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EFFICACY OF *Parkia biglobosa* FOR THE CONTROL OF INSECT PEST IN SMOKED DRIED *Clarias gariepinus.*

[1]KWALA, G. J., [2]SOLOMON, S.G., [2]ATAGUBA, G.A., *[2, 3]OKOMODA, V.T., and **[3,4]IKHWANUDDIN, M.
[1]Department of Fisheries and Aquaculture, Federal University of Lafia,
P.M.B 146 Lafia, Nasarawa State, Nigeria.
[2]Department of Fisheries and Aquaculture, College of Forestry and Fisheries,
Joseph Sarwuan Tarka University (formerly, Federal University of Agriculture Makurdi),
Makurdi P.M.B. 2373 Makurdi, Nigeria.
[3]Higher Institution Centre of Excellence, Institute of Tropical Aquaculture and Fisheries Research (AQUATROP), Universiti Malaysia Terengganu, 21030 Kuala Nerus, Terengganu, Malaysia.
[3]STU-UMT Joint Shellfish Research Laboratory, Shantou University, Shantou, 515063, Guangdong, China
*Corresponding author e-mail: okomodavictor@yahoo.com phone no: +2348030618864
**Corresponding author e-mail: ikhwanuddin@umt.edu.my phone no: +60168083452

ABSTRACT

Investigation into the control of insect pests and improvement of the keeping quality of Clarias gariepinus smoked with Parkia biglobosa parts and products was attempted in this study. The phytochemical parameters of P. biglobosa Charcoal (PBC), Bark (PBB), Leaf (PBL), and Wood (PBW) were done and used to smoke dry forty (40) pieces of table size C. gariepinus (i.e., 10 for each treatment). The smoked fish was then stored for 6 months to monitor insect pest infestation, organoleptic parameters, and its keeping quality. The result of phytochemicals showed that the PBW had the highest value of phenol (4.21mg/g), saponin (6.44mg/g), tannin 3.76mg/g) and alkaloid (2.66mg/g). PBC on the other hand had the least value of phenol (2.17mg/g), while saponin, tannin, and alkaloids were not detected. The organoleptic assessment was in favour of the PBC compared to the other treatments in terms of colour, appearance, flavour, taste, smell, and general acceptability (5.32). However, drying the fish with the PBL gave the least organoleptic assessment. Regardless, there was evidence of deterioration as the storage time advanced in all treatments. The insect pest detected during the storage period was Dermestes maculatus and infestation was most severe when the fish were smoked with PBC and least with PBW. This pest infestation was observed to increase as the storage time increased. Although the findings of this study suggest that PBW is best for smoke-drying C. gariepinus, it also demonstrated the potential of PBB as an alternative fuel source. This alternative can be adopted to reduce the competitive use of wood.

Keywords: Insect pest, Phenol, Length of storage, organoleptic assessment

INTRODUCTION

Fish is one of the cheapest sources of animal protein consumed all over the world and it has been used to correct protein deficiencies in many low-income countries in the tropics (Akinwumi, 2011). This is most evident in Africa, where animal protein is limited and expensive, hence, intake of cured fish is used to increase household protein intake. Since, it is comparably and sometimes better than other sources of protein (Akinwumi *et al.*, 2006). However, fish is highly perishable, because shortly after harvesting, it starts to undergo spoilage. Once spoilage sets in, the odour, texture, colour, and chemical composition of the fish are affected (Gupta and Gupta, 2006). It is projected that fish post-harvest losses are often above 50% in developing countries; this exceeds losses of other food commodities (Olatunde, 1998). To prevent insect pest infestation and extend the shelf life of the fish, different methods have been employed; they include but are not limited to smoking, sun drying, freezing, salting, canning, etc., (Awan and Okaka, 1985; Gupta and Gupta, 2006). Among the indigenous methods of preservation employed by farmers in the tropics, smoking is considered the simplest and easiest adaptable method of fish preservation (Olayemi *et al.*, 2011). It does not require sophisticated equipment and produces readily acceptable products which have desirable colour, flavour, and taste (Ames *et al.*, 1999). The shelf-life of smoked fish is quite longer than fish preserved using other methods because of the reduced moisture content (Eyo, 2001).

The firewood used for traditional smoking contains phenolic compounds; these have been implicated in improving the preservation of smoked products, their organoleptic parameters, and keeping quality during storage (Kjellstand and Petersson, 2001). The preservative properties (i.e., phenols and phenolic compounds) present in the tree trunk used as firewood are also present in other parts of the plant including the leaves, bark, roots, and fruits (Opeke, 2005). However, the effects of the processing of wood into charcoal as regards the phytochemicals are still very much unknown. The global search for alternative fuel sources as well as natural preservatives (antioxidants) to combat fish spoilage has inspired research into using tree parts and products for preservation purposes (Ogali, 1994). It is, however, noteworthy that fish spoilage can also be caused by insect pest infestation in addition to the actions of microbes, enzymes, and fat oxidation. Insect pest infestation has been reported to cause substantial losses to the nutritive value of fish in storage (Odeyemi and Daramola 2000; Ogbonnaya and Ibrahim, 2009). FAO (2002) had earlier reported considerable losses in the weight of cured fish due to the damage caused by an insect pest. These losses they estimated to be up to 50% from beetle infestation alone following months of storage. The Calliphoridea, Sarcophagidae (blowflies) and Dermestidea (beetle) have so far been implicated in damages resulting from insect infestation of fish in previous studies (Sastawa and Lale, 1998; Johnson and Esser, 2002). However, *Dermestes maculatus* is the most preponderant insect pest of dried fish in sub-Saharan Africa (Johnson and Esser, 2002; Dobie *et al*., 1991).

The conventional approach of reducing losses from insect infestation through the use of chemical treatments (pesticide and insecticide) has been widely condemned because of their potentially hazardous nature to public health at high doses and the possibility of bioaccumulation in humans (Mohammed and Yusuf, 2001; Ayuba and Omeji, 2006). Therefore, much recent research has identified natural plants such as Neem Seed as promising bio-pesticides for the control of *D. maculatus* in stored fish (Ajao, 2012). *Parkia biglobosa* is one of such medicinal plant that can serve this purpose. The African locust beans as it is fondly called are available in a wide range of environments in Africa. It is an important economic tree, with high medicinal attributes. Abioye *et al.*, (2013) had earlier reported its potential in managing bacterial infections. However, its application in the prevention of postharvest losses in fish has not been well reported. This study is therefore designed to provide information on the potentials of different parts and products of *P. biglobosa* (i.e., leaf, bark, wood, and charcoal) in the control of insect pest infestation and preservation of smoked *C. gariepinus*.

MATERIALS AND METHODS

This study was carried out at the Department of Fisheries and Aquaculture Federal University of Agriculture Makurdi. Its geographical coordinates lie at Latitude 7^0 44' North and Longitude 8^0 35' East Benue State, Nigeria. Table-sized *C. gariepinus* were obtained from Wadata Market in Makurdi (7° 44' 42.36" N and 8° 30' 45.36" E) and transported in an ice box to the Department of Fisheries and Aquaculture, University of Agriculture Makurdi. Once on campus, the ten (10) fish samples designated for each treatment (totaling 40) were gutted and washed thoroughly with clean water. The cleaned fish samples were then kept on racks (protected by a mosquito net to prevent perching by flies) to first drain before placing them in six drum-type smoking kilns (two for each treatment). Each of the smoking kilns has *P. biglobosa* leaf (PBL), *P. biglobosa* bark (PBB), *P. biglobosa* charcoal (PBC), and *P. biglobosa* wood (PBW) as the fuel sources and each treatment replicated. The maximum temperature in the smoking chamber was monitored and controlled to prevent charring of the fish samples. After smoke drying the fish, they were packed in a woven mesh wire basket (conventional storage practiced in sub-Saharan Africa) from where samples were taken for organoleptic assessment and insect pest infestation assessment monthly for six (6) months.

The qualitative and quantitative screening of bioactive compounds (i.e., phenol, tannin, alkaloid, and saponin) in the different parts and products (i.e., leaf, bark, wood, and charcoal) of the *P. biglobosa* was done using standard methods described by Sofowora, (1993) and Singleton *et al.*, (1999). Organoleptic evaluation of the smoked *C. gariepinus* was performed using twenty (20) previously trained panelists. The panel scored the samples for appearance, colour, smell, flavour, taste, and general acceptability using the hedonic scale method adopted by Ihekoronye and Ngoddy (1985) (i.e., 7 = excellent; 6 = very good; 5 = good; 4 = fair; 3 = poor; 2 = very poor; 1= extremely poor). Insect pests observation and evaluation were done of fish in each basket following the method described by Wahedi and Kefas (2013). The insect pest (i.e., egg, larvae, and adult) in each basket were counted distinctly and identified with the aid of a microscope, hand lens and the identification keys earlier compiled by Cornes (1973) and FAO (1989). The data were analyzed using Minitab 14 for Windows (Minitab Inc, State College, Pennsylvania. USA). First, descriptive statistics were done, followed by the analysis of variance (ANOVA) at a 5% level of significance once normality and homogeneity of variance were confirmed. Where significant differences occurred, the means were separated using Fisher's LSD.

RESULTS

The qualitative and quantitative results of phytochemicals in the *P. biglobosa* as shown in Table 1 indicate the highest value of phenol (4.21mg/g), Saponin (6.44mg/g), Tannin 3.76mg/g) and Alkaloid (2.66mg/g) in the PBW. However, only phenol was detected in the PBC with the least value of 2.17mg/g ($P<0.05$). The phytochemical content of the PBB was much more than that in the BBL as observed in this study.

The organoleptic assessment of the stored *C. gariepinus* smoked using the different parts and products of *P. biglobosa* is shown in Table 2. Our findings indicate that the fish earlier dried with PBW had better appearance (5.22), flavour (5.13), taste (5.16), smell (5.33), and general acceptability (5.32) judging from the highest hedonic score. The PBL however, had the lowest score of 4.48, 4.61, 4.46, 4.39, and 4.55 respectively. In the same vein, processing with PBC gave the highest score for colour (5.28) while leaf had the least (4.58) value (P<0.05).

Only the *Dermestes maculates* was seen to infest the *Clarias gariepinus* smoked using the different parts and products of *P. biglobosa* and the result obtained are presented in Tables 3, 4, 5, and 6. The result showed that infestation of *D. maculates* did not occur in the first three months of storage (i.e., May, June, and July) as seen in the different treatments. In August, eggs and the larva of *D. maculates* were seen but not adults. Thereafter, the number of eggs, larvae, and adults increased as the storage duration was prolonged in all treatments. A total of 141 *D. maculates* were observed in stored fish smoked with PBC; the highest number recorded in this study (Table 3). A total number of 131 and 130 *D. maculates* were seen in fish smoked with PBL and PBB respectively. While, on the other hand, only 102 numbers of the insect pest were observed with the smoke drying of *C. gariepinus* with PBC and storing for 6 months.

Table 1: Active compounds present in the various parts of *P. biglobosa* used to smoke *C. gariepinus*.

Parts used	Phenol	Saponin	Tannin	Alkaloid
	mg/g			
Charcoal (PBC)	2.17±0.02[a]	ND	ND	ND
Bark (PBB)	3.44±0.01[b]	6.02±0.02[b]	2.86±0.01[b]	2.03±0.02[b]
Leaf (PBL)	3.13±0.01[c]	4.31±0.01[a]	2.55±0.02[a]	1.87±0.01[a]
Wood (PBW)	4.21±0.00[d]	6.44±0.01[c]	3.76±0.01[c]	2.66±0.01[c]
P-Value	0.000	0.000	0.000	0.000

Mean in the same column with different superscripts differ significantly (P<0.05)
ND= Not Detected

Table 2: Mean Organoleptic Assessment of Stored *Clarias gariepinus* Smoked using Charcoal, Bark, Leaf and Wood of *Parkia biglobosa*

Treatment	Appearance	Colour	Flavour	Taste	Smell	General Acceptability
Charcoal	5.21±0.09[b]	5.28±0.10[b]	5.07±0.10[b]	5.07±0.10[c]	5.06±0.09[b]	5.21±0.09[b]
Bark	4.63±0.13[a]	4.67±0.13[a]	4.65±0.13[a]	4.76±0.12[ab]	4.49±0.13[a]	4.68±0.11[a]
Leaf	4.48±0.14[a]	4.58±0.13[a]	4.61±0.13[a]	4.46±0.13[a]	4.39±0.13[a]	4.55±0.13[a]
Wood	5.22±0.10[b]	5.16±0.10[b]	5.13±0.11[b]	5.16±0.09[b]	5.33±0.11[b]	5.32±0.10[b]
P-Value	0.000	0.000	0.002	0.000	0.000	0.000

Means in the same column with different superscripts differ significantly (p<0.05).

Table 3: *Dermestes maculates* infestation in Stored *Clarias gariepinus* Smoked using Charcoal of *Parkia biglobosa*

Time (Month)	Egg	Larva	Adult	Total number of pests
May (initial)	-	-	-	-
June	-	-	-	-
July	-	-	-	-
August	10	9	-	19
September	14	12	11	37
October	14	13	13	40
November	17	13	15	45
Total	55	47	39	141

Table 4: *Dermestes maculates* infestation in stored *Clarias gariepinus* Smoked using Leaf of *Parkia biglobosa*

Time (Month)	Egg	Larva	Adult	Total number of pests
May (initial)	-	-	-	-
June	-	-	-	-
July	-	-	-	-
August	9	9	-	18
September	13	12	10	35
October	14	13	11	38
November	14	13	13	40
Total	50	47	34	131

Table 5: *Dermestes maculates* infestation in Stored *Clarias gariepinus* Smoked using Bark of *Parkia biglobosa*

Time (Month)	Egg	Larva	Adult	Total number of pests
May (initial)	-	-	-	-
June	-	-	-	-
July	-	-	-	-
August	10	9	-	19
September	12	12	10	34
October	15	11	11	36
November	17	12	11	40
Total	54	44	32	130

Table 6: *Dermestes maculates* infestation in stored *Clarias gariepinus* Smoked using Wood of *Parkia biglobosa*

Time (Month)	Egg	Larva	Adult	Total number of pests
May (initial)	-	-	-	-
June	-	-	-	-
July	-	-	-	-
August	7	9	-	15
September	10	8	7	25
October	10	10	8	28
November	12	11	10	33
Total	39	38	25	102

DISCUSSION

The result of the study revealed that *P. biglobosa* parts and products contain active compounds with wood and charcoal having the highest and lowest values respectively. This agrees with the works earlier reported by Opeke (2005). The presence of phenol in different parts and products of the tree have significant effects on the keeping qualities (i.e., shelf life) and the organoleptic characteristics of fish (Kjellstand and Petersson 2001). The studies by Cardinal *et al.*, (2006) and Jonsdottir *et al.*, (2008) also collaborated with this work, when they noted that the phenolic compounds in plants influenced the sensory characteristics of smoked fish. The absence of other phytochemicals in the PBC may be a result of the processing used for its manufacturing (incomplete combustion). It is well known that some phytochemicals are thermolabile (Musa *et al*., 2018; Okomoda *et al*., 2021), hence may have been lost in the production of charcoal and unavailable during the processing of the fish. The organoleptic assessment in this study shows there was deterioration and reduction in the quality of the smoked fish stored over time regardless of the part or product of *P. biglobosa* used. Consequently, as the storage time increases, assessment scores changed from a very good/good product before storage to fair/poor after the storage of six (6) months. The reduction in the quality of smoked stored fish observed could be attributed to the invasion by insect pests which is in credence with the work of Ayuba and Omeji (2006). They reiterated the fact that insect infestation is the most prominent cause of the loss in quality and quantity of stored dried fish in Nigeria.

The insect pest *Demerstes maculatus* was identified in the four treatments in this study. *C. gariepinus* smoked with charcoal is more prone to insect pest infestation *D. maculatus* attack while the wood treatment had the least attack. This is following the study by Egwunyenga *et al*., (1998). Amusan and Okorie (2002) had earlier identified that *Demerstes maculatus* is a predominant insect pest of stored smoked fish as well as a major pest of cured fish. The level of insect infestation in the present study is directly proportional to the duration of storage. This is in line with the work by Ajayi *et al.*, (2006) and Wahedi and Kefas (2013) who observed that insect pest infestation increased with the storage period. The increasing infestation is because of increased insect breeding and consumption as reported by Eyo, (2001). Fragmentation, loss of the physical qualities, and frass of the smoked fish were observed across all treatments which probably is a result of the insect attack. This also collaborates with the works of Davies *et al.*, (2014) that fragmentation is one of the early signs of fish quality deterioration under storage. The onset of insect infestation depends on a change in environmental conditions that creates a favourable predisposing factor (Haines and Rees, 1989; Daramola *et al.*, 2007). The fact that fish smoked with *P. biglobosa* charcoal had the highest insect infestation in contrast with wood may be explained by the concentration of phenols and the absence of other phytochemicals in the PBC compared to the PBW. A similar opinion has been expressed with Neem tree fuel wood when used to smoke freshwater and marine fish by Oduor-odote *et al.*, (2010).

CONCLUSION

This study shows that different parts of *P. biglobosa* contained some active compounds at different concentrations. Charcoal is the easiest and most readily available fuel source used in Nigeria. However, our findings have shown that some of the beneficial phytochemicals that are effective for the preservation and control of fish deterioration and insect pest infestation such as *D. maculatus* are absent. Hence, although our findings suggest the PBW to be the best fuel source for drying *C. gariepinus*, as it improves the keeping quality of the final product, we have also demonstrated the potential of PBB as an alternative. The use of PBB in place of conventional but ineffective PBC will help reduce the burden of the competitive use of wood and charcoal.

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