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Full Length Research Article

EFFECTS OF INSECT INFESTATION ON THE ECONOMIC VALUE OF SMOKED FISH IN SOME SELECTED MARKET IN BIU LOCAL GOVERNMENT AREA, BORNO STATE, NIGERIA

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ABSTRACT
The effects of insects' infestation on the economic value of smoked fish were assessed, which aim at ascertaining the impacts of insects on the value of smoked fish. The sampling technique used was structured questionnaire to obtain information on socioeconomic characteristics of the respondents and economic loss encountered. Smoked fishes were bought from 3 markets, and checked in the laboratory for identification of insect pests. Results revealed that age bracket of 41-50 were the highest 36(30%) respondents, men dominate smoked fish business and married men and women were also discovered to be higher with 86(71.67%). Majority [64(53.3%)] of the respondents were secondary lever. The household size of 1-5 and Islam were the highest among the respondents with 54(45%) and 93(77.5%) respectively. The results also revealed that small scale seller (43.4%) were more and majority of the fishmongers spent between 1-10 years in the business, and about 39(32.5%) of the respondents believed that local processing techniques was responsible for fish infestation by insects. Majority [84(70%)] of the respondents provided labour for themselves and *Clarias gariepinus and Oreochromis niloticus* were the major fish market by the respondents. Generally, *Oreochromis niloticus* was mostly affected by insect infestation. Higher percentage [44(37%)] of the respondents made >#50, 000 as a profit per month and poor marketing was the major challenges encounters by the fishmongers. The major lost encountered by the respondents was Lack of profit. Two species of insect were identified throughout the period of this study; namely *Necrobia rufipes* and *Dermestes maculatus.* But *Necrobia rufipes* was the most common among the three species of fish at all the three market, with *Dermestes maculatus* identified only in *Schilbe mystus* at Mirnga market. Provision of adequate and modern processing facilities by Government will help mitigate the challenges of fish processing.

Keywords: Effects, Infestation, Insects, Nutritional Value, Smoked fish.

INTRODUCTION

Fish constitutes the major source of animal protein in Africa, it has the most balanced amino acid profile and it's being consume across all religious and cultural barriers (Bolarinwa *et al.,* 2015). Fish serves as a very good and cheap source of animal protein which contains essential nutrients required by the body for growth (Aboirei *et al.,* 2009), it is enriched with essential minerals, vitamins and unsaturated fatty acids (US department of health and human services and US department of agriculture, 2015). According to the Food and Agriculture Organization 'FAO' (2020), word fish production has increased dramatically during the past 60years to around 179million tons in 2018 with a value $401 billion. Global fish consumption also increased 9.0kg per capita in 1961 to 20.5kg in 2018. Fishes occupy higher tropical levels in the food chain; they are considered one of the most common Bio-indicators for pollutants (Rajeshkumar and LI, 2018). Fishes serves as a source of food and income for most people in the developing countries particularly Africa (FAO, 1996). The demand of fish is increasing throughout the word due to the recognition of its nutritional value. Fish begins to impair as soon as they are being caught or die off, even after the fish have been processed especially of traditional method it has been used which is smoking. Several research had shown that, smoking gives not only the fish a needed taste and smell but provides lengthier shelf life through its antibacterial and its oxidative effects decreasing pH, imparting coloration of the fish as well as augmenting the drying process and acting as an adversary to spoilage agents (Sengor *et al.,* 2004) and chemical degenerative alterations (Sowumi, 2007). According to Akinwumi (2014), smoking of fish has been a healthier inventive method of fish processing in relations to retaining protein value and decreased in the moisture content. Insects commonly associated with smoke fish infestation include beetles, weevils, and moths, among others (Osibona *et al.,* 2018). These insects have been found to lay eggs on the fish during processing or storage, leading to larval infestation and subsequent damage. The larvae feed on the fish, causing structural damage, off-flavors, and discoloration, rendering the product unappealing to consumers (Nwanna *et al.,* 2020). The economic impact of insect infestation on the smoke fish industry extends beyond the direct losses incurred due to damaged products. Consumer preferences play a crucial role in shaping market demand, and the presence of insects in smoke fish can lead to reduced consumer acceptability and a decline in market share. Furthermore, the need for additional measures to control insect infestation can increase production costs for smoke fish producers. Therefore, the present study aims at ascertaining the impact of insect infestation on the economic value of smoked fish in Biu market, Borno State.

MATERIALS AND METHODS

Description of Study Area

The study was carried in Biu LGA. Which is the second largest LGA in Borno State in terms of population, located on the southern part of the state. It is bounded to the North by Adamawa State, South by Yobe State, West by Gombe State, with of coordinate of

10˚38'00N and 12˚05'31E. Biu economy is known for its mixed agriculture, herding cattle's, sheep's, cows, horses, goats, fish and cultivation of crops (Wallchart, 2024) such as cotton, rice, sorghum, cowpea, maize, millet.

Data Collection

The primary data were collected through the use of structured questionnaires, which were administered to the respondents alongside with interview techniques. Some smoked fish species were randomly collected from the three market, and taken to Biology laboratory, Nigerian Army University Biu for identification of insects and measurement of economic impacts of the insects.

Procedures for the Identification of Insects Species

Procurement of fish samples (Clarias gariepinus, Oreochromis niloticus and Schilbe mystus) for insects' identification

Fish samples (smoked) for the experiment were obtained from three main markets in Biu namely Biu central market, General hospital market and Mirnga market. At the time of purchase, the fishes were randomly selected from the fishmongers. The length of time between smoking of all the fish and procurement were between 5 to 7 days. Fish species identification was carried out according to descriptive features documented by Webb *et al.* (1981).

Experimental Bioassay

In each sample, the adult's insects were identified according to the keys by Cornes (1973). Thereafter, each fish sample was placed in a medium size transparent plastic bucket (height 18cm and a diameter of 16cm), covered with a wire gauze (1mm mesh size). The wire gauze was held in place with a rubber band. A batch of the same fish sample (in which identified insect pests were observed) were used to determine the initial proximate analysis of the fish samples. Weights of the dried fish samples were taken bi-weekly for six weeks using a weighing balance in order to determine weight differences caused by insects. Final proximate analyses were conducted on each fish samples to determine the effects of insect pest infestations (Association of Official Analytical Chemist 'AOAC', 2019).

RESULTS AND DISCUSSION

Demographical information's

Demographical information's of the respondents is shown on table 1. The results revealed that age bracket of 41-50 was the highest [36(30%)] among the respondents, while age 50 and above was the least [21(17.5%)] among the respondents. These findings agreed with Olulaye *et al*. (2009) and Ya aishe *et al*. (2009), who both reported that majority of the sampled farmers in their study were within the productive age of between 21 and 50 years. Danba (2020) also reported same for river Taraba in Taraba State. This also revealed that larger proportions of the respondents were adults and can adequately be regarded as active, agile, and physically disposed to marketing activities. Age is very important in agricultural activities, because it has a significant influence on the decision-making process of farmers with respect to adoption of improved farming technologies and other production-related decisions. On the bases of sex, male was higher [93(77.5%)] than the female [23(22.5%)] respondents. This agreed with Ayeloja, *et al.* (2020), Danba (2020) and Amos (2013) who observed that males constituted the majority of catfish marketing in River Taraba and Wamba LGA of Nasarawa state with 66.6% and 86.50% of the respondents respectively. The result disagrees with the findings of Adebayo (2013) who opined that processed fish marketers are more dominated by female gender than male. Married men and women were also discovered among the respondents with 86(71.67%), than the single [26(21.67%)], divorced [3(2.5%)] and widowed [5(4.67%)] respectively. This agreed with the work of Ayeloja, *et al.* (2020), who more reported 74% of married men and women than single, widowed, widower and divorced. This might be connected with the responsibility of the families that always laid on the married men and women. Majority of the respondents were secondary lever with 64(53.3%), while tertiary has the least of 16(13.3%) respondents. This disagreed with Danba (2020) who reported that 33.3% of the respondents were primary and those that do not have access to formal education. The level of education is believed to influence the use of improved technology in agriculture businesses and, hence, farm productivity. The level of education determines the level of opportunities available to improve livelihood strategies, enhance food security, and reduce the level of poverty. It affects the level of exposure to new ideas and managerial capacity in production and the perception of the household members on how to adopt and integrate innovations into the household's survival strategies. Oluwatayo, *et al.* (2008) observed that the more educated a farmer is, the more the chances that the farmer will adopt innovations than the uneducated ones. Mohammed, Omotosho and Falola (2009) also noted that level of education is expected to influence farmer's adoption of agricultural innovations and decision on various aspects of farming. They also maintained that education is highly important for sustainable agricultural growth and development. Fish marketing was the primary occupation of the respondents with 75(77.32%), while 45(22.68%) had fish processor as they primary occupation. This was in agreement with the work of Ayeloja, *et al.* (2020) who recorded 67.00% of the respondents with fish marketing as they primary occupation. In the case of secondary occupation, fish processing has the highest percentages of the respondents with 97(80.83%). This result varies from the result reported by Ayeloja, *et al.* (2020), who 98.00% of the respondents has fish marketing as they secondary occupation. Majority of the respondents has a household size of 1-5 with a percentage of 54(45%), while >10 was the least with 30(25%). The implication was that those families with lower household size were more efficient. This varies with the work of Quartey (2005) and Danba (2020) who in they separate studies reported that household size affects efficiency since there may be synergies from larger household size in both production and consumption. Both reported household size of 11-15 and 6-10 as the most efficient in fish business. The business was dominated by Islam with 93(77.5%) of the respondents, while Christianity recorded the least with only 27(22.5%) of the respondents. This agreed with Ayeloja, *et al.* (2020) who reported similar results from their studies. The dominance of Islam might be associated with the dominance of Islam in Biu.

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Table 1: Demographical information's of the Respondents

Variable	Frequency	Percentages
Age		
<20	0	0
21-30	32	26.67
31-40	31	25.83
41-50	36	30
>50	21	17.5
Total	**120**	**100**
Sex		
Male	93	77.5
Female	27	22.5
Total	**120**	**100**
Marital Status		
Single	26	21.67
Married	86	71.67
Divorced	3	2.5
Widowed	5	4.67
Total	**120**	**100**
Educational Status		
Primary	18	15
Secondary	64	53.3
Tertiary	16	13.3
Others	22	18.3
Total	**120**	**100**
Primary Occupation		
Fish Processing	45	22.68
Fish Marketing	75	77.32
Total	**120**	**100**
Secondary Occupation		
Fish Processing	97	80.83
Fish Marketing	23	19.17
Total	**120**	**100**
Household size		
1-5	54	45
6-10	36	30
>10	30	25
Total	**120**	**100**
Religion		
Christianity	27	22.5
Islam	93	77.5
Total	**120**	**100**

Scale of Market and Marketing Experience

The results of scale of market and marketing experience is presented on table 2. The results revealed that the respondents comprised of the small-scale seller (43.4%), Retailer (35.8) and Wholesaler (20.8%). Small scale sellers were dominance among the respondents during the period of this study. Small scale sellers were the highest based on the responds of the respondents during the period of this study. This might be as a result of lack of awareness about the significant and important of fish marketing among Biu population. Base on the interview with the fish marketers, majority of them were not from Biu. This revealed that knowledge about the economic impact of fish was lacking among the indigenous people of Biu. The year of experience in the business, 40% spent 1-10 years, 35% spent 11-20 years, 17.5 spent 21-30 years and only 7.5 spent >30 years in the business. 1-10 years has the highest respondents and >30 years had the lower respondents. These results implied that marketers in the study area do not have sufficient experience in fish marketing. This finding varies with Ayeloja, *et al.* (2020) and Girei *et al*., (2013) who opined that majority of the respondents which accounted for about 31.00% and 83% numbering falls within the age limit of 16-20years and 20 - 49 years in their respective business. They both reported that majority of the marketers in the study area have sufficient experience in fish marketing.

Table 2: The Scale of Marketing and Marketing Experience of the Respondents

Variable	Frequency	Percentages
Scale of Market		
Small scale seller	52	43.4
Retailer	43	35.8
Wholesaler	25	20.8
Total	**120**	**100**
Marketing Experience		
1-10	48	40
11-20	42	35
21-30	21	17.5
>30	9	7.5
Total	**120**	**100**

Business Size and Sources of Income

Table 3 present the business size and sources of income of the respondents. The results revealed that 83(69.2%), 27(22.5%), 9(7.5%) and 1(0.8%) had a business size of >#50, 000, #31, 000 – #40, 000, #21, 000 – #30, 000 and #10, 000 – #20, 000 respectively. This was also in line with Ayeloja, *et al.* (2020) who reported that majority of the respondents (33.00%) from their study had a business size between #50, 001 – 100, 000. The findings also reflect what was reported by Magawata *et al*. (2014) that the capital base of processors ranges from < N20000->100000. For the sources of income, 115(95.8%) used they personal income for the business and only 5(4.2% used funds provided by the family members. While Friends, Bank, Association and Contributions indicated that no funds were provided through them to support the business. Similar observation was made by Ayeloja, *et al.* (2020) with about 76.19% of the respondents from their study used personal/self-income in the business.

Table 3: Business Size and Source of Income of the Respondents

Variable	Frequency	Percentages
Business size		
10, 000 – 20, 000	1	0.8
21, 000 – 30, 000	9	7.5
31, 000 – 40, 000	27	22.5
>50, 000	83	69.2
Total	**120**	**100**
Source of Income		
Self	115	95.8
Friends	0	0
Family members	5	4.2
Bank	0	0
Association	0	0
Contribution	0	0
Total	**120**	**100**

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Reasons for Infestation, Source of Labour and Types of Fish Market

The results of reasons for infestation, source of labour and types of fish market is shown on table 4. The results revealed that 39(32.5%) of the respondents believed that local processing techniques was responsible for the infestation of fish by the insects, 20(16.67%) were of the believed that this occurs because of poor marketing, 19(15.83%) said it was because of lack of storage facilities and lack of financial assistant, 11(9.17%) responded that it was poor storage facilities, 5(4.17%) believed it was because of high cost of processing facilities, 4(3.33%) said it was lack of packaging facilities and 3(2.5%) revealed that it occurs as a result of poor transportation of the products. Ayeloja, *et al.* (2020) reported that majority (84%) of the respondents faced 'financial constraint' as a major constraint, showing that financial constraint was a major problem facing smoked fish mongers. Madugu and Edward (2011) in their studies in Adamawa State, Nigeria also stated that one of the main problems confronting processed fish marketers in the area was poor access to capital which was ranked to be the first problem (45%) as a result of inadequate sources of finance and the problem of collateral before obtained loan. This result was in variance with both Ayeloja, *et al.* (2020) and Madugu and Edward (2011) since the current study revealed that, the major problem was local processing techniques. 84(70% provided labour for themselves, 25(20.8%) used family members to provide support, only 11(9.2%) used Association members to provide labour and none of the respondents got his/her labour through friends for the period of this study. This was in agreement with Ayeloja, *et al.* (2020) who reported same in his study with 56.07% providing self-service. It was also similar to the study of Nwabueze and Nwabueze (2010) where it was reported that, few fish marketers in Delta State Nigeria had access to loans as many of them were self-sponsored and many of them complained of not having any form of assistance and did not know how to go about obtaining loans from credit facilities. For the types of fish marketed by the respondents, *Clarias gariepinus and Oreochromis niloticus* were the major fish market by the respondents with about 44(34%). While the less was those that market *C. gariepinus* and *Schilbe mystus* with only 4(3%) respondents. This result was in contrast with Ayeloja, *et al.* (2020) who reported *Clarias* spp. as a major fish sold by the majority of the respondents (37.90%), followed by *Tilapia* spp. (22.98%). The reason for the majority of the respondents involves in marketing of *Clarias gariepinus and Oreochromis niloticus* may be as a result of their acceptability among the consumers. Danba, *et al.* (2020) made similar observation from River Taraba in Taraba State.

Table 4: Reason for infestation, Source of Labour and types of fish Market by the Respondents

Variable	Frequency	Percentages
Reasons for infestation		
Local processing techniques	39	32.5
Inadequate extension services	0	0
Lack of storage facilities	19	15.83
Lack of financial assistant	19	15.83
Poor transportation	3	2.5
Poor storage facilities	11	9.17
Poor marketing	20	16.67
Lack of packaging facilities	4	3.33
High cost of processing facilities	5	4.17
Total	**120**	**100**
Source of Labour		
Self	84	70
Friends	0	0
Association members	11	9.2
Family members	25	20.8
Total	**120**	**100**
Types of fish Market		
Clarias gariepinus, Oreochromis niloticus and *Schilbe mystus*	30	25
Clarias gariepinus	18	15
Oreochromis niloticus	7	6
Schilbe mystus	8	7
Clarias gariepinus and *Schilbe mystus*	4	3
Clarias gariepinus and Oreochromis niloticus	44	34
Oreochromis niloticus and *Schilbe mystus*	9	8
Total	**120**	**100**

Types of Fish most Infested by Insects and Profit per Month

Table 5 present the types of fish most infested by insects and profit per Month. The results shows that *Oreochromis niloticus* was the species affected mostly by insects' infestation with about 88(73%) of the respondents agreed that the species was prone to insects' infestation, while 23(19%) believed that it was *Clarias gariepinus* and 9(8%) said it was *Schilbe mystus* that was affected by insects' infestation. This agreed with the work of Omoregie *et al.* (1995), Ofojekwu *et al*. (2001) and Folorunso e*t al.* (2006) who reported that *Oreochromis niloticus* harboured more adult beetles. During the period of this study, 44(37%) of the respondents reported that they made higher than fifty thousand (>#50, 000) as a profit, while those that made between #11, 000 - #15, 000 were the less with only 6(5%) of the respondents. This implies that the monthly income of the respondents was higher than the workers national minimum wages. Similar observation was made by Hamid 2020) at Mubi on the value addition of fisheries sub-section to economic.

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Table 5: Most infested Fish by the insect and Profit per Month by the Respondents

Variable	Frequency	Percentages
Types of fish most infested by insects		
Clarias gariepinus,	23	19
Oreochromis niloticus	88	73
Schilbe mystus	9	8
Total	**120**	**100**
Profit per Month		
5, 000 – 10, 000	8	7
11, 000 –15, 000	6	5
16, 000 –20, 000	22	18
21, 000 –25, 000	29	24
>50, 000	44	37
>100, 000	11	9
Total	**120**	**100**

Challenges Encounter in the Business and Types of Lost Encounter

The challenges encounter in the business and types of lost encounter by the respondents were presented on table 6. Some of the challenges encountered were lack of finance, poor marketing, market demand, Season changes, and damage in fish and insects' infestation. Poor marketing recorded the higher percentages (37.5%) of the respondents who believe that it was the major challenges, while Season changes and damage in fish recorded less percentages (0.8%) of the respondents respectively for the period of this study. This in line with the opinion of Oluwatoyin *et al.* (2010) in their study of the indigenous fish processing and preservation practices amongst women in Southwestern Nigeria. Season changes and damage were a minor constraint according to 0.8% of the respondents, this is in contrast with the report of Akpabio and Ekanem (2008) who found that there is a very high extension need by fish. This study was in variance with the work of Ayeloja, *et al.* (2020) who reported that the major challenges was Lack of financial assistance. Majority of the respondents believed that Lack of profit was the major lost encountered during the period of this study. This implies that, the capital base of the respondents was never affected by the insect's infestation (despite the challenges, they can still recover their capital).

Table 6: Challenges and Lost Encountered by the Respondents

Variable	Frequency	Percentages
Challenges encounter in the business		
Lack of finance	23	19.2
Poor marketing	45	37.5
Market demand	31	25.8
Season changes	1	0.8
Damage in fish	1	0.8
Insects' infestation	19	15.9
Total	**120**	**100**
Types of lost encounter		
Lack of profit	90	75
Loss of capital	30	25
Total	**120**	**100**

Loss Recorded after Preservation and the Species of Insects Identified

Table 7 shows the results of the loss recorded after preservation for six week and the species of insects identified. The result revealed that *Oreochromis niloticus* was the species that was mostly infested with a loss of 46.09% and 30.32% at General hospital market and Biu market, while *Clarias gariepinus* (30.15%) was highly infested at Mirnga market than *Oreochromis niloticus* and *Schilbe mystus* which recorded 30.04% and 16.67% respectively. *Schilbe mystus* was the lest infested among the three species with an infestation rate of 16.67%, 10.24% and 4.89% for Mirnga market, General hospital market and Biu market respectively. This agreed with the work of Folorunso, *et al.* (2006) who reported that *Oreochromis niloticus* harboured more adult beetles and recorded the lowest percentage of crude protein of 69.40%. Two species of insects were identified throughout the period of this study; namely *Necrobia rufipes* and *Dermestes maculatus*. But *Necrobia rufipes* was the most common among the three species at all the three market with *Dermestes maculatus* been identified only in *Schilbe mystus* at Mirnga market for the period of this study. The result obtained from this study suggest that beetle could cause significant reduction in the economic value of the three species of fish. With the losses in *Oreochromis niloticus* been significantly. Early reports had shown that infestation of fish with *Dermestes* and *Necrobia* species could consume the flesh and tissues of dried fish if adequate protection is not provided. Omoregie *et al.* (1995) and Ofojekwu *et al*. (2001) had reported a significant reduction for crude protein levels in fish that harbors insect pests. The results also revealed that the longer the period of storage of dried fish the higher the level of infestation and this should cause a decrease in the nutritional content of the fish. Same was reported by Folorunso, *et al.* (2006). Since severity of infestation is directly proportional to the length of storage, it is perhaps reasonable to suggest that length of storage may have played a role in reducing the nutritional content of the stored fish species.

Table 7: Insects Species Identified and loss Encountered after Preservation for six Week

Markets	Fish Species	Initial fish Preserved	After 2week	After 4week	After 6week	% loss	Species of Insects infested
BM	*Clarias gariepinus*	143.04	135.77	126.12	125.84	12.02	*Necrobia rufipes*
	Oreochromis niloticus	226.48	182.70	174.09	157.80	30.32	*Necrobia rufipes*
	Schilbe mystus	179.65	178.79	173.22	170.86	4.89	*Necrobia rufipes*
GHM	*Clarias gariepinus*	126.65	120.27	98.60	81.86	35.54	*Necrobia rufipes*
	Oreochromis niloticus	306.04	271.72	250.82	164.99	46.09	*Necrobia rufipes*
	Schilbe mystus	173.41	167.13	156.44	155.66	10.24	*Necrobia rufipes*
MM	*Clarias gariepinus*	130.25	124.71	115.29	90.98	30.15	*Necrobia rufipes*
	Oreochromis niloticus	284.43	223.72	208.50	201.10	30.04	*Necrobia rufipes*
	Schilbe mystus	191.04	185.85	168.16	159.19	16.67	*Dermestes maculatus*

BM = Biu market**, GHM =** General hospital market**, MM =** Mirnga market

Conclusion

In conclusion, the results obtained from the current study on the effects of insect's infestation on the nutritional value of smoked fish in some selected markets revealed that age bracket of 41-50 were the highest and respondent groups were dominated by men, married men and women were also discovered to be higher among the respondents, with majority of the respondents went to secondary. The household size of 1-5 were higher, and the business was dominated by Islam for the period of this study. The results also revealed that small scale seller were more among the respondents and majority of the fishmongers spent 1-10 years in the business, and higher number of the respondents believed that local processing techniques was responsible for the infestation of fish by the insects which. Majority of the respondents provided labour for themselves, while *Clarias gariepinus and Oreochromis niloticus* were the major fish market by the respondents. *O. niloticus* was the species that was mostly affected by insect's infestation as obtained from this study. Higher percentage of the respondents made higher than fifty thousand (>#50, 000) as a profit per month and the respondents who believe that poor marketing was the major challenges. Two species of insects were identified throughout the period of this study; namely *Necrobia rufipes* and *Dermestes maculatus.* But *Necrobia rufipes* was the most common among the three species at all the three locations with *Dermestes maculatus* been identified only in *Schilbe mystus* at Mirnga market.

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