24±0.06	64.32±1.25	1.86±0.03	0.08
Synodontis ocellifer	3.90-7.10	3.62±0.05	6.52±9.13	55.99±0.033	0.99±0.01	001
Alestes baremose	4.41-7.32	2.91±0.04	8.23±0.05	55.31±0.25	1.96±0.04	0.2

[a] Values are means of triplicate determination+ SD

From Table 2. It was observed that the moisture content has decreased from initial moisture content (M.C.) of 11.17 to a range of between 3.90 to 4.72 as depicted in Table 2. Due to the reduction in moisture content, it was observed that the crude protein, crude lipid and ash all increased. This low moisture content is an indication that the dried fish samples have a tendency to be very stable. This results is in agreement by the work conducted by [3]

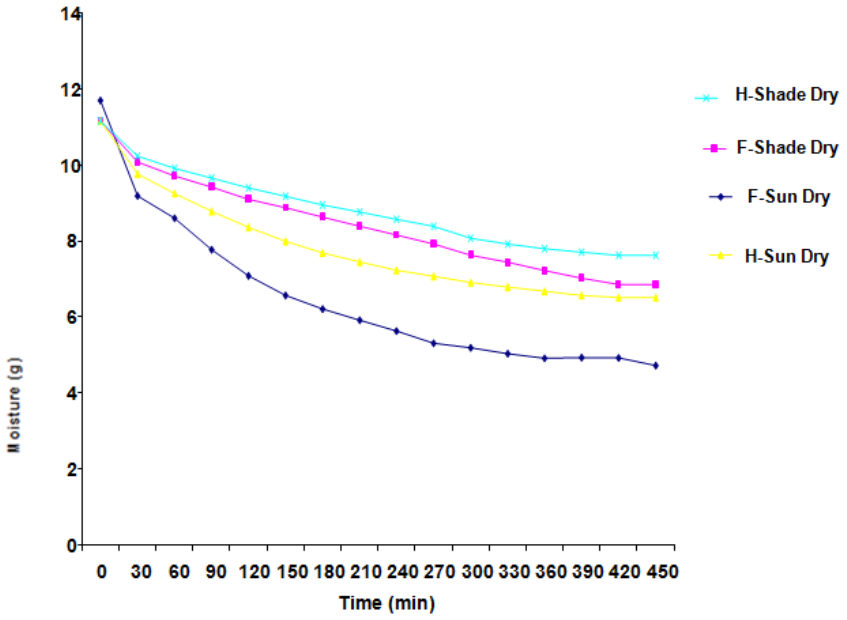

Fig 1: variation moisture content of *Tilapia zilli* with time in minutes

Figure one shows the variation moisture content of *Tilapia zilli* fish for open-sun and shade drying in minutes. The result of this data was compared of fish samples dried under the open-sun and the shade.

The initial moisture content was 11.17g for flesh sample and 11.17g for head sample as shown in figure 1 above. The moisture content decreased from 11.17g to 4.72 after 7:30 hours of sun drying but when compared with the fresh head sample under the sun for 7:30 hours, result obtained showed that the moisture content decreased from 11.17g to 6.51g, and this shows that the heat radiation penetration required to dry the head sample was more as compared to the flesh sample. The decline in moisture content was greatest in flesh sample than in the head sample which dried slowly. This indicates that the head sample had more moisture.

This result was compared to the shade drying sample, result reveals that drying was slower under the shade than in the sun for both samples that is flesh sample dried for 7:30 hours under the shade was 11.17g to 6.85g and head sample dried for the same period of time showed a moisture content decrease from 11.17g to 7.63g. these results portrays that drying fish sample under the sun is faster than in the shade [2] shows that, diffusion will increase with rise in temperature. Drying will therefore proceed more rapidly with temperature increase.

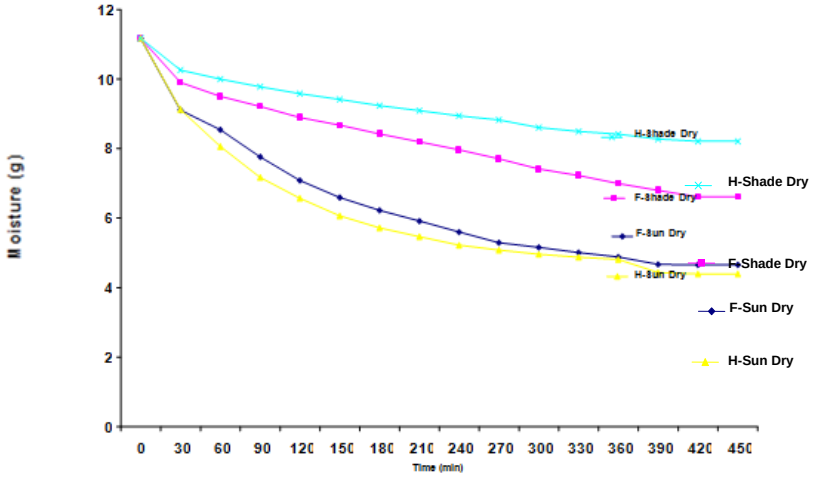

Fig 2: variation of moisture content *Clarias geriepinus* with time in minutes.

In figure 2 shows variation of moisture content between the dehydrated fish samples under the sun and shade drying. It is evident in the result that there was a clear variation. Fish sample dried under the open-sun and head sample dried under the shade, portrays the following result under the same temperature. For flesh sample 11.17g was reduced to 4.65g and the head sample the moisture content was reduced from 11.17g to 4.39g, comparing the results of sun drying and shade drying from an initial weight 11.17h the result shows that flesh sample was reduced to 6.61g and 8.21 respectively. This indicated that sample dried under the sun is faster. Considering the use of drying and shade drying it has been observed that the sun drying take period of dehydration of fish sample [10, 11, 12].

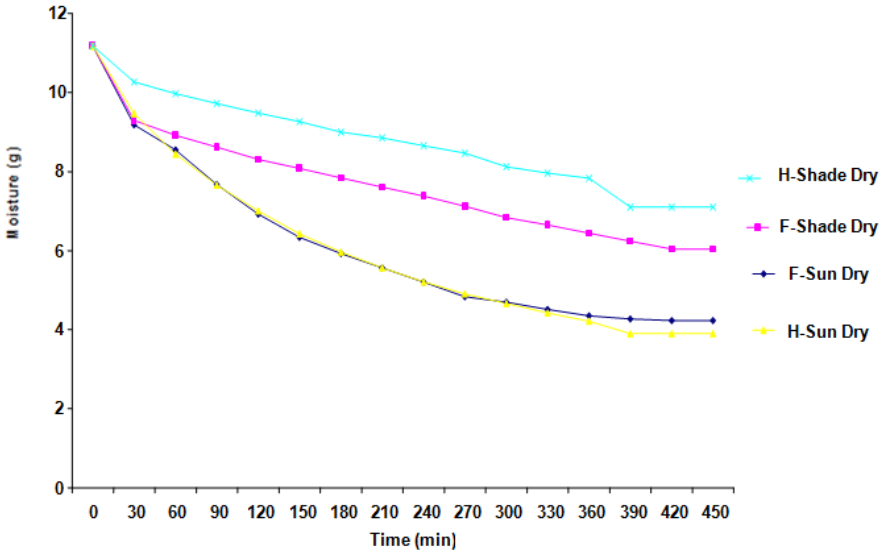

Fig 3: variation of Moisture Content of *Synodontis ocellifer* with time in minutes.

Figure 3 shows changes in moisture content of *Synodontis ocellifer* for sample dried under the sun and in the shade temperatures. From the result it was observed that, flesh sample for both sun and shade drying and head

sample for sun drying had a linear decrease in moisture content from 11.17g to 8.6g as compared to head sample for shade drying with a decrease in moisture content from an initial 11.17g to 10.2g. it was also observed that flesh and head samples which was dried under the same temperature had the same pattern of moisture decrease (fig 3). Though at time 330 minutes there was a slight difference in moisture decrease observed between the two samples.

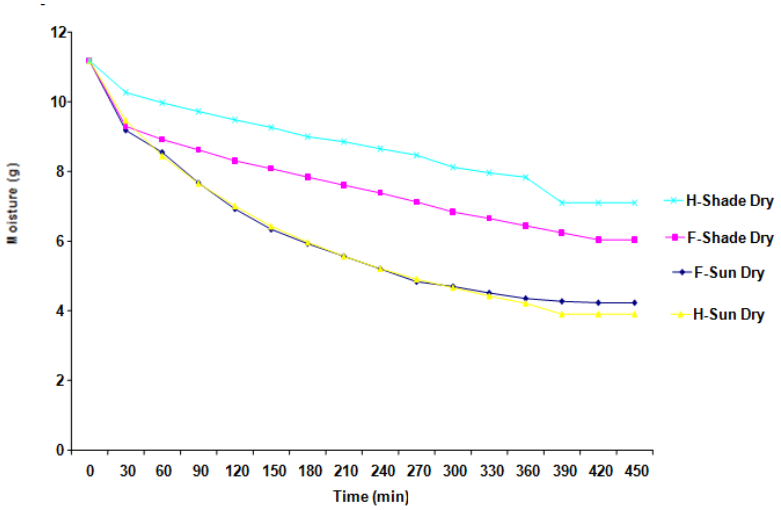

Fig 4: variation of Moisture content of *Alestes baremose* fish for sun drying and night with time in minutes.

Figure 4 shows the moisture content between the fish dried in the open-sun and in the shade drying respectively. It is evident from the results show in figure 4 that variation of moisture content was different due to two clear reasons. One reason is the difference in the use of open-sun drying and drying of fish in the shade. The second reason is the size differences of the fish species. Flesh and head sample dried under the open sand which indicated the following results for flesh samples, the initial weight was 11.17g and was reduced to 4.7g and the head sample the moisture content was reduced from 11.17g to 4.49g respectively.

The moisture content of flesh dried under shade decreased from 11.7g to 6.5g followed by head dried under same shade also decreased from 11.17 to 8g respectively. Therefore, the declined in moisture content was greatest in open-sun drying while that of shade-dried samples showed lower drying rate constants.

IV. Conclusion

This study shows that sun drying is a viable method of producing a good quality dried fish. Open sun and shade drying achieved by simply exposing the fish sample to the sun is a fast and easy method which gives a product of acceptable quality, with an efficient drying process for fish preservation.

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