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Original Article

Effect of Firewood and Sawdust Smoke on Chemical and Physical Properties of Clarias Fish Meat

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ABSTRACT

This study was conducted to determine chemical composition and sensory evaluation of dried and fresh smoked of *Clarias sp* fish meat prepared using firewood and sawdust at traditional kilns. *Clarias sp.* fish (20 kg) was collected from Elmorada fish Market Omdroman (Sudan), these fish were in the range of 26 – 36 cm in length and 140 – 350 g in weight, the studied samples were divided into two main groups; fresh and dried. Each group was divided into two subgroups and treated with firewood and sawdust separately. The final products of the studied fish were analyzed for proximate analysis (crude protein, fat, moisture, dry matter, ash and nitrogen free extract) in addition to sensory evaluation. The study revealed that there were no significant differences in moisture, protein, fat, ash and nitrogen free extract content among studied samples. In the case of sensory evaluation of the smoked product, the fish smoked with firewood gave better overall acceptability than those smoked with dust wood. It could be concluded that the sawdust can be used practically as alternative to firewood to reduce the cost of smoking and waste of carpenter.

Keywords: Firewood, dust smoke, chemical physical attributes, *Clarias sp*.

INTRODUCTION

Shortage and deficiency of food supplies that the requirements of an increasing world population are major problems which are likely to lead to malnutrition and poor health. The current world fish production amount to 116 million tons, almost 50 percent of total world landings are estimated to be from small-scale capture fisheries, and most of the production is used for direct human consumption (FAO, 1997). However, aquaculture production is estimated at 16 million tons of fish which constitutes 23% of food fish supplies (FAO, 1997). In the Arab world, the fishery resources are estimated at eight million and seven hundred metric tons, but until now only five million tons were located, and economically four million and four hundred thousand tons are available for exploitation **(**Arab organization for Agricultural Development Report (1996). The fisheries resources of the Sudan form only less than 3.5% of total world estimates while they cover an overall area estimated at 100.000 km^2 of land water and 700 km^2 of Red sea coast (FAO, 1997).

Medani, (1972) showed that fish represent the source of animal protein for many Nilotic tribes in southern Sudan and the characteristics of fish consumption pattern. Abu Gideiri, (1973) stated that in the Sudan the importance of fish in the diet, seems to follow a markedly pattern regional pattern. Handling and post-harvest treatment of fish in Sudan shows a wide spectrum as the choice, consumption and ways of utilization. People consume fresh fish or presented in one away or other (salted, dried or smoked). Most recently fishes themselves have been used for other purposes as feeds for other animals, e.g. fish meals for poultry, or fishes themselves, or even remains of fish as fertilizers in agriculture (Abu Giddier et al., 1999).

One of the most important smoked fish in Sudan those formed an economical values are *Clarias spp.* fish, which served as dried fish (local name: Kejeik) which traditionally produced by Nilotic tribes, of the south from the Nile Sudd swamps. Fish may be re-dried after smoking, depending on the moisture content (Abu Giddier *et al.,* 1999). Sun drying and smoking are the final, yet an important step in traditional method of fish processing in many African countries, with the exception of Fessiekh, Mindeshi and Terkin in the Sudan (Essuman, 1992). Smoking demands great quantities of firewood and wood is becoming scarce and expensive eroding the profit of processors who often have to purchase it, the situation is known to be critical in fishing villages and urban centers where fish processing takes place on a daily basis. Most type of wood hard or soft can be used for smoking fish. Red mangrove wood which is available in

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tropical countries burns well even immediately after cutting but hardwood being the best burns slowly and produces more smoke than soft wood. The use of firewood though a traditional energy resource in fish smoking is an increasing environmental concern (Akande *et al*., 1998). Research and development work on development of fuels for use in smoking has been minimal thus far and should now be seriously looked into as part of future trends in area of fish processing, some alternatives presently in use either separately or in combination with firewood include such materials as palm nut, coconut husk, sugar cane trash and etc.

The main objectives of this study:

1- to develop an alternative use and efficiency of local fuels, (wood and its sawdust; Teak wood *Cordia africana*), in smoking of fish using traditional kilns.

2- and to determine the effect of firewood and sawdust smoke on the chemical and physical attributes of *Clarias* Sp. meat.

MATERIALS AND METHODS

Locality

This study was conducted at Sudan University of Science and Technology (sustech.edu), College of Science and Technology of Animal production, department of fisheries and Wildlife Science.

Experimental Trials

Fresh *Clarias sp* fish (20 kg) was purchased from Elmawarda Fish Market (Sudan). These fish were in the range of 26 – 36 cm in length and 240 – 350 g in weight. Fish were thoroughly washed with tap water and weighed, and then gutted using clean knives and washed again with tap water to remove all traces of viscera and blood. The fish were then immersed into a salt solution (NaCl 10%), and divided into two batches; one batch was dried in the sun and open air for one day and other batch was kept fresh. The products were prepared and introduced into steel kiln smoker which was consisted of two parts as follows: 1. the smoking chamber with dimension 86 x 87 x 93 cm^3. 2.The chimney of two parts, the marginal part of 75 cm, height of 80 cm and diameter of 25 cm whose fuel was composed of Teak wood *(Cordia Africana*) at rate of 4 kg and kept at an average temperature of 45◦C throughout the period of exposure for continuous two hours.

Smoking process

The studied fish were divided into two fresh and dried groups while each of them was further divided into subgroups that smoked with sawdust and firewood separately using traditional kiln. The time taken to smoke of dried fish samples with firewood was 5 hours, while it took 12 hours in the case of sawdust, also the time taken to smoke fresh fish with firewood was 6 hours while it took 14 hours when using sawdust. The smoked products were taken to laboratory for analysis.

Chemical analysis

The gross chemicals of samples were determined according to standard methods of Association of Official Analytical Chemists (AOAC, 1984**)** for moisture, fat, protein, ash and nitrogen- free extract.

Sensory evaluation

The sensory evaluation was undertaken to determine the taste, odour, texture and general acceptability of the smoked products. The panelists of ten members who already have experience with scoring smoked fish in addition to staff members and some students of college of Science and Animal production Sudan University of Science and Technology. An overall acceptability score was given to smoked product using scale of 8-excellent, 7-very good, 6-good, 5-fairy good, 4-fair, 3-poor, 2-very poor and 1-extremely poor.

Statistical analysis

Data of biochemical constituents of studied fish were analyzed by one - way ANOVA procedures and SPSS version 10.

Results and Discussion

The results of this study shed a light on fish meat (*Clarias sp.*) somking, in view of its high preference by and its availability in dry and wet seasons for consumers. The studied fish product parameters were analyzed, investigated chemically, organoleptically and recorded in Tables 1,2,3,4 and 5.

The result of investigation on *Clarias sp.* meat indicated that the chemical composition resulting from smoking by firewood and sawdust on studied fish no significant difference ($P > 0.05$) was found to be in moisture, protein, fat, and ash values. These findings were in the line of Ali *et al.*, (1996) who studied the chemical composition of some of Nile fish species in addition to its body characteristics, yield indices and chemical composition. Also these results were in agreement with the finding of Akande *et al*. (1998) who found that no significant difference in the gross chemical composition of *Clarias garpeninus* smoked using firewood and sawdust in an improved Chorkor oven. The ash contents were shown in this study a lowest mean value in the fresh and dried smoked products; this might be resulted from the analysis which carried out on the edible portion of fish not incisive of the bones. Also the results revealed that a combined smoking with drying (open – air), obtained a highest level of gross chemical composition particularly in the case of protein and fat content, while the ash content recorded the lowest level as previously reported (Akande *et al.*,1998).

In the case of dried fish smoked with firewood, the moisture content (14.9%) , dry matter (85.2%), crude protein (21.3 %), fat (5.7%) , ash (3.9%) , NFE (65.2 %) were obtained in comparison to smoked with sawdust with

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moisture content (10.5%), dry matter (89.4%), crude protein (21.3%), fat (5.1%), ash (3.8%), N.F.E (65.2%) that showed a considerable variations. These findings in agreement with Ikeme, (1991) who studied characterization of traditional smoked dried fish in Nigeria. Chemical composition can vary widely, not only from fish of the same species, but also within an individual fish, according to age, six, and environmental condition (FAO, 1997).

Sensory assessment as judged by taste panelists was presented in Table 5. Fresh Fish smoked using firewood (5.6) were found to be better in terms of overall acceptability when compared with sawdust smoked products (4.5). Dried fish smoked using firewood were also found to be better in terms of overall acceptability (5.0) fairly good when compared with fish smoked with sawdust (4.5). Also these results were in agreement with Clifford *et al.* (1980), who observed that the texture, toughness and dryness of smoked fish were greatly influenced by the panelist's preference.

Table1. Chemical composition of fresh and dried studied fish (*Clarias sp*).

Treatment	Moisture	Dry matter	Crude protein	Crude fat	Ash	Nitrogen free extract
Fresh fish (smoking with sawdust)	89.55±0.64	10.5±0.64	21.3±0.35	5.1±0.1	4.0±.14	51.5±2.1
Fresh fish (smoking with fire wood)	91.35±0.49	8.65±0.49	21.3±0.39	5.2±0.1	3.70±0.14	59.7±0.63
Dried fish (smoking with sawdust)	14.85±1.9	85.2±1.6	22.9±0.91	5.7±0.2	3.9±0.07	65.2±0.42
Dried Fish (smoking with fire wood)	10.45±0.64	89.4±0.64	26.2±0.49	7.8±0.1	3.8±0.07	65.2±0.42

Values as mean of 10 fish species for each treatment. SD = Standard deviation.

The appearance of smoked fish is usually judged based on the black golden luster, which the heavy smoke of the sawdust may have conferred on the product as opposed to the firewood. The panelists judged the sawdust smoked fish slightly firmer in texture than the firewood smoked fish. This may also explained from the fact that the low fire characteristic of burning sawdust as opposed to the initial high heat produced from firewood may have prevented case hardening of the fish and thereby making the texture more acceptable to taste panelists. Skrede and Strobeken (1986) observed that the color of smoked products depends on textural properties, chemical composition, and the liquid binding ability of the muscle. The result of this study particularly in the case of smoking fish with sawdust was fair good comparing with that results obtained by firewood. When the findings were analyzed statistically there was no significant difference.

Table 2. Effect of firewood and sawdust smoke on dry matter and Crude protein of studied fish

Treatment / Smoking		Dry matter		Crude protein	
		Firewood	**sawdust**	**Firewood**	**Sawdust**
	Fresh	8.7±0.49	10.5±0.2	21.3±0.31	21.3±0.35
	Dried	89.4±0.64	85.5±0.49	22.9±0.95	26.2±0.49
Main effects:					
Samples	**Fresh**	6.00±0.202		24.00±0.359	
	Dried	9.55±0.202		22.05±0.359	
	Sig. level	NS		NS	
Smoked	**Firewood**	7.22±0.202		25.05±0.359	
	Sawdust	8.32±0.202		22.00±0.359	
	Sig. level	NS		NS	
Interaction Sig. level		NS			

NS = Not significant. SD Standard deviation

Sawdust can be obtained at practically with no cost. Initially, a combination of sawdust and wood may be used in fish smoking as used to the sawdust only. Sawdust can be made into briquettes, which will reduce waste and constant replenishment. The duration of smoking using firewood (5 hrs) is less than sawdust (12 hrs) period, this could be a

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disadvantage because it means that the labour cost may be increase. However, this problems was never might to fish smokers in the villages are used to smoking overnight. It could be concluded that the sawdust can be used practically as alternative of firewood to reduce the cost of smoking and waste of carpenter.

Table 3. Effect of firewood and sawdust smoke on fat and ash content of studied fish

Treatment / Smoking		Fat		Ash	
		Firewood	**sawdust**	**Firewood**	**Sawdust**
	Fresh	5.2±0.1	5.1±0.1	3.70±0.14	4.0±0.14
	Dried	7.8±0.1	5.7±0.2	3.8±0.07	3.9±0.07
Main effects:					
Samples	**Fresh**	5.20±0.061		3.80±0.056	
	Dried	5.40±0.061		3.85±0.056	
	Sig. level	NS		NS	
Smoked	**Firewood**	5.10±0.061		3.72±0.056	
	Sawdust	5.50±0.061		3.92±0.056	
	Sig. level	NS		NS	
Interaction Sig. level		NS			

NS = Not significant. SD Standard deviation

Table 4. Effect of firewood and sawdust on nitrogen free extract and moisture content of studied fish

Treatment / Smoking		Fat		Ash	
		Firewood	**sawdust**	**Firewood**	**Sawdust**
	Fresh	59.7±0.63	51.5±2.1	91.35±0.49	89.55±0.64
	Dried	65.2±0.42	65.2±0.42	10.45±0.64	14.85±1.9
Main effects:					
Samples	**Fresh**	63.00±0.575		90.50±1.08	
	Dried	55.55±0.575		12.65±1.08	
	Sig. level	NS		NS	
Smoked	**Firewood**	62.42±0.575		50.9±.1.08	
	Sawdust	56.12±0.575		52.2±1.08	
	Sig. level	NS		NS	
Interaction Sig. level		NS			

NS = Not significant. SD Standard deviation

Table 5. The mean values of overall acceptability of organoleptic indices of smoked product

Parameters / Treatment		Color M±SD	Odor M±SD	Taste M±SD	Texture M±SD	Appearance M±SD	Overall acceptability M±SD
Fresh (n=10)	**Smoking with sawdust**	4.1±2.02	4.7±1.15	4.8±1.9	4.6±1.8	4.0±1.3	4.5±1.6
	Smoking with firewood	4.6±1.42	5.9±1.52	5.30±1.4	6.6±1.8	5.7±1.3	5.6±1.5
Dried (n=10)	**Smoking with sawdust**	5.0±.81	5.0±1.8	4.6±1.6	4.6±1.6	3.2±1.6	4.5±1.5
	Smoking with firewood	5.4±1.42	5.5±1.50	4.6±1.6	5.4±1.4	4.3±2.1	5.0±1.6

Note: each result is mean ± standard deviation of ten panelist response on a scale of 8 = excellent, 7= very good, 6= good, 5= fairly good, 4= fair, 3=poor, 2= very poor and 1= extremely poor.

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