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Effects of Storage Periods on Chemical Composition of *Clarias. gariepinus* Smoked Using Biomass Briquettes

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Abstract

The effect of storage period on the nutritional qualities of smoked African Catfish (*Clarias gariepinus*) were evaluated. Fresh fish samples were obtained from a fish market in Minna, Nigeria. Fish samples were gutted, thoroughly washed with clean tap water, brined in 25% salt solution for one hour and smoked in a modified drum smoking kiln. Samples were kept at room temperature and analysed for nutritional quality indices over a period of six weeks. The result indicates no significant difference ($p>0.05$) in mean proximate composition of the smoked fish samples during storage periods. Composition of the smoked fish samples during storage periods showed no significant difference ($p>0.05$) in Crude Fibre, Fat, NFE and total volatile base nitrogen (TVB-N) contents. Significant differences ($p<0.05$) were recorded in moisture, ash and percentage crude protein contents of the smoked fish product during storage period. The result of this finding showed significant difference ($p<0.05$) in Potassium (K), Calcium (Ca) and Phosphorus (P), however there was no significant difference ($p>0.05$) in Sodium (Na), and Magnesium (Mg) content. The result also depicted that there was significant difference ($p<0.05$) in the mineral composition (potassium and phosphorus) during the storage periods of melon shell briquettes smoked fish samples.

Keywords:
Storage period, Nutritional Quality, Smoked fish

Introduction

Fish smoking is the commonest preservation method in Nigeria because of the ease of processing which makes it acceptable in remote fishing villages where the technology for other preservation methods is not readily available (Oyero, 1999).

Wood is the largest source of fuel in many developing countries like Nigeria, especially for fish smoking with about 200 million people in developing nations, depending on wood biomass for their daily domestic energy needs (FAO, 1990). There is huge pressure on the use of fuel wood. With increasing pressure on the earth's resources, turning different kinds of organic waste into clean-burning fuel such as briquettes helps save forests and cut greenhouse gas emissions by substituting wood, charcoal and fossil fuels for fish smoking and other industrial processes. Biomass briquettes are potential energy source for fish smoking, as they are currently generated as waste in many homes in developing countries. Aside from being cleaner and easier to handle, biomass briquettes are also less polluting (David and Anne, 2014).

Catfish (*Clarias gariepinus*) is a commercially important freshwater fish species in Nigeria; it has enjoyed wide acceptability in most parts of the country because of its exceptional taste, flavor and good

texture (Kumolu *et al.*, 2009). The study, therefore, evaluated the storage quality of *C. gariepinus* smoked with melon shell briquettes in comparison with wood.

Materials and Methods

The fish smoking experiment was carried out in the Fishery Unit of the Teaching and Research Farm of the School of Agriculture and Agricultural Technology, Gidan Kwano campus (longitude 09° 31.052N latitude 006° 26.42'E at 200m high,) Federal University of Technology, Minna, Nigeria. Thirty fresh *C. gariepinus* with weight ranging from 500g to 800g were purchased from the Mobil fish market in Minna, Nigeria. They were gutted and then washed thoroughly with clean tap water to remove blood and slime. The fish were brined in 25% salt solution for one hour and were then drained for about 30 minutes (Oyero *et al.*, 2006). Thereafter, fish samples were divided into two groups of 15 each and were smoked in Improved modified drum smoking kiln, using firewood and melon shell briquettes respectively. The fish were turned regularly to prevent charring for 13 hours until dried to a constant weight.

The proximate analysis of the fish samples smoked with melon shell briquettes and firewood for moisture, ash and carbohydrate contents were determined as described by AOAC (2005). Crude protein, fibre and fat contents were determined using the methods described by Pearson (1976). The TVB-N was determined as described by Malle and Poumeyro (1989).

Mineral contents of all the samples were also determined by atomic absorption spectrometry (AAS), flame photometry and spectrophotometer according to the methods of AOAC (2003).

The data collected was subjected to statistical analysis using one way Analysis of variance (ANOVA) and Duncan Multiple Range Test was used for mean separation. The statistical analysis was conducted by using IBM SPSS version 20 software.

Results

The result of proximate composition of the firewood-smoked fish samples during storage periods in Table 1 showed no significant difference ($p>0.05$) for all parameters. The table also depicts that the mean proximate compositions of the melon shell briquettes smoked fish samples during storage periods showed no significant difference ($p>0.05$). However, there were differences in mineral contents of firewood smoked fish product during storage periods as shown in Table 2. There was significant difference ($p<0.05$) in Potassium (K), Calcium (Ca) and Phosphorus (P) values, but sodium (Na) and Magnesium (Mg) showed no significant difference.

The result in Table 2 also showed that there was a significant difference ($p<0.05$) in the K and P during the storage periods in melon shell briquettes smoked fish samples. However, Na, Ca and Mg did not vary significantly.

Table 1: Effects of storage periods on proximate composition and TVB-N of firewood melon shell briquettes smoked *C. gariepinus*

	Fire wood				Melon shell briquettes			
	Storage periods							
Parameters	1st	14th	28th	42nd	1st	14th	28th	42nd
Moisture (%)	26.67±1.59^a	26.17±1.86^a	25.5±0.29^a	23.5±0.5^a	23.17±1.9^a	22.50±2.02^a	21.00±0.29^a	19.33±0.17^a
Fat (%)	17.0±1.73^a	15.83±1.3^a	14.5±0.29^a	15.58±0.29^a	11.00±0.87^{a,b}	12.00±0.87^b	10.83±0.76^{a,b}	10.33±0.76^a
C.P (%)	23.86±0.68^a	25.23±1.11^a	25.93±0.75^a	25.14±0.15^a	24.41±0.76^a	25.32±0.67^a	25.87±0.38^a	25.6±0.10^a
Ash (%)	17.0±1.73^a	15.83±1.3^a	14.5±0.29^a	15.58±0.29^a	17.67±0.44^b	16.50±0.58^{a,b}	15.33±0.17^a	15.17±0.60^a
CF (%)	1.17±0.17^a	1.5±0.29^a	1.17±0.17^a	1.33±0.17^a	1.17±0.17^a	1.67±0.44^a	1.33±0.17^a	1.33±0.17^a
NFE (%)	22.8±7.97^a	19.4±5.54	22.30±1.46^a	24.2±0.46^a	22.58±3.1^a	22.18±3.0^a	25.63±0.84^a	28.23±1.12^a
TVB-N (mg/100g)	26.1±3.27^a	32.7±5.73^a	30.8±3.70^a	31.3±1.81^a	26.60±1.62^a	30.80±1.40^a	29.4±2.14^a	28.47±0.47^a

Mean±SE (standard error of mean), FW SFP (firewood smoked fish product), MSB SFP (melon shell smoked fish product)

Table 2: Changes occuring in minerals content of firewood and melon shell briquettes smoked *Clarias gariepinus*, during the storage periods

	Fire wood				Melon shell briquettes			
	Storage periods							
Parameters (mg/100g)	1st	14th	28th	42nd	1st	14th	28th	42nd
Na	83.3±8.3^a	80.8±5.1^a	89.2±5.8^a	90.8±6.5^a	112.7±12.7^a	109.3±14.3^a	111.7±9.3^a	105.7±7.5^a
K	57.5±4.3^a	53.3±2.2^a	121.7±3.3^b	133.3±4.4^b	106.7±3.5^a	108.3±6.9^a	210.0±7.6^b	205.0±5.0^b
Ca	651.3±13.6^b	561.6±31.8^b	388.5±32.6^a	449.9±47.6^a	637.3±15.9^a	562.7±19.2^a	609.7±38.9^a	592.3±25.1^a
Mg	6.41±0.01^a	6.57±0.02^b	6.52±0.03^b	6.50±0.05^{a,b}	6.33±0.3^a	6.67±0.3^a	7.00±0.0^a	7.00±00^a
P	2.31±0.04^a	2.50±0.06^b	2.67±0.04^c	2.89±0.04^d	2.00±0.0^a	2.33±0.3^a	3.00±0.0^b	3.00±0.0^b

Mean±SE (standard error of mean), FW SFP (firewood smoked fish product), MSB SFP (melon shell smoked fish product)

Discussion

The mean proximate composition during storage period of firewood smoked fish samples and that of the melon shell briquettes, were not significantly different at first day to 42nd day of storage. This is in-line with the report that protein forms the largest quantity of dry matter in fish (Pannevis, 1993). There was an increase in the percentage of crude protein of the smoked fish products during the storage periods. This could be due to gradual decrease in the moisture content of the smoked fish product (Eyo 2001). Changes observed in percentage ash and percentage lipid content during storage may have been due to leaching out of some extractable soluble minerals and hydrolysis of some of the lipid fractions (Daramola *et al.*, ,2013).

Decrease in the percentage moisture content during storage, could be attributed to the temperature of the storage medium (25°C-34°C) room temperature. Fish at 10-15% moisture content, reportedly had a shelf life of 3-9 months when stored properly (Jallow 1995). Reduction in lipid content could be attributed to oxidation of poly-unsaturated fatty acids (PUFA) contained in the fish tissue to products such as peroxides, aldehydes, ketones and the free fatty acids (Horner 1992). However, the rate of fat deterioration was very gradual. Fish oil has been found to be more liable to spoilage than other oils due to their greater number of unsaturated fatty acids as shown by the lower specification number and higher iodine value (Eyo 1993). The greater the degree of unsaturation, the greater would be the tendency for fat oxidation (rancidity). There might be high risks of rancidity during prolonged storage conditions due to the fatty nature of fish.

The Total Volatile Base Nitrogen (TVB-N) increased during storage. This is widely used as an indicator of the degree of lipid oxidation (Daramola; *et. al.* 2013). It helps to measure the level of fish spoilage and to explore the shelf life of fish. TVB-N to the Total Nitrogen has been recommended as a useful index of quality in fish (Huss, 1988). Kirk and Sawyer (1991) suggested the value of 30-40mg N

per 100g as the upper limit. And the limit of acceptability of fish is reported to be 30mg N per 100g by Connell (1995). Beyond this level, white fish and prawns are regarded as unacceptable. However, results from this study both in firewood smoked fish product and melon shell briquettes smoked fish products showed that stored smoked fish products still have their final TVB-N values (32.7±5.73and30.80±1.40) within acceptable limits, since they all have values less than 35 mg N per 100g for fish muscle set by the EEC (1995).

Melon shell contains 2.10% Calcium, 0.42% Magnesium, 1.30% Potassium, 259.85ppm Sodium (ppm) and 30.11ppm Phosphorus (Ogbe *et al.,* 2013). These values are low compared to firewood and may have accounted for the low concentration of mineral elements in melon shell briquettes smoked fish product of this study compared to firewood smoked fish products. Sodium chloride diffuses to muscles from the outside due to difference in osmotic pressure between the brine and fish muscle. This process does not continue indefinitely. Sodium and chlorine ions form a water binding complex with protein which itself exerts an osmotic pressure and eventually equilibrium is reached (Horner, 1997). It also clear from the results of this study that smoked *Clarias gariepinus* is a good source of macro and micro mineral elements in spite of the two different source of fuel for smoking the fish samples and may contribute to health, growth and development of human beings. The high Calcium content observed in firewood and melon shell briquettes smoked fish product (651.3±13.6 and 637.3±15.9mg/100g respectively) during storage are of nutritional benefit, particularly for children and the aged who need higher intakes of calcium for bone formation and maintenance. Calcium and potassium play a vital role in regulating thyroid activity. The Potassium content recorded at day 42 for firewood and day 28 for melon shell briquettes smoked fish samples storage period, are within the ranges needed to maintain the regulation of thyroid activity in good balance (ARL,2012). The minerals composition (sodium, potassium and calcium) in this study were high in all the smoked fish samples. Onyia *et al.,* (2010) reported similar findings and attributed this to the dominance of the element in the water body.

Conclusion

The nutritional and chemical compositions of smoked *Clarias gariepinus* showed variations from 1st day to 42nd day of the storage. Results however indicate that smoking method either with the use of firewood or melon shell brisquettes as energy source, is an important preservation method which could preserve the nutritive values of fishes and possibly reduce post-harvest losses.

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