NUTRITIVE PROPERTIES AND CONSUMER ACCEPTANCE OF SOLAR TENT AND SUN DRIED *KILISHI* FROM BONY-TONGUE (*Heterotis niloticus,* Cuvier 1829) IN A SEMI-ARID ZONE OF NIGERIA

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ABSTRACT
This study was carried out to determine the nutritional characteristics of solar tent and sun dried kilishi of bony tongue fish (Heterotis niloticus). Thirty freshly caught samples of Heterotis niloticus from Lake Alau in Maiduguri, Nigeria with an average weight of (239.6 ± 44.9 g) were used for the study. The kilishi from the species was prepared using two different slurry formation of high (50%) and low (24.35%) proportion of groundnut dough and spices mixture respectively. The kilishi was dried in solar tent and open sun-drying in three replicates. The proximate composition was determined for moisture, protein, ash, crude fibre, and crude fat, in percentages. The prepared kilishi products were subjected to statistical analysis using two- way analysis of variance (ANOVA). The result of proximate composition indicated that the solar-dried kilishi recorded significantly higher (P > 0.05) protein content 63.03 ± 1.64, higher ash content 5.33 ± 0.81 and crude fibre (19.00 ± 0.81) while the sun dried kilishi recorded higher moisture content 7.60 ± 0.81 in sun dried product despite lower values in fibre 6.00 ± 0.08, fat 2.00 ± 0.40 and crude protein 50.76 ± 0.02. Sensory scores of solar-dried rated significantly higher values for taste, colour, flavour, appearance and general acceptability with mean scores of 5.20 ± 0.90, 6.00 ± 0.90, 5.90 ± 0.16, 6.20 ± 0.16, and 5.90 ± 0.63 respectively, while the sun dried kilishi recorded lower sensory parameters 4.30 ± 0.89, 5.10 ± 0.81, 4.90 ± 0.16, 3.40 ± 0.08, and 5.10 ± 0.81 respectively for the above parameters. It can be concluded that kilishi prepared from solar tent was the most acceptable by the taste panel while the sun dried kilishi was least accepted. However, fish kilishi from solar-dried tent form a product attractive to consumers and increased shelf-life, hence explored alternative preservation techniques to reduce fish spoilage and post-harvest losses.
Keywords: kilishi, *Heterotis niloticus*, sun, solar tent, drying.

INTRODUCTION

Fish is an extremely perishable food with deterioration commencing immediately after harvest (Agbo *et al.*, 2002). Prior to death, the enzymes normally get involved in the digestion of ingested food and all microbial activities are controlled. As soon as fish dies, enzymatic action begins on the flesh and alimentary system leading to soft destructive changes. The process is referred to as autolysis. Post-harvest losses could be minimized by the application of proper preservation and processing methods (Eyo, 1997). Sun-drying is one of the oldest known fish preservation methods. It involves the subjection of fish to heat from the sun by spreading it on a flat surface that is exposed to sunlight. This enables moisture loss to be achieved and so, results in the drying of the fish. The characteristic low moisture content of dried fish makes them to be shelf stable at low water activities (Ligia, 2002). Solar energy has been used for centuries by man for drying animal flesh, skins, preserving meat, fish and agricultural crops (Akinola *et al*., 2006). Solar dryers have been developed worldwide as a means of generating solar energy for drying varieties of agricultural product (FAO, 1992). Therefore, solar dryers introduction to developing countries will reduce post-harvest fish losses, produce better quality products compared to sun or shade drying which are traditional (Yaldiz *et al*., 2001). Fish drying is an age long practice across the world. It is one of the methods of fish preservation and value addition which can improve the quality.

Processing methods include raising the temperature by canning, boiling, removal of moisture by natural drying, mechanical drying, smoking, salting and fish product development such as *kilishi* (Magawata and Oyelese, 1999).

Spices can be defined as natural vegetable products that are used to add seasoning and impart aroma to food (ISO, 1972). Spices like other food substances, may carry some bacteria, yeast, molds, spores and even some insects. The use of natural spices in meat and fish processing to curtail rancidity is recommended and these include the use of green onion, green pepper seeds and tomato peel on roasted beef (ICMSF, 1986). *Kilishi* is Hausa word which refers to slicing, dressing, sun-drying, application of slurry of spices and roasting on a glowing fire, processed goat, sheep or beef. *Kilishi* production is traditionally practiced in the northern parts of

Nigeria, (Igene *et al*., 1989). It appears to have developed among the early Fulani and Hausa herdsmen as a means of preserving meat in the absence of modern facilities, in order to enhance long storage. Fish *kilishi* was tested not only as a good protein source, but also as a much acceptable means of preservation. Little information appears to be available on fish *kilishi*, (Magawata and Oyelese, 2000; Ipinjolu *et al.,* 2004 and Aliyu and Falusi, 2006).

Heterotis niloticus was chosen for *kilishi* preparation because of its availability locally and higher flesh to bone ratio (Achionye – Nzeh and Omoniyi, 2002). It is commonly known as bony tongue and a valuable fish in Nigeria, which belongs to the family Osteoglossidae (Paugy and Teugels, 1990). This study, therefore aimed at the production of solar tent and sun-dried *kilishi* from bony tongue (*H. niloticus*).

MATERIALS AND METHODS

Fish samples

Thirty fresh samples of Bony-tongue (*Heterotis niloticus*) were purchased from Lake Alau in Maiduguri, Borno State. These were transported to the fish processing unit, laboratory, Department of Fisheries, University of Maiduguri, where the average weight was obtained using weighing balance, washed, descaled, degutted and filleted with the help of sharp knife and scissors.

Slurry formulation

Two different combinations of ingredients and spices were prepared. The formulations were thick due to high proportion of the principal ingredients (defatted groundnut) used. The formulations varied with lower and higher concentrations of groundnut dough, spices and ingredients, S_2 and $S_{1,}$ respectively as shown in Table 1.

Table 1: Different proportion of ingredients and spices used

SNo	Ingredients/spices Common name	Scientific names	Weight (g)	Proportion of ingredients (%)	
				S_1	S_2
1	Defatted groundnut	*Arachis hypogeae*	1700	50.00	24.35
2	Onion	*Allium cepa*	320	16.09	30.00
3	Ginger	*Zingiber officinala*	180	5.83	2.65
4	Dried hot pepper	*Capsicum frutescens*	60	2.75	2.0
5	Cloves	*Eugenia caryophyll*	40	1.40	1.77
6	Black pepper	*Piper quinensis*	60	2.80	1.75
7	Salt	*Sodium chloride*	30	2.0	2.00
8	Turmeric	*Curcuma conga*	40	1.50	2.00
9	Maggi (meat stock) cube		30	2.0	2.00
10	Cinnamon	*Cinnamon verum*	90	2.58	6.00
11	Coriander seed	*Coriandum sativam*	30	2.0	3.66
12	Fenugreek	*Trigonella foenum graecum*	91	1.09	1.76
13	Green cardamom	*Elettaria cardamonim*	166	6.0	2.0
14	Calabash nutmeg	*Monodora myristica*	84	1.19	2.0
15	Lemon grass	*Cymbopogan citrates*	92	1.08	9.30
16	Chilli	*Capsiam spp*	30	0.6	3.0
17	Garlic	*Alium sativum*	91	1.09	3.76
				100.00	**100.00**

S_1 – Higher concentration of ingredients, S_2 – Lower concentration of ingredients

Experimental design and treatment

The two formulations (S_1 and S_2) constitute the treatments of the experiment and each treatment was replicated three times for each sun-dried and solar dried products in a completely randomized design (CRD) as shown in Fig. 1.

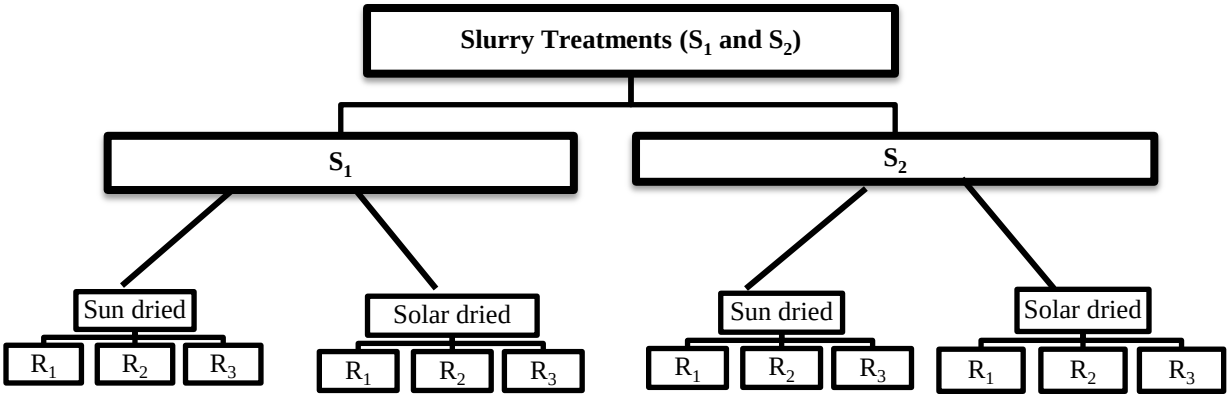

Fig. 1: Different treatments for both sun-dried and solar dried replicates

Drying of fish fillets using a solar tent dryer

Fresh fish

Freshly obtained fish from Lake Alau and were transported to the fish processing unit, Department of Fisheries, University of Maiduguri, Maiduguri.

Fish dressing

The samples were washed thoroughly with saline solution and the scales, bones, fins, heads and tail removed using dissecting set. This enhanced easy filleting of the fish.

Filleting of fish

The samples were exposed to air for 5 minutes so as to reduce the moisture content. With the use of a sharp knife, the samples were cut ventrally from the tail to the head region in fillet form as shown in plate 1.

First solar drying and sun drying

The freshly prepared fillets were introduced to the solar tent dryer and sun drying raft to reduce its moisture content by evaporation for one hour as shown in plates 2 and 3.

Infusion of partially dried fillets into slurry

The dried fillets were infused in the prepared formulated slurry containing spices and ingredients thoroughly for 10 minutes to ensure absorption of the slurry as shown in plate 4.

Second solar drying and sun drying

The infused fillets samples were mounted again in a solar tent dryer and sun drying raft for 21 hours to undergone second drying. This was to ensure a permanent absorption of the slurry on the fillet.

Roasting

After drying, the dried fillets were roasted for seven minutes on a drum smoking kiln (to ensure blending of ingredients into the dried fish fillets and to enhance taste of the finished products).

Final *kilishi*

The product obtained after roasting is the final prepared *kilishi* of the samples plates 5 and 6.

Plate 1: Filleting of fish samples

Plate 2: Initial Solar drying of fillets

Plate 3: Initial sun-drying of fillets

Plate 4: Soaking of partially dried fillet in the slurry

Plate 5: Solar-dried *kilishi* after roasting

Plate 6: Sun-dried *kilishi* after roasting

Procedure for *kilishi* production

The flow chart for *kilishi* production procedures is presented in Fig. 2.

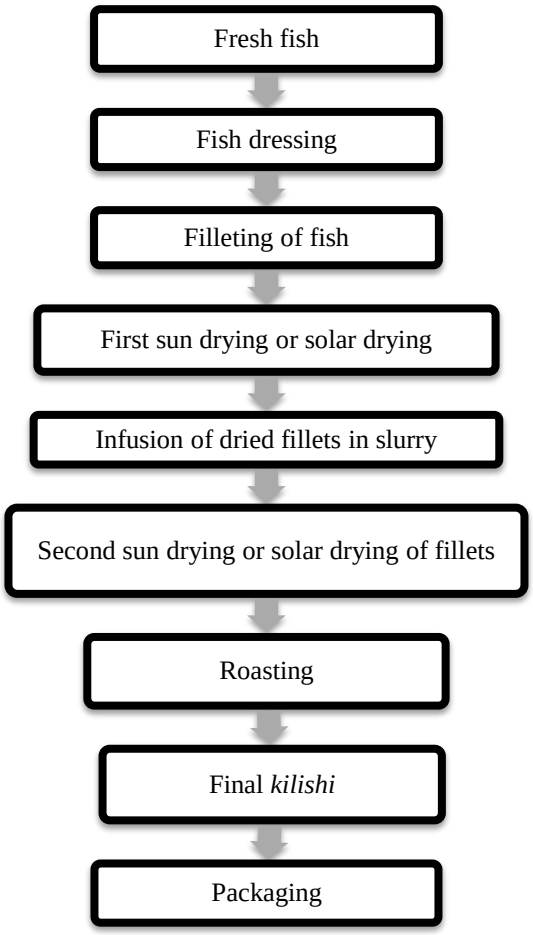

Fig. 2: Flow chart of *kilishi* production

Quality assessment of freshly prepared fish *Kilishi*

Proximate analysis

The initial and final proximate composition of fish *kilishi* was determined according to the Association of Official Analytical Chemists (AOAC, 2006) procedures. The moisture content (%), ash content (%), ether extracts (%), fibre (%), protein (%) and nitrogen free extracts (%) were determined.

Organoleptic assessment

Samples from the prepared *kilishi* products were subjected to sensory evaluation immediately to obtain data for the selection of the best out of the two formulations for each sun dried and solar tent samples. The test utilizes the sense of touch, smell, sight, taste and general acceptability for quality assessment of dried *kilishi* fish. The sense of touch was used to assess the texture of the fish, and sight to detect changes in colour and general appearance of the sample. The sense of smell helps in determining the flavour of good and bad quality of sample. The sense of taste is quite helpful in determining the palatability and general acceptability of the dried *kilishi* samples.

Data analysis

Analysis of variance was performed by two-way analysis of variance (ANOVA) using statistix 9.0 version software packages. Differences between the mean values were separated using Least Significance Difference (LSD) test and the significance was defined at $P<0.05$. Tables and figures were used as illustration.

RESULTS

The results in Table 2 indicate the fresh state proximate composition of *Heterotis niloticus* used for the production.

Table 2: Proximate composition of fresh *Heterotis niloticus*

	Composition (%)					
	Moisture	**Dry matter**	**Ash**	**Fibre**	**Ether extract**	**Crude protein**
H. niloticus	75.66 ± 0.83	24.34 ± 1.63	4.00 ± 1.63	9.00 ± 1.63	2.00 ± 0.40	44.2 ± 1.63

The results of proximate composition of dried *kilishi* prepared with two different slurry formulation (S_1 and S_2) and two drying methods (sun and solar) are shown in Table 3. *Kilishi* of S_1 formulation dried with solar tent recorded significantly ($p < 0.05$) higher protein (63.0 3 ± 1.64%) and higher fibre (19.00 ± 0.81%) despite having the highest ash content (5.33 ± 0.81%). The result of sensory evaluation are presented in Table 4 for the panel assessments. The result obtained in the Table 5 revealed the effect of drying methods on weight reduction.

Table 3: Proximate Composition of dried *Kilishi* of *Heterotis niloticus*

Formulation	Moisture (%)	Dry matter (%)	Ash (%)	Fibre (%)	Ether (%)	Crude Protein C.P (%)
S_1 (solar-dried)	7.00 ± 0.40^{bc}	93.00 ± 0.40^{b}	5.33 ± 0.18^{a}	19.00 ± 0.81^{a}	6.00 ± 0.81^{a}	63.03 ± 1.64^{a}
S_1 (sun-dried)	2.10 ± 0.44^{d}	97.54 ± 0.16^{a}	5.00 ± 0.16^{a}	15.00 ± 0.40^{b}	6.00 ± 0.81^{a}	55.15 ± 0.81^{b}
S_2 (solar-dried)	4.20 ± 0.16^{cd}	95.50 ± 1.71^{ab}	5.00 ± 0.16^{a}	11.83 ± 0.84^{c}	3.00 ± 0.16^{b}	52.87 ± 0.01^{b}
S_2 (sun-dried)	7.60 ± 0.81^{d}	92.40 ± 1.63^{b}	5.00 ± 0.16^{a}	6.00 ± 0.08^{e}	2.00 ± 0.40^{b}	50.76 ± 0.02^{d}

Means in the same column with same superscript are not significantly different (P > 0.05)

Table 4: Sensory ratings of *kilishi* of *Heterotis niloticus* according to drying method and slurry formulation

	Organoleptic parameters				
Formulations	**Appearance**	**Taste**	**Colour**	**Flavour**	**General acceptance**
S_1 solar	4.90 ± 0.08^{a}	4.10 ± 0.08^{a}	5.10 ± 0.86^{b}	5.60 ± 0.14^{ab}	5.50 ± 0.14^{a}
S_2 solar	6.20 ± 0.16^{b}	5.20 ± 0.90^{ab}	6.00 ± 0.90^{a}	5.90 ± 0.16^{a}	5.90 ± 0.63^{a}
S_1sun	3.40 ± 0.08^{b}	4.30 ± 0.89^{ab}	5.10 ± 0.81^{b}	4.90 ± 0.16^{b}	5.10 ± 0.81^{a}
S_2 sun	4.60 ± 0.81^{c}	4.30 ± 0.61^{b}	5.10 ± 0.14^{b}	4.90 ± 0.16^{b}	5.10 ± 0.81^{a}

Means in the same column with same superscript are not significantly different (P > 0.05).

Table 5: Effect of drying methods on percentage weight lost of *Heterotis niloticus*

	Weight parameters (g)		
Slurry formulation	**Initial weight**	**Final weight**	**% weight lost**
S_1 solar $_1$	190 ± 1.63^{a}	60.50 ± 0.08^{c}	68.16 ± 0.81^{b}
S_2 solar $_2$	316 ± 1.76^{a}	218 ± 0.89^{a}	31.11 ± 0.048^{c}
S_1 sun $_1$	236 ± 0.89^{a}	37.83 ± 1.64^{d}	75.42 ± 1.63^{a}
S_2 sun $_2$	216 ± 1.63^{a}	160 ± 4.89^{b}	44.72 ± 1.79^{d}

Means in the same column with same letter are not significantly different (P>0.05)

DISCUSSION

The proximate composition values at the fresh state was higher than the values reported by Chukwu and Shaba (2009) in raw catfish (71.85 ± 0.07%) and that of Ipinjolu *et al.* (2004) in *Heterotis niloticus* (69.36 ± 0.07%). *H. niloticus* was known to have higher flesh to bone ratio and excellent meat quality (Achionye-Nzeh and Omoniyi, 2002).

Kilishi of S_1 formulation dried with solar tent recorded significantly higher protein (63.03 ± 1.64%), higher fibre (19.00 ± 0.81%) despite having the highest ash content (5.33 ± 0.81%).This result was in disagreement to the value reported by (Ipinjolu *et al.*, 2004). They reported that high proportion of groundnut dough mixture resulted in low protein content of fish *kilishi*. The low protein content recorded highest moisture content (7.60 ± 0.81%) thereby exposing the fillets to attack by insects, microbes and allowing contamination by sand and dirt which was reported by other researchers (Olokor, 2001; Akinola *et al*., 2006). It also revealed the lowest protein content in S_2 (sun-dried) 50.76 ± 0.02% and highest moisture content 7.60 ± 0.81%. S_1 (sun-dried) also recorded dry matter of 97.54 ± 0.16% and low moisture content of 2.10 ± 0.44%. FAO/APHCA (1989) reported that moisture content of 12% is the level beyond which fish product begin to grow mould after a few days, while the final moisture of all species of fish under study was less than 12% and close to the range reported by (Magawata and Oyelese, 1999). However, the nutritional quality of fish depends largely on the quantity and quality of its crude protein (Oni, 2002).

The result of the sensory scores of *kilishi* prepared with S_2 (solar dried) revealed that this was the most preferred by the panelists for taste (5.20 ± 0.90%), appearance(6.20 ± 0.16%), colour (6.00 ± 0.90%), flavour (5.90 ± 0.16%) and general acceptability (5.90 ± 0.63%), while S_1 (sun-dried) has the lowest acceptance scores by the panelist for appearance, flavour and general acceptance with the mean values of 3.40 ± 0.08%, 5.90 ± 0.16% and 5.90 ± 0.63% respectively. The lower concentration of the groundnut dough and ingredients in slurry 2 (S_2) formulations had influenced by the panelist decision. The solar-drying method prevents the *kilishi* from

contamination with dust, flies, egg deposit which affect the quality of *kilishi* during processing and drying. This goes in line with result of Jega (2012) that the lower concentration of the groundnut dough in his formulation enabled the 'fishy´ taste to be more prominent. Therefore, the overall result of mean analysis conducted indicated that *kilishi* prepared with slurry 2 (S_2) formulations was organoleptically more acceptable. The value addition had transformed the specie product and improved its acceptance by consumers who hitherto could have rejected it if it were to be presnted fresh.

The result on weight loss shows that, the initial weight of fresh fillets has no significance difference ($P > 0.05$) in all the treatments. The result also revealed that solar-dried treatment appeared relatively low loss weight, which has more moisture loss than those of Sun-dried *kilishi*. This agreed with Doe *et al.* (1977) that solar drying prevents influx of flies, which affect the quality of fish during drying, minimizes heat loss and regulates heat during the drying process hence reduction in the drying period.

CONCLUSION

It can be concluded that fish *kilishi* was highly accepted by consumer immediately after roasting. Though, the two drying methods used in the study were accepted by the consumers, but solar dried *Kilishi* was mostly preferred. The groundnut paste used significantly affects the product quality of *kilishi* in terms of nutritional value, but Slurry 2 appears to be more acceptable to the consumers. There is an increase in protein content of final *kilishi* due to lower moisture content compared to fresh sample. Finally, it was suggested that preparation of fish *kilishi* should be explored as a means of preserving fish to arrest spoilage especially during glut supply and to diversify fish product; and this will increase the acceptability of *Heterotis niloticus* and reduce post-harvest losses.

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