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Effect of Some Selected Fossil Fuels on the Nutrients Composition and Consumer Acceptability on Smoked-Dried Redbelly Tilapia (*Coptodon zillii*)

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Abstract

Fuel wood is among the most expensive items in fish processing, knowledge on smoking efficiency of various agricultural wastes particularly sugarcane bagasse could be substitute for wood for fish smoking thereby reducing the cost, the problem of deforestation and eventually control of environmental pollution. The study was aimed to assess the effects on nutritional composition and cost-benefit analysis of using ebony wood and sugarcane bagasse as fuel sources for smoke drying of fish. The result of this study showed that the highest (65.15±0.20) crude protein was recorded in *Coptodon zillii* smoked with ebony wood and the least (16.08±0.13) in fresh *C. zillii*. Similarly, for ash, crude fat and nitrogen free extracts were observed, and the better moisture reduction (4.28±0.03) was recorded in *C. zillii* smoked with bagasse and least (3.38±0.08) from *C. zillii* smoked with ebony wood. The differences in the proximate composition of the smoked *C. zillii* using ebony wood and sugarcane bagasse were significant ($p<0.05$). The organoleptic assessment of the smoked *C. zillii* using ebony wood and sugarcane bagasse were significantly different ($p<0.05$). The cost (₦150) for smoking with sugarcane was less with an equal quality with the cost (₦250) for smoking with ebony wood which is not environmental friendly.

Keywords: Fossil Fuels; Organoleptic Analysis; Nutrient Composition; Smoked Fish; *Coptodon zillii*

Abbreviations: SFC: Specific Fuel Consumption; BR: Burning Rate; LSD: Least Significance Difference.

Introduction

Fish is an important source of animal protein in the diet of man. Fish is a good source of inexpensive premium protein, as it contains all of the essential amino acids [1]. Fishes are excellent low fat sources providing benefits such as low cholesterol [2]. Fish is a highly perishable commodity that undergoes spoilage as soon as it is harvested. Once spoilage sets in, the odor/flavor, texture, color and chemical composition change [3]. One-third of fish produced worldwide was estimated to be wasted [4]. The processing

and preservation of fresh fish were of utmost importance since fish is highly susceptible to deterioration immediately after harvest and also to prevent economic losses [5].

Diospyros mespiliform (West African Ebony) is Hochst (Ebenaceae) is a tree that grows wild in tropical Africa. It is used in ethno medical practice against malaria in northern Nigeria [6]. *Diospyros mespiliform* is known as Kanya in Hausa, Igidudu Yoruba, Onye-ojiIgbo and бalege Fulfulde [7]. Previous studies in laboratory showed that the plant has analgesic, anti-inflammatory and antipyretic effects [8], with CNS activity that is sedative in nature [9]. The plant was also reported to have potent antibacterial [10,11] and anti-trypanasomal activities [12]. Studies of quantitative phytochemical screening of *Diospyros mespiliformis* (West African Ebony) also shows Presence of Alkaloid, Flavonoid, Saponins, Quinones, Tannins and Phenols in its Crude Seed, Mucilage and Seed Extracts [7].

Bagasse is a fibrous residue of the cane stalk left after crushing and extraction of the juice. It consists of fibre, water and relatively small quantity of solids mostly sugar. Bagasse is commonly used as a substitute for wood in many tropical and sub-tropical countries for the production of pulp, paper and board in most countries like India, China, Colombia, Iran, Thailand and Argentina [13]. Much research efforts and many applications are directed at exploring bagasse potential as a renewable energy for the production of bio-based materials (for example, briquettes or pellets and bioethanol) [14]. Since excessive cutting of wood can lead to deforestation and desert encroachment there is the need for alternatives. However, utilization of sugarcane bagasse (waste products) as fuel source will enhance good smoke-dried quality product that would draw consumer's attention as well as reduce environmental pollution and deforestation [13]. Smoking involves use of wood fuel which in turn affects product quality [15]. However, changes in the quality of fish products produced depending on the type of wood fuel used for smoking have not been closely monitored. In addition to improving organoleptic quality, this could offer the chance to introduce newer wood fuel products until now unused for fish smoking. However, the utilization of sugarcane bagasse (waste products) and *Diospyros mespiliformis* (West African Ebony) wood as fuel sources will enhance good smoke-dried quality products that would draw consumers' attention as well as reduce environmental pollution. The preservation of fish is therefore considered a major hindrance to its production, utilization and consumption, especially in the tropical countries in Africa [16]. Therefore, this study was aimed at investigating the changes in Nutrient composition and organoleptic characteristics of *Coptodon zillii* smoked with West African Ebony and sugarcane bagasse.

Materials and Methods

Study Area

The study was conducted in the Fish processing unit of the Department of Fisheries and Aquaculture, Faculty of Agriculture, Federal University Dutse, Jigawa state, Nigeria.

Procurement of Fish Samples

A total of 12000 g of fresh *Coptodon zillii* was procured from a landing site of Kalgwai dam, Kaugama Local Government, Jigawa State. The sample was identified with the aid of identification key of Olaosebikan BD, et al. [17] and were transported using insulated cold flask to the processing unit.

Fish Preparation and Smoking Activities

The fish were gutted, descaled washed thoroughly with water severally until they were clean and dipped into a brine solution (9g of salt/liter of water) for 5-10 minutes. They were later grouped into two treatments (Sugarcane bagasse and ebony wood) and spread on wire mesh, to drain under a shed. After Forty-five minutes, the fish were arranged on the racks and placed in the dryer. Temperature of 70°C was maintained in the dryer for the first hour, using ignited bagasse and ebony wood chaff. The temperature was then reduced to 40 – 50°C till the end of the drying period.

Packaging of Smoked Fish

The fish products were allowed to cool after the smoking process and packed in groups in a carton later transferred to room temperature for storage.

Proximate Composition Analysis

Proximate composition of fresh and smoked *C. zillii* which include moisture, fat, dry matter and ash content were assayed as describe by AOAC [18].

Organoleptic Assessment

The Organoleptic evaluation was assessed by a 10 (Ten) man panel consisting of staff and students using the 7-point hedonic scale (7 = excellent; 6= very good; 5 = good; 4 = fair; 3 = poor; 2 = very poor; 1 = extremely poor) for colour, appearance, flavour, taste and general acceptability.

Cost-Benefit Analysis

The cost-benefit of smoked tilapia using sugarcane bagasse and west African ebony wood was analyzed. Specific Fuel Consumption (SFC), Burning Rate (BR), Weight of fuel

per kg of fresh fish, cost of fuel per kg of fresh fish, and % weight lost was calculated as:

$$Specific\ Fuel\ Consumption\ (SFC) = \frac{(Mass\ of\ fuel\ consumed\ (kg))}{(Total\ mass\ of\ smoked\ fish\ (kg))}$$

$$Burning\ Rate\ (BR) = \frac{(Weight\ of\ fuel\ materials\ used\ (kg))}{(Smoking\ duration\ in\ minute)}$$

$$Weight\ of\ fuel\ per\ kg\ of\ fresh\ fish = \frac{(Weight\ of\ fuel\ materials\ used\ (kg))}{(Weight\ of\ fresh\ fish\ (kg))}$$

$$Cost\ of\ fuel\ per\ kg\ of\ fresh\ fish = \frac{(Cost\ of\ fuel\ materials\ used\ (N))}{(Weight\ of\ fresh\ fish\ (kg))}$$

$$\%\ weight\ lost = \frac{(Weight\ lost(kg)\ X100)}{(Weight\ of\ fresh\ fish(kg))}$$

Statistical Analysis

Data were subjected to analysis of variance and a significance test for difference among sample variance using the least significance difference (LSD) in the mean comparison of means at p<0.05 level of significance using Statistix 10.0 software version.

Results (Tables 1-3)

Parameters	Fish Sample		
	Fresh	Smoked with Ebony	Smoked with bagasse
Moisture content %	78.18±0.23[a]	3.38±0.08[c]	4.28±0.03[b]
Crude protein%	16.08±0.13[c]	65.15±0.20[a]	58.22±0.24[b]
Crude fat%	1.04±0.01[c]	13.77±0.09[a]	12.58±0.08[b]
Ash content %	1.53±0.03[c]	4.53±0.04[b]	5.12±0.03[a]
NFE%	3.19±0.14[c]	13.20±0.24[b]	19.82±0.17[a]

The Mean values in the same column with different subscript are significantly different at (p<0.05)

Table 1: Proximate Composition of Fresh and Smoked *C. zillii* using Ebony wood and Sugarcane bagasse.

Parameters	Smoked with Ebony	Smoked with bagasse
Appearance	7.00±3.00[b]	8.50±1.50[a]
Texture	7.00±1.00[a]	6.00±3.00[b]
Taste	9.50±0.50[a]	8.50±1.50[b]
Flavour	8.00±3.00[a]	7.50±0.50[b]
Aroma	7.00±3.00[a]	6.50±2.50[b]
Freshness	6.50±3.50[b]	8.50±0.50[a]

Table 2: Organoleptic assessment of the Smoked *C. zillii* using Ebony wood and Sugarcane bagasse.

Parameter	Smoked with ebony wood	Smoked with bagasse
Weight of fresh fish (kg)	6	6
Weight of smoked fish(kg)	2	2.1
Duration of smoking(min)	171	184
Smoking temperature(^{0}C)	60-70	60-70
Specific Fuel Consumption(kg)	5.5	2.86
Burning Rate(kg/min)	0.04	0.06
Weight of fuel/kg of fresh fish(kg)	1	1.83
Cost of fuel/kg of fresh fish(₦/kg)	41	25
Percentage Weight loss (%)	65	66.67

Table 3: Cost-benefit Analysis of using Ebony wood and Sugarcane bagasse in smoke drying of *C. zillii*.

Discussion

From the result obtained in (Table 1), showed that the fresh *Coptodon zillii* fish moisture content, which was 78.18±0.23%, decreased to 3.38±0.08% for fish smoked-dried using Ebony wood and to 4.28±0.03 for fish smoked-dried using Sugarcane bagasse. The fresh fish values were consistent with earlier research by Kumolu-Johnson CA, et al. [19] and Idah PA, et al. [20], who found 77.90±9.73 and 75.11% moisture content respectively. According to Rodrigues ET, et al. [21], one of the primary goals of smoking fish is to lower the moisture content of the fish to roughly 15-20 percent. This is applied to retard the post-harvest losses process in fish [1]. This resultant reduction in moisture content of the smoked fish product will reduce rate of spoilage and in turn elongate the shelf life of the smoked products [16]. Although fish smoked-dried using Ebony wood had lower moisture content than fish smoked-dried with Sugarcane bagasse, no significant difference was found in the amount of moisture lost in either case ($P>0.05$). While the crude protein content was found to be 16.08±0.13% in fresh fish before smoking, it was determined as 65.15±0.20% in those applied Ebony wood after smoking and 58.22±0.24% in smoked fish from Sugarcane bagasse. This concurred with related investigations by Mohammed MA, et al. [1], Bello MM, et al. [13], Eyo AA [15] and Obande RA, et al. [22]. Modibbo UU, et al. [23] reported that a reduction in moisture content resulted in an increase in crude protein. Ninawe AS, et al. [24] reported that dried fish had higher protein content than fresh fish. On the other hand, fat content was found as 13.77% for fish smoked with Ebony wood and 12.58% for fish smoked with Sugarcane bagasse (Table 1). The fish low fat level was a sign that fat content decreases as fish are exposed to dryness, which agrees with findings by Mohammed AM, et al. [1] and Bello MM, et al. [13] who recorded fat contents of 12.74% and 13.74% for *Oreochromis niloticus* and *Clarias gariepinus* smoked using ordinary wood and neem wood. There was significant change in ash content after smoking process ($P<0.05$).

The Organoleptic assessment of the Smoked *C. zillii* with the taste panel response revealed that people preferred fish smoked using Sugarcane bagasse over those smoked using Ebony wood. There was a significant difference in Organoleptic attributes among the smoked-dried fish using Selected Fossil fuels on the data recorded from general acceptability by the panelists ($P<0.05$) (Table 2). These results are in agreement with an earlier study [13] which found that Sugarcane bagasse-smoked fish had a golden-brown color and desirable texture and an attractive smoky flavour. The Organoleptic qualities of a processed fish are of great importance due to the fact that every consumer demands good qualities from their fish consumption [25].

The results in Table 3 shows the analysis of ebony wood and sugarcane bagasse consumption, smoking duration and temperature in the smoking of *C. zillii* that 6, and 11kg each of fuel source, were used to smoked 12kg of fish samples at average temperature ranges of 60-70°C. The costs of smoking 1 kg of the fish samples using the ebony wood and sugarcane bagasse were: ₦41.00k and ₦24.00k respectively. And the length of time taken to smoke each of the samples using ebony wood and sugarcane bagasse was: 171 and 184 min, respectively.

Conclusion

In conclusion, Sugarcane bagasse can be used in fish smoking. Fish smoked with bagasse had a better nutritional composition and a more appealing in colour than fish smoked with ebony wood.

Additionally, bagasse can be used as a substitute for wood when smoking fish and it can be recommended that, bagasse be used as a fuel source in both humid and arid environments.

Conflict of Interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Author's Contribution

Conceptualization RWS and MYH; Investigation RWS and AAA; Project administration RWS, Methodology, AAA and MYH; Formal Analysis, RWS; Supervision AAA; Writing – Original Draft Preparation RWS; Writing-Review & Editing MYH, MS and WAD. All authors were involved in critical interpretation of the data, manuscript revision, and final version approval.

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