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Comparative Quality Assessment of Fish (*Clarias gariepinus*) Smoked with Cocoa Pod Husk and Three Other Different Smoking Materials

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Abstract: A study was conducted to investigate the possibility of using dried Cocoa Pod Husk (CPH) to replace other conventional smoking materials such as firewood, sawdust and charcoal in the smoking of fish. Twenty kilogram of live mud fishes, *Clarias gariepinus* were bought from the open market in Ibadan, killed, gutted, thoroughly rinsed and then salted. The salted fishes were then divided into 4 equal portions (5.0 kg) and smoked for about 2 h. Each portion on 4 different smoking sources A-sawdust, B-zharcoal, C-cocoa pod husk and D-firewood. There were colour variations and different degrees of skin damage. The portion smoked with sawdust had an appreciable brownish colour compared to the others. The firewood smoked sample had a slight glossy appearance and its oily skin was retained at the end of the smoking exercise. The portions smoked with charcoal had an almost black colour without glossy skin and a considerable skin damage. The least damage to the skin of the fish was observed in sample smoked with CPH. A faint powdery appearance covered the skin of the CPH smoked sample. Analysis of the mean hedonic scores for taste, flavour, appearance and overall acceptability showed no significant differences ($p \leq 0.05$) among the 4 samples. However, the mean value for the portion smoked with CPH was the highest. Proximate analysis of the smoked samples showed highest percentage crude protein value (66.04) in firewood smoked sample and least value (33.60) in sawdust smoked sample. Highest percentage lipid (6.09) occurred in CPH smoked sample. The fungal colony count was lowest (68×10^3 cfu g^{-1}) in fishes smoked with CPH but highest in those smoked with charcoal (130×10^3 cfu g^{-1}). The result of the experiment showed that CPH is suitable for smoking fish and that its phenolic properties had antioxidative, antifungal and preservative effects on smoked fish.

Key words: *C. gariepinus*, Cocoa Pod Husk (CPH), firewood, sawdust, charcoal, smoked fish

INTRODUCTION

In Nigeria, demand for fish is on the increase due primarily to the health benefits of eating fish and secondarily to increase in human population and the Rinderpest disaster and drought bane which reduces the availability and affordability of red meat (cattle, sheep and goat). Fish constitute about 40% of the animal protein intake in Nigeria (Olatunde, 1998).

However, fish is an extremely perishable food and this consequently resulted in colossal loss due to post harvest spoilage. A number of physical and chemical changes occur in fish after harvest (postmortem) which resulted into quality deterioration. The main causes of spoilage in fresh fish are: Autolysis and bacterial decomposition (Eyo, 1983). At the death of fish, certain endogenous biochemical changes occur which condition the fish for proliferation by the spoilage bacterial (Ikeda, 1979). Few hours after death, stiffening of the fish muscle occur whereby fish lose its flexibility through a process called *Rigor mortis* (Regenstein and Regenstein, 1991). Oxidative rancidity is another factor which contribute to spoilage in fatty fishes (Eyo, 2001). Of all the preventive measures to arrest spoilage in fish, at domestic and local levels, smoking remain the cheapest. It is also the most preferred of all the treatment methods. As documented by Tull (1997) smoking impact flavours and preservative effect on fish. Smoked fish according to Oyelese (2003) attracts high foreign exchange to Nigerian government.

Cocoa pod husk which waste away in tonnage annually on most farms in Nigeria has revealed on analysis that it contained phenolic compound (Opeke, 2005). This study therefore aimed at comparing the smoke quality of Cocoa pod husk with other conventional smoking materials and its effect on smoked fish.

MATERIALS AND METHODS

The kilns: The smoking kilns used for smoking samples A, B and D were the conventional types common to the

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South Western Nigeria, while a drum Kiln device used by Cocoa Research Institutes of Nigeria (CRIN), to ash CPH was adopted for smoking sample C.

Kiln A: A giant metal tin with open roof was loaded with sawdust. The middle of the tin was blocked with another cylinder to create a hole in the midst of the sawdust when finally removed. With the aid of a small wood soaked in kerosene, fire was introduced to ignite the sawdust. After about 10 min, the salted fresh fishes were placed on the fire with the aid of metal gauze.

Kiln B: This is a common coal pot type which has its upper compartment loaded with charcoal. The lower compartment is empty and has an aperture via which air enters the Kiln to facilitate continuous burning of the charcoal. With the aid of metal gauze, the processed fish sample was placed above the heat source.

Kiln C: This Kiln is similar to the Drum type smoking Kiln described by Eyo (2001) but with the smoking rack situated about 10cm below the top end of the drum. It was made of a complete open roof metal (44-gallon size) with square shape aperture at the base and without any barrier between the heat source and the top end. As in B above, the smoking rack made of wire mesh was used to expose the fresh fishes to heat source. Dried CPH was introduced through the base opening and ignited to supply heat.

Kiln D: This has similar features with kiln C except that its size is half that of Kiln C. Firewood was introduced through the base aperture and ignited to supply heat.

Fish sample: The fresh fishes used in this experiment 20 kg live *C. gariepinus* were purchased from the open market in Ibadan, Oyo State. The fishes were killed by breaking their skulls. They were then cut open from the ventral side and all their viscera were removed skillfully. They were thoroughly rinsed and salted. The processed fishes were then divided into four equal portions.

Sensory evaluation: Twenty judges were selected and used for the organoleptic assessment of the smoked fishes. Questionnaires for the panelists were prepared using points on the hedonic score previously described by Eyo (1983).

Chemical analysis: Analyses of the proximate composition of both fresh and smoked fishes were carried out according to AOAC (1980).

Statistical analysis: Data collected were analyzed by analysis of variance (SAS, 1995). The Duncan‘s multiple range test was used to compared difference among means (Gomez and Gomez, 1985).

RESULTS AND DISCUSSION

The mean hedonic scores obtained for the taste, flavour, appearance and overall acceptability of the 4 differently smoked samples were presented in Table 1 Brownish appearance was observed on the sample of fish smoked with sawdust. The brownish colour of the firewood smoked sample had a glossy oily appearance. The sample smoked with cocoa pod husk retained that light brown colour of the fresh fish but with light powdery (white) soot on its skin. The charcoal smoked sample alone had a charred skin (skin damage). There was a slight muscle fragmentation on the sample smoked with charcoal. The moisture content values of all the smoked fish samples were generally low (Table 2).While that of the sawdust sample (10.71) was significantly lower ($p<0.05$) relative to others. The crude protein values decreased in this order: Firewood> Cocoa pod husk> Charcoal> Sawdust. Percentage ash (9.2) and lipid (1.58) contents of the sawdust smoked sample were lower compare to others.

The total fungal colony counts on the skin of the treated samples were shown on Table 3. Total fungal count was highest (130×10^3 cfu g^{-1}) on the skin of the Charcoal smoked sample and the least (68×10^3 cfu g^{-1}) on the CPH smoked sample. These observations were in conformity with the magnitude of heat energy released during smoking.

Table 1: Mean hedonic scores for the fish samples smoked with sawdust, charcoal, cocoa pod husk and firewood

Treatment	Color appearance	Flavour	Taste	Overall acceptability
A Sawdust	9.12a	7.14c	6.17	7.62
B Charcoal	7.22a	6.637	7.08b	7.18
C Cocoa Pod Husk	8.79ac	7.20c	8.04	8.66bc
D Firewood	7.88d	7.12b	8.01c	8.03

Means with the same letters within each column are not significantly different ($p<0.05$)

Table 2: Initial and final proximate composition of the 4 smoked fish samples

	Proximate composition			
	% Moisture	% Ash	%Crude protein	% Lipid
Initial	9.84	10.22	70.42	6.51
Final				
Smoke source				
Sawdust	10.71	9.12	33.60	1.58
Charcoal	8.08	12.16	61.56	3.14
Cocoa Pod husk	7.16	11.24	64.51	6.09
Firewood	7.66	10.20	66.04	4.10

Table 3: Fungal colony count of the smoked fish samples

Treatment	Mean fungal count
Sawdust smoked sample	74×10^{3}cfu g^{-1}
Charcoal smoked sample	130×10^{3}cfu g^{-1}
CPH smoked sample	68×10^{3}cfu g^{-1}
Firewood smoked sample	110×10^{3}cfu g^{-1}

Brownish appearance observed on the fish sample smoked with sawdust was similar to that of *Alestes nurse* sample smoked with Kainji Gas smoking Kiln as reported by Eyo *et al.* (1992), but without glossy appearance. Similar observation was also reported by Krasemann (2006) that smoking of white fish with soft wood material added appreciable colour to the smoked product. The sawdust Kiln device also resemble that used by Krasemann (2006).

The mean hedonic scores obtained for the taste, flavour, appearance and overall acceptability of the four differently smoked fish samples are presented in Table 1. There were no significant differences ($p<0.05$) among the mean scores of the 4 samples. However, the mean value for the portion smoked with CPH was the highest. A light powdery (whitish) soot was observed on the sample smoked with CPH.

Of the 4 treatment samples, the firewood smoked sample had a slight glossy attractive appearance, while the sample smoked with charcoal had the highest skin damage (charring). This may be due to both intense heating action of the charcoal and the coal pot kiln, which positioned the fish very close to the heat source. Akinneye *et al.* (2007) reported that smoke-dried fishes had the most attractive colour as against oven and sun dried samples.

The moisture contents of the smoked fishes were observed to be low across table (Table 2). This was in agreement with the report of Eyo (1992) that moisture content was generally low for fish smoked with various smoking kilns except the Watanabe smoking kiln whose firing source was far away from the smoking fish. Eyo (1997) equally reported that burning reduces moisture content by up to 15.56%, whereas smoking reduces it up to 35.03%. The value for protein content for charcoal smoked sample was substantially lower than the other sample. This may be due to the intensity of the heat generated by the kiln which led to protein denaturation (Akinneye *et al.*, 2007). Heat generated by the sawdust smoking kiln was relatively lower than others and similar trend was observed in values for percentage Ash and lipid c ontent of this same treatment. The opinion of Eyo *et al.* (1992) and Eyo (2001) seems to be applicable in the case of firewood and CPH smoked sample as heat intensity had an inverse relationship with moisture contents and a direct relationship with crude proteins. The crude protein value for CPH smoked sample was a little lower than that of firewood. Eyo (2001) moreover reported that a loss in fish body weight was not only as a result of fall in moisture content but also fall in percentage crude protein. This observation corroborated the report of Dvorak and Vognarova (1965) that intense smoking caused notable decrease in Lysine availability. This is because Lysine is the most sensitive basic amino acid to intense heat. Percentage loss of lysine according to Hoffman *et al.* (1977) varies from 6-33% and may be higher 53-56% during hot smoking (Caurie, 1975). Loses in other amino acids such as arginine, histidine and thiamine as well as a decline in the Net Protein Utilization (NPU) have also been reported (Jackson *et al.*, 1945). Irrespective of the loses in some essential acid, Lionarous (1970) reported that over 75% of the protein and above 50% vitamins and minerals are retained in smoked fish.

The total fungal colony count on the skin of the treated samples are shown in Table 3 observation of the mean values of the colony count showed a peak value on the sample smoked with charcoal and the least value on the CPH smoked sample. According to Encyclopedea Van Derwall, Charcoal is made by allowing a closely packed pile of wood to burn with insufficient air, as a result of which the volatile materials mainly phenolic which are preservative are driven off and the carbon of the wood is left. The very high fungal colony count on the charcoal smoked sample may be due to the fact that charcoal produced the least smoke compared to the 3 other smoking materials. Also the charred skin exposed the muscle of the sample more to fungal action. Krasemann (2006) reported that smoke provides a protective film on the surface of smoked fish.

The lowest colony count on CPH smoked sample could be attributed to 2 factors: The golden liliac flame released during CPH pyrolysis which precooked the fish muscle and reduced the percentage moisture contents on the fish (Chan *et al.*, 1975).

The white powdery soot deposited on the skin of the fish by CPH has a bacteriostatic and bactericidal effect (Olsen, 1976). CPH exhibited the antibacterial quality due to the presence of Phenolic compounds in the husk. McGee (2004) agreed with this when he reported that Phenol and Phenolic compounds in wood smoke are both antioxidants, which slow down rancidification of animal fats and antimicrobials, which slow bacterial growth. Krasemann (2006) reported that wood smoke is composed of millions of microscopic particle, which rises like a fog and vapour. The foglike vapour from wood contains volatile oils which enhance the characteristic taste and flavour as well as preservative qualities of smoked fish. Smokes contributes to fish preservation by acting as an effective antioxidant and bacteriostatic agent. Kjallsrand

and Petersson (2001) buttressed this fact when they reported that 2,6dimethylphenols which characterize hardwood smoke are stronger antioxidants than the corresponding 2-methoxyphenols present mainly in softwood smoke. The antioxidant activity is highest for the 2, 6 dimethoxylphenols with 4 alkenyl and 4-alkyl group which constitute 60-70% of the total amount of dimethoxlphenols in hardwoods. According to Lee (1933), the deposited smoke on fish skin had antifungal effect. This consequently prolongs the shelf life of smoked product.

CONCLUSION

The results have shown that cocoa pod husk is a good smoking material and that its utilization will help in prolonging the shelf life of smoked fishes. There is need for further investigation to develop a better smoking device which will maximize the utilization of both the quality soot from CPH pyrolysis and the intense liliac flame of the husk. Also the chemical analysis of the soot should be investigated to know the active ingredient of the soot that is bacteriocidal and this could be extracted for chemical preservation of fishes.

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