MPRI-JOMDR | INTERNATIONAL JOURNAL OF ORGANIC AND MEDICINAL DEVELOPMENT RES.
VOL. 1 NO. 1 JUN-2022

INVESTIGATION OF CONSUMPTION OF SMOKED FISH STORED USING INSECTICIDE DURING INSURGENCY PERIOD IN BORNO STATE, NORTH-EASTERN, NIGERIA

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Abstract

The study was conducted to investigate consumption of smoked fish stored using insecticide. The objective was to identify socioeconomic characteristics of the respondents, examine the insect species found in the fish and identify types of insecticides used and measures taken by sellers and consumers. The result indicates that majority 36.7% of the fishermen fell within the age bracket of 36-45years, majority (78.3%) of the respondents were male, 53.3% were engaged in fishing activities. The result reveals that most of the fish species stored were cat fish (36.7%), followed by tilapia (24.2%), African lung fish (15.0%), Nile tilapia (*Oreochromis niloticus*) (9.2%), Synodomis species (8.3%) while the lowest according to the

KEYWORDS: *Fish. Traders. Consumer. Insecticide. Treatment*

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percentage respondents is for *Hetrobrunchus niloticus* (6.6%). Most of the fish were stored for commercial purpose (74.2%), cat fish, tilapia, and African lung fish were the three most widely stored fish. The result indicates that 46.7% of the respondent applied insecticide once, 36.6% applied it twice and 16.7% applies the insecticides thrice within 0-6month of storage. Aluminum phosphide, permethrin, Cypermethrin, Diclorvos, Tetramethrin, Fenithrothion, Bioresmethrin, Pirimiphos-methyl, Chlorpryrifos-methyl are the most commonly applied insecticides by the fishermen/traders in for storing their fish product against infection and infestation. The insecticide for the control of insects, 29.1% applied insecticide for the control of fungal infestation, 21.2% apply insecticide for the control of rodent, while 12.6% use insecticide for the control of mold infestation. The result on the common insect found infesting the fish at stores indicate that 58.3% were *Dermetes maculatus,* 33.3% infestation from *Necrobia rupifes* while 8.4% infestation was from *Trogoderma* spp, 50.0% infestation were *Dermetes maculatus,* 37.5% *Necrobia rupifes,* 12.5% *Trogoderma* spp, 61.9% of adults and larval were *Dermetes maculatus,* 28.6% *Necrobia rupifes* 9.5% adults and larval stages were from *Trogoderma* spp, 10.0% apply insecticide immediately after smoking the fish, 21.7% apply after one hour of smoking, 28.3% apply insecticide after one week of smoking, 33.3% apply two weeks of smoking, 6.7% apply insecticide after every month, 33.3% stored the smoked fish for less than a month, 20.0% store the fish for three month, 17.6% store the fish for five month, 15.8% store it for six month, 8.3% store the fish for one year, 5.0% store the fish for more than a year and above, 50.0% percept the effect of insecticides on change in flavor, 31.7% percept effect as change in quality, 18.3% percept the effect in cooking quality, 90.8% were not using protective clothing during insecticide application, only very few 9.3% use protective clothing during insecticide application, 73.3% of the respondents used direct application of insecticides on fish. The majority 51.7% experience headache and 31.7% stomach cramp and 16.6% experience diarrhea for a short time. Most of the respondents made observation for the

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absent of insect and odour/smell of fish as an indication for the presence or absence of insecticide on fish. It was equally evident that consumers use crude ways to establish the presence of insecticides on treated fish.

INTRODUCTION

Dried fish provide an excellent source of protein in the diet of many people all over the world. Fish protein compares favorably with eggs, meat and milk in amino acid content, and has a higher level of essential lysine and methionine both are lacking in a cereal based diet (Ileke *et al.,* 2020a). In Nigeria, particularly in Lake Chad region most of the fish caught were processed through sun drying or smoked partly due to unavailability of ice for preservations. However, dried fish product deteriorates very rapidly from infestation by pestiferous insects, mainly by beetles species of the genera *Dermestes* and *Necrobia* (Ileke *et al.,* 2020b). In addition, improperly dried fish or adequately dried fish that has reabsorbed moisture could harbor large population of blowfly belonging to the genus *Chrysomyia.* These insect pests generally infest dried fish during storage, transportation and marketing, thus responsible for extensive damage to marketed fish leading to enormous weight loss (Ileke *et al.,* 2020b). Due to banned in transportation of fish in lake chad shore, most of the fisher men and trader use pesticide for long term storage of their products, this in turn bring detrimental effect on health status of consumers.

However, occurrence of harmful chemicals in the food products has become an issue of great debate in recent decades. Pesticides and other foreign substances in food products pose an immediate threat to human health, whereas other contaminants gradually build up in the human body, causing disease long after first exposure (Anyakora *et al.,* 2008). It is also well known that many pesticides can accumulate in living species causing long-term and chronic effects, but there are difficulties in defining chronic exposure and disease outcomes, given the existence of a large series of variables of interest, such as lifestyle, occupation, diet preferences, and smoking, all of which must be taken into account to establish a disease-exposure relationship in the epidemiological investigation. Chemicals play

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an important role in the efforts of countries to achieve economic growth and fulfill their development objectives, but, as much as they are vital for ensuring food security and economic growth, incorrect and indiscriminate use can be disastrous for human health (Rodriguez, 2020). In this context, chemicals can have a dual nature; they can be either beneficial or harmful, depending on numerous factors, such as the amounts to which exposure occurs. Pesticides are common chemicals used to eliminate a great variety of unwelcome living organisms, particularly in agriculture. They are widely used in agriculture for the purposes of crop protection and in public health to control vector-borne infectious diseases (Musa *et al.,* 2010). Because of high biological activity, and, in some cases, long persistence in the product, pesticides may cause harmful effects to human health (Li and Jennings, 2017). Improper handling may result in severe acute poisonings; in some cases, adverse health effects may also result from long-term, low-level exposures. As a result of widespread diffusion of pesticides, a great part of the population may be exposed to pesticides due to occupation. Several groups of people, characterized by quite different patterns and degree of exposure, face the risk of adverse effects. Occupational exposure typically occurs in workers involved in the manufacture of pesticides and among specific users in public health (e.g., exterminators of house pests). In the agricultural sector, exposure to pesticides typically occurs among farmers and professional applicators of pesticides. Regarding the general population, individuals may be exposed to pesticide residues in food and drinking water on a daily basis or to pesticide drift in residential areas close to spraying areas. The objectives of this study is to investigate consumption of smoked fish treated with insecticide in Maiduguri, Borno state north-eastern Nigeria.

METHODOLOGY

Study area

The study area is Borno state is one of the 36 state in federal republic of Nigeria which was created in 1976 and located in north eastern part of country, while Maiduguri metropolitan council, is one of the twenty-seven Local Government Areas of Borno State. The Local Government Area was created in 1976 (BSG, 2007). It lies within latitudes 11°51N and 13°12E, it occupies a total landmass of 160 square kilometer (MLS, 2008). The climate of the area is characterized by dry and hot seasons, minimum temperature

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ranging from 15-20°C, while the maximum temperature ranges from 37-45°C. The annual rainfall ranges from 500mm to 700mm per annum (NMA, 2008). The rainy season is usually from May to October with low relative humidity and short wet seasons. The topography is generally low land plain, and the soil is generally sandy with short grasses and thorny shrubs.

Methods of data collection

Data for the study were obtained from both primary and secondary sources. The primary data was obtained with the aid of a structured questionnaire and personal interview was also conducted for fishermen/women, fish sellers and consumers who cannot read and write; and the results of the interview were interpreted. While the secondary sources of information include textbooks, journals, past project, internet, etc.

Data Analysis

The analytical tools employed for this study was descriptive statistics such as frequency and percentage. This was used to achieve all the specific objectives.

RESULTS AND DISCUSSIONS

Table 1: Socio Economic Characteristics of Respondents

Variables Age (years)		Frequency	Percentage
25-35		24	20.0
36-45		44	36.7
46-50		30	25.0
>51		22	18.3
Total		**120**	**100**
Education			
Non-formal education		42	35.0
Primary education		30	25.0

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Secondary education		34	28.3
Tertiary education		14	11.7
Total		**120**	**100**
Gender			
Male		94	78.3
Female		26	21.7
Total		**120**	**100**
Occupation			
Civil servant		8	6.7
Farming		22	18.3
Trading		26	21.7
Fishing		64	53.3
Total		**120**	**100**
Family size			
1-3		25	20.8
4-6		32	26.7
7-9		51	42.5
10-12		12	10.0
Total		**120**	**100**
Years in the business			
1-2 years		11	9.2
3-4 years		14	11.7
5-6 years		40	33.3
7-8 years		29	24.2
9-10 years		21	17.5
Above 10 years		5	4.1
Total		**120**	**100**

Source: Field survey, 2021

The socio-economic characteristics of respondents examined include: age, education level, gender and major occupation, family size and years of

business. The findings are presented in Table 1 shows that majority 36.7% of the fishermen fell within the age bracket of 36-45years, 25.0% fall within age bracket of 46-50years, 20.0% were within the age bracket of 25-35years while 18.3% were within the age bracket of 50years and above. The result also shows that 35.0% percentage had non-formal education, 28.3% had secondary education, 25.0% had primary education while 11.7% had tertiary education. However, the result shows that majority (78.3%) of the respondents were male, while only 21.7% were female. This indicates that majority of the fishermen and marketers in the study area were male. This is probably because male have great responsibility in their families as heads. The results of the analysis also indicate that 6.7% were civil servants, 18.3% indicated that their major occupation were farming, 21.7% were engaged on trading while 53.3% were engaged in fishing activities, respectively (Table 1). Furthermore, the result indicates that 20.8% had family size of 1-3 persons, 26.7% had family size of 4-6 persons, 42.5% had family size of 7-9 persons while 10.0% had family size of 10-12 persons respectively. Moreover, the result reveals that 9.2% had 1-2 years in business, 11.7% had 3-4 years, 33.3% had 5-6years, 24.2% had 7-8years of business experience, 17.5% had 9-10years while 4.1% had above 10years of business experience (Table, 1)

Table 2: Species of fish stored by respondent.

Species of fish	Frequency	Percentage
Claria gariepinus	44	36.7
Tilapia species	29	24.2
African lung fish	18	15.0
***Synodontis* species**	10	8.3
Hetrobrunchus niloticus	8	6.6
O. niloticus	11	9.2
Total	**120**	**100**

Source: Field survey, 2021

The Table 2 shows that most of the fish species stored were cat fish (36.7%), followed by tilapia (24.2%), African lung fish (15.0%), Nile tilapia (*Oreochromis niloticus*) (9.2%), Synodomis species (8.3%) while the lowest according to the

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percentage respondents is for *Hetrobrunchus niloticus* (6.6%). This implies that fishermen and traders preferred storing cat fish (*Claria gariepinus*) most likely because of the high returns after a successful storage (Table 2).

Table 3: Purpose of fish storage by respondent

Purpose of storage	Frequency	Percentage
Commercial purpose	89	74.2
Family consumption	21	17.5
Both family and commercial	10	8.3
Total	**120**	**100**

Source: Field survey, 2021

The Table 3 reveals that most of the fish were stored for commercial purpose (74.2%), (17.5%) stores the fish for their family consumption while (8.3%) stored fish for their personal use, it is also indicate that cat fish, tilapia, and African lung fish are the three most widely stored fish in Maiduguri (Table, 3), and the storage is mostly done for commercial purposes (Table 3). This implies that fish stored by the fishermen/traders in Maiduguri will have wider distribution among the populations as these represents the main stable fish of most state in Nigeria (FAO, 2009) (Table 3).

Table 4: Frequency of application of insecticide on smoked fish

Frequency application (0-6month)	Frequency	Percentage
Once	56	46.7
Twice	44	36.6
Thrice	20	16.7
Total	**120**	**100**

Source: Field survey, 2021

The Table 4 also indicate the frequency of insecticide applications on smoked fish during storage. The result indicates that 46.7% of the

respondent applied insecticide once, 36.6% applied it twice and 16.7% applies the insecticides thrice within 0-6month of storage (Table, 4)

Table 5: Common Synthetic Insecticide Used by Fishermen in storing the fish

Synthetic insecticide used	Frequency	Percentage
Dichlorvos	34	13.4
Permethrin	40	15.8
Aluminum phosphide	46	18.2
Cypermethrin	38	15.0
Chlorpyrifos-methyl	12	4.7
Pirimiphos-methyl	24	9.5
Tetramethrin	32	12.6
Fenithrothion	29	11.5
Bioresmethrin	27	10.7
Total	**252**	***

Source: Field survey, 2021

*multiple responses

The Table above indicate the kind of insecticides commonly used by fishermen/traders in protecting stored fish was presented in Table 4. The result shows that most of the fishermen/traders 18.2% use Aluminum phosphide tablets in protecting their fish, 15.8% use permethrin powder, 15.0% use Cypermethrin, 13.4% use Diclorvos, 12.6% use Tetramethrin, 11.5% use Fenithrothion, 10.7% use Bioresmethrin, 9.5% use Pirimiphos-methyl. The least insecticide used was Chlorpryrifos-methyl 4.7%. The result further reveals that three insecticidal formulation; Aluminum phosphide, permethrin and Cypermethrin are the most commonly applied insecticides by fishermen/traders in Maiduguri for storing their fish product against infection and infestation (Table 5).

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Table 6: Purpose of insecticide applications by fishermen

Purpose of application	Frequency	Percentage
Control of insect	56	37.1
Control of fungal infestation	44	29.1
Rodent control	32	21.2
Mold control	19	12.6
Total	**151**	**100**

Source: Field survey, 2021

*multiple responses

The above Table indicate that 37.1% of the respondent applied pesticide/insecticide for the control of insects, 29.1% applied pesticide for the control of fungal infestation, 21.2% apply pesticide for the control of rodent, while 12.6% use pesticide for the control of mold infestation respectively (Table 6).

Table 7: Percentage of infestation of different insect species found on smoked fish without insecticide

Infestation without insecticide	Frequency	Percentage
Dermestes maculatus	70	58.3
Necrobia rupifes	36	30.0
Trogoderma spp	14	11.7
Total	**120**	**100**

Source: Field survey, 2021

The Table 7 indicate the percentage infestation of different insect species found on smoked fish without insecticides for the period storage. The result indicate that 58.3% were *Dermetes maculatus,* 30.0% infestation from *Necrobia rupifes* while 11.7% infestation was from *Trogoderma* spp (Table, 7).

Table 8: Percentage of infestation of different insect species found on smoked fish with insecticide

Infestation with insecticide	Frequency	Percentage
Dermestes maculatus	70	58.3
Necrobia rupifes	40	33.3

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Trogoderma spp	10	8.4
Total	**120**	**100**

Source: Field survey, 2021

The Table 8 indicate the percentage infestation of different insect species found on smoked fish with insecticides after six month of storage. The result indicate that 58.3% were *Dermetes maculatus,* 33.3% infestation from *Necrobia rupifes* while 12.5% infestation was from *Trogoderma* spp (Table, 8).

Table 9: Occurrence of adults and larval stage of insect species on smoked fish after application of insecticide

Occurrence of larval/adults	Frequency	Percentage
Dermestes maculatus	13	61.9
Necrobia rupifes	6	28.6
Trogoderma spp	2	9.5
Total	**21**	**100**

Source: Field survey, 2021

The Table 9 indicate the percentage occurrence of adults and larval stage found on smoked fish after application of insecticides. The result indicate that 61.9% of adults and larval were *Dermetes maculatus,* 28.6% were *Necrobia rupifes* while 9.5% adults and larval stages were from *Trogoderma* spp (Table, 9).

Table 10: Duration of keeping smoked fish before insecticide application

Duration of keeping	Frequency	Percentage
Immediately after smoking	12	10.0
An hours after	26	21.7
One week after	34	28.3
Two weeks after	40	33.3
One month after	8	6.7
Total	**120**	**100**

Source: Field survey, 2021

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The Table 10 also indicates the duration of keeping smoked fish before insecticide applications, the result reveals that 10.0% of respondent apply insecticide immediately after smoking the fish, 21.7% apply after one hour of smoking, 28.3% apply insecticide after one week of smoking, 33.3% applied it after two weeks of smoking, while 8 respondent making 6.7% apply insecticide after every month.

Table 11: Duration of storage of smoked fish after application of insecticide in the study area

Duration of storage	Frequency	Percentage
Less than a month	40	33.3
Three month	24	20.0
Five month	21	17.6
Six month	19	15.8
One year	10	8.3
Above a year	6	5.0
Total	**120**	**100**

Source: Field survey, 2021

The Table 11 shows that 40 respondent making 33.3% stored the smoked fish for less than a month, 24 respondent making 20.0% store the fish for three month, 21 respondent making 17.6% store the fish for five month, 19 respondent making 15.8% store it for six month, 10 respondent making 8.3% store the fish for one year while 6 respondent making 5.0% store the fish for more than a year and above (Table 11)

Table 12: Traders/consumers Perception on effect of insecticide on smoked fish

Purpose of storage	Frequency	Percentage
Change in flavor	60	50.0
Change in quality	38	31.7
Change in cooking time	22	18.3
Total	**120**	**100**

Source: Field survey, 2021

The Table 12 indicates the trader/consumers perception on effect of insecticide on smoked fish 60 respondent making 50.0% percept the effect on change in flavor, 38 respondent making 31.7% percept effect as change in quality while 22 respondent making 18.3% percept the effect in cooking quality (Table 12).

Table 13: Training background by Fishermen/women on insecticide application

Training on pesticide application	Frequency	Percentage
Trained	3	2.5
Non-trained	117	97.5
Total	**120**	**100**

Source: Field survey, 2021

The result of training background indicates that the majority of traders (97.5%) have never had any formal or non-formal training or supervision on site of insecticide application only few (2.5%) had training on insecticide application. Similarly, the result further revealed that majority of the traders and the insecticide applicators had any sort of formal training in insecticide handling and application (Table 13). Mvumi and Stather, (2003) reported similar finding while studying pesticide application in Cameroun. The chances of these insecticide being applied repeatedly on these fish products with consequent possibilities of residues development on the smoked fish at levels above their Allowable Daily Intakes (ADIs) for human are also evident. There are also the possibilities of chronic poisoning of the consumers and traders alike by these insecticidal groups due to repeated exposures. There is therefore the need for training of the pesticide applicators on stored product more especially fish as this will go a long way in addressing FAO concerns for ill health associated with those applying pesticides (FAO, 2008) (Table 13).

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Table 14: Place of insecticide application by fishermen/women and traders

Place of Insecticide application	Frequency	Percentage
Riverside	7	5.8
Home	48	40.0
Market side	37	30.8
Ware house	28	23.4
Total	**120**	**100**

Source: Field survey, 2021

The result of the place of insecticide application is presented in Table 14. The result shows that mostly (40.0%) operate in home, 30.8% operate in market side, 23.4% operate in warehouse. Fewer respondents (5.8%) apply insecticide in the riverside. Similarly, the result indicates that most applications are done in open space (Table 14). This will probably increase the possibility of poisoning especially where necessary insecticides application precautions are adhered to (Table 14).

Table 15: Protective clothing used by fishermen during application

Protective clothing	Frequency	Percentage
No protective	109	90.8
With protective	11	9.3
Total	**120**	**100**

Source: Field survey, 2021

The results for using protective clothing during insecticide application is presented in Table 15. The result shows that majority of the respondents (90.8%) were not using protective clothing during insecticide application, only very few (9.3%) use protective clothing during insecticide application. The drawback to achieving this reduction hypothesized above is the fact that, no protective coverings were used by the applicators to reduce contact with insecticides (Table 15). It could therefore be expected that toxicities from multiple route of exposure, contact, oral or inhalations would increase. Insecticides applications are in general mostly done without

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protective clothing in most agricultural systems in Africa (FAO, 2008) (Table 15).

Table 16: Method of insecticide application by fishermen

Method of pesticide application	Frequency	Percentage
Direct application	88	73.3
Placement of tablet	32	26.7
Total	**120**	**100**

Source: Field survey, 2021

The results for method of insecticides application on stored fish is presented in Table 16. The result reveals that majority (73.3%) of the respondents used direct application of insecticides on fish. The least 26.7% are placement of insecticides in tablet form. This further cements the fact that multiple routes of contaminations are possible (Table 16).

Table 17: Side effect experienced as a result of insecticide application

Side effect of pesticide	Frequency	Percentage
Headache	62	51.7
Stomach cramp	38	31.7
Diarrhea	20	16.6
Total	**120**	**100**

Source: Field survey, 2021

The result for side effect experienced as a result of insecticide application is presented in Table 17. Most of the respondents indicated experiencing one of the three symptoms listed. The majority (51.7%) experience headache and others (31.7%) indicated stomach cramp and 16.6% experience diarrhea for a short time. Indications of possible toxicities to traders/consumers by these insecticides was evident that all respondents had experienced some sort of reactions due to exposures to insecticides. FAO/WHO (2005), estimate that about a million people are being poisoned by pesticides annually with 20,

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000 cases resulting in death. Most of these toxicities and fatal consequences are through pesticides used by small-scale farmers without adequate knowledge acquired through formal training and failure to wear appropriate clothing (Table 17).

Table 18: Method used in Determining Presence or Absence of insecticide in Fish by seller/consumers

Determining presence or absence of insecticide	Frequency	Percentage
Observation for absent of insects	41	34.2
Smell/Odour	79	65.8
Total	**120**	**100**

Source: Field survey, 2021

The result for the method used to determine the presence or absence of insecticide is presented in Table 18. The data indicates that most of the respondents use observation for the absent of insect and odour/smell of fish as an indication for the presence or absence of insecticide on fish. It was equally evident that consumers use crude ways to establish the presence or otherwise of the insecticides on the treated fish. Few of the respondent used mere observations (34.2%), while majority (65.8%) use smelling/odour for the determining the presence of insecticide. This implies that traders consider the smoked fish to be fit for re-sale and therefore safe for consumption if they no longer spot traces of applied chemicals on the treated smoked fish and to lesser degrees if they do not perceive the odour of the insecticidal materials on same. There is no due regard for waiting period viz-a-vis the dosages applied with no reasonable allowance, made for effective biodegradability of these products to less harmful constituents (Lale, 2002) (Table 18).

CONCLUSION AND RECOMMENDATIONS

Conclusion

The study reveals that application of insecticides smoked fish after post-harvest significantly affect human health leading to physical, economical

and nutritional loss of fish quality. The result also reveals that insect species are the major pest infesting smoked fish in Maiduguri, Borno state, Nigeria and the larvae and adult stage of *Necrobia rufipes* and *Dermestes maculatus* does most of damage to the stored fish. The results obtained in this study need to be interpreted with caution since it is known that long term exposure to insecticide pose serious threat to consumer's health and as well as decrease in nutritional quality of any smoked fish destined for consumptions.

Recommendations

i. There should also be a coordinating team of Public-Private partnership for close monitoring on use of insecticides on fish destined for trading and consumptions.

ii. Fishermen/women, retailer's distributors and consumers should be sensitized on the effect insecticide on human body after longer period of exposure and consumption of treated fish.

iii. Also multimedia awareness activities in local language should be massively conducted against the negative effect of insecticide on human body and as well as environment.

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