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Insect Pest of Dried and Smoked *Tilapia* Species in Idah Local Government Area of Kogi State of Nigeria

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Abstract

This study is on insect pests associated with dried and smoked Tilapia species (Oreochromis niloticus) in Idah Local Government Area in Kogi State, Nigeria. The study was conducted to identify the major storage pests infesting processed Tilapia and to compare the level of infestation between smoked and dried fish. A total of forty (40) smoked and forty (40) dried Tilapia species were obtained from Idah market and stored in four separate cages under laboratory conditions for three months. Observations were made at three-day intervals, during which pest species were identified and counted. Data collected were analysed using frequencies, percentages, pest density, and comparative analysis. The results revealed the presence of three major arthropod pest species: *Dermestes maculatus*, *Camponotus consobrinus*, and *Necrobia rufipes*. Smoked Tilapia recorded a total of 116 pest individuals with an overall pest density of 2.90 pests per fish, while dried Tilapia recorded 66 pest individuals with a pest density of 1.65 pests per fish. *Camponotus consobrinus* was the dominant pest on smoked Tilapia, accounting for 66.4% of the total infestation, whereas *Dermestes maculatus* was the dominant pest on dried Tilapia, constituting 68.2% of the total pest population. However smoked fish harboured a higher overall number of pests, dried fish recorded a greater abundance of tissue-destructive pests capable of causing substantial physical damage and weight loss. The study concludes that both smoked and dried Tilapia are susceptible to insect pest infestation during storage, with the type of processing influencing pest species composition and infestation intensity. Effective storage practices, improved processing methods, regular monitoring, and the use of safe pest control measures are recommended to reduce post-harvest losses and ensure the safety and quality of fish products. The findings provide baseline information that can contribute to improved fish preservation and storage management in Idah Local Government Area and similar environments.

Keywords: *Tilapia* Species, *Dermestes Maculatus,* Idah Local Government Area

Introduction

Inland fresh water provides mankind with major sources of edible fish and other aquatic foods (Tait, 2019). Fish is one of the most important animal proteins in terms of food available in the tropics, poverty alleviation, employment, income generation and foreign exchange earnings (FDF, 2015) [14]. Developing countries capture 80% of the world harvest and a large proportion of these catches are consumed locally (FAO, 2018). In many Asian countries, over 50% of the animal protein intake comes from fish, while in Africa the proportion is only 17.5% Willman *et al.,* (2018).

Nigerians are large fish consumers; the demand estimated was 1.4 million metric tons/year (FAO, 2018). This means that any shortfall in fish availability will affect the animal protein intake of the people in the country (Eyo, 2020). Eyo and Awoyemi (2018) [10] reported that insects infest dried fish during storage by feeding extensively on the flesh. It was found out that insect activities may cause up to 50% loss in weight of dried fish during storage. Insect larvae Dermestes maculatus and Necrobia rufipes are known to attack stored dried fish. Odeyemi *et al.,* (2020) ascertained that microbial and insect pest infestation in the tropics is put at between 20% and 50%.

Tilapia species are among the most important warm water fishes used for aquaculture production. The culture of tilapia is practised in over 80 countries in the tropical and subtropical regions of the world with a total production of 478,641 metric tonnes, with an average compound growth rate of about 12% per annum since 1986 (FAO, 2017; Lovshin, 2017). According to Balarin and Hatton (2019), the culture of tilapia can provide a welcome solution to the insufficient protein supply still existing in numerous developing countries. Tilapia species are widely recognized as one of the most important groups of finfish for culture purposes in a wide range of freshwater culture systems, from simple waste-fed fish to intensively stocked and managed culture systems (Pullin, 2015; Fitzsimmons, 2020).
Drying is one of the most popular means of preserving and storing fish. However, drying of fish does not guarantee the ends to the problems of preservation, storage and distribution of fish. Dried fish can suffer considerable loss of weight due to feeding damages by insects and mites. Under adverse condition quantitative losses of up to 30% due to fly damage during processing and up to 50% due to beetle damage during storage have been reported (FAO, 2019) [12]. In addition, infestation of dried fish by insects and mites in dried fish may cause public health hazard as they are transmitters of diseases causing pathogens to man that may lead to intestinal disorders and allergies (Busvine, 2018; Osuji, 2018). Dermestid beetles are associated with the spread of anthrax in some countries, whereas mites are known to cause itching and dermatitis (Busvine, 2018). Furthermore, flies which often perch on dried fish have been implicated as vectors of pathogens causing severe enteric disorders such as dysentery, cholera etc (Busvine, 2018).
There is a growing demand for fish protein in Nigeria due to the volatility of meat supplies due to issues of insecurity, banditry, cattle rustling and health repercussion on elderly one on consumption of beef. There are a lot of post- harvest fish losses due to spoilage. Fish preservation is therefore inevitable to preserve fish. Common methods of fish preservation in Nigeria is by freezing, drying smoking. Fish drying and smoking are the most common methods of fish preservation and storage in Nigeria (FAO, 2019) [12].
As insects cause serious losses to stored dry fish and impact negatively on human health, this study is conducted to find out the major Insect pest of tilapia fish in Idah Local Government Area, Kogi State.
The main goal of this research work is to provide base line information on the most common types of insect population in dried *Tillapia* in Idah Local Government.
In addition, infestation of dried fish by insects and mites in dried fish may cause public health hazard as they are transmitters of diseases causing pathogens to man that may lead to intestinal disorders and allergies (Busvine, 2018; Osuji, 2018). Dermestid beetles are associated with the spread of anthrax in some countries, whereas mites are known to cause itching and dermatitis (Busvine, 2018). Furthermore, flies which often perch on dried fish have been implicated as vectors of pathogens causing severe enteric disorders such as dysentery, cholera etc (Busvine, 2018). Contaminants of insect origin in fresh fish handling usually lead to insect pests infestation in the storage and leads to harvest loss and market value (Osuji, 2018).
There is a growing demand for fish protein in Nigeria due to the volatility of meat supplies due to issues of insecurity, banditry, cattle rustling and political instability. However, domestic production of fish from culture fisheries, capture fisheries and imports cannot meet local demand. This is further compounded by post- harvest fish losses due to spoilage. Fish preservation is therefore inevitable to preserve fish. Common methods of fish preservation include freezing, drying, salting, marinating etc. Fish drying is one of the most common methods of fish preservation and storage in Nigeria (FAO, 2019) [12].
As insects cause serious losses to stored dry fish and impact negatively on human health, this study is conducted to investigate the Insect pest of tilapia fish in Idah Local Government Area, Kogi State. This will provide useful information for dealing with the problem of fish preservation, storage and help to ensure food safety and security.
Even if we preserve our fish in smoked and dried, there are still infested with insect pest of various species and these reduces the production, qualities and quantities of the fish and thus render it unconsumable. So, it is very important to ascertain the various types of storage insect pest of smoked and dried *Tilapia* species to protect them in the storage. Since Nigerians preserve fish in form of smoked and dried.

Materials and Methods

Study Area

The study area is Idah Local Government Area in Kog State. While the experiment were carried out in the Department of Animal and Environmental biology, Prince Abubakar Audu University Anyigba Kogi State. On latitudes 7°15'N-7°29'N and longitudes 7°11'E – 7°32'E of Kogi state.

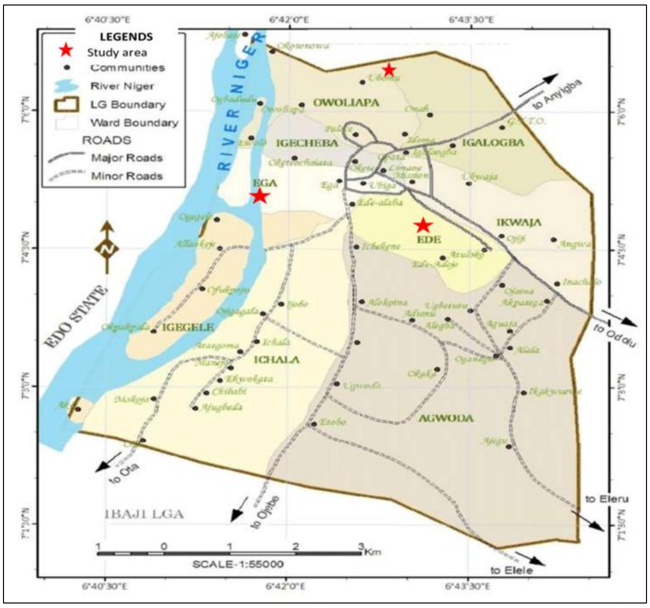

Fig 1: Map Showing Kogi state and Idah, the Study Area

Tilapia Sample

Fourty (40) smoked tilapia were purchased from Idah market and were kept inside ten (10) separate iron basket mesh, ten (10) tilapia each in one basket mesh, the basket mesh is to protect the fish from rats.
Fourty (40) dried tilapia spp. were also purchase from Idah market and were treated as in smoked fish. They were kept in Prince Abubakar Audu University biological laboratory. They were observed for every three days interval and the number of larva and insects observed were identified and the numbers were recorded as well (FAO, 2010).

Statistical Analysis

Simple percentages, frequencies of occurrence and means will be used to analyze the data collected was used for the analysis of variance (ANOVA). Smoked Tilapia spp. were compared with the dried *Tilapia* spp. by ANOVA test.

Results

Pest Infestation on Smoked *Tilapia* spp.

The observation of smoked *Tilapia* spp. stored across four cages (10 fish per cage; total = 40 fish) revealed the presence of three arthropod pest species: *Dermestes maculatus* De Geer (*Coleoptera: Dermestidae*), *Camponotus consobrinus* Erichson (Hymenoptera: Formicidae), and *Necrobia rufipes* De Geer (*Coleoptera: Cleridae*). A grand total of 116 pest individuals were recorded from smoked Tilapia throughout the three months storage period, yielding an overall pest density of 2.90 pests per fish. Among the three species recorded, *Camponotus consobrinus* (sugar ants) was overwhelmingly dominant, accounting for 77 of the 116 individuals representing 66.4% of the total pest infestation on the smoked fish. *Dermestes maculatus* was the second most abundant species with 32 individuals (27.6%), *while Necrobia rufipes* had the fewest records with 7 (6.0%).

At the cage level, Cage 4 recorded the highest with 38 individuals and a pest density of 3.80 pests per fish, with *C. consobrinus* alone accounting for 25 of these records. Cage 3 recorded the lowest infestation level with 19 and a pest density of 1.90 pests per fish. *C. consobrinus* was present in all four storage cages without exception, with counts ranging from 12 individuals in Cage 3 to 25 in Cage 4, underscoring its pervasive attraction to smoked fish. *D. maculatus* was likewise recovered from all four cages, with cage-level counts ranging from 4 (Cage 2) to 13 (Cage 1). *N. rufipes* was entirely absent from Cage 2 and recorded in small numbers in the remaining three cages (range: 1–4 individuals), suggesting a more localized infestation pattern for this species on smoked Tilapia. The complete cage-by-cage species counts, pest densities, and percentage compositions are presented in Table 1.

Table 1: Abundance and Percentage Composition of Pest Species Recorded on Smoked *Tilapia spp.* Across Four Storage Cages

Cage	No. of Fish	*D. maculatus*	*C. consobrinus*	*N. rufipes*	Total Pests	Pest Density†	% Dm	% Cc	% Nr
1	10	13	18	2	33	3.30	39.4	54.5	6.1
2	10	4	22	0	26	2.60	15.4	84.6	0.0
3	10	6	12	1	19	1.90	31.6	63.2	5.3
4	10	9	25	4	38	3.80	23.7	65.8	10.5
Total	40	32	77	7	116	2.90	27.6	66.4	6.0

† Pest Density = total pests per cage ÷ number of fish per cage. Dm = *Dermestes maculatus*; Cc = *Camponotus consobrinus*; Nr = *Necrobia rufipes*.

Pest Infestation on Dried Tilapia spp.

Dried Tilapia spp. stored under the same cage conditions (10 fish per cage; total = 40 fish) also yielded the same three pest species: *D. maculatus, C. consobrinus*, and *N. rufipes*. A total of 66 pest individuals were recorded from dried Tilapia, dried with oven pest density of 1.65 pests per fish, substantially lower than the 2.90 recorded for smoked Tilapia. Strikingly, however, the rank order of species abundance was lower compared to smoked fish. *Dermestes maculatus* emerged recorded the highes pest species on dried Tilapia, contributing 45 of the 66 individuals recorded and representing 68.2% of the total pest load in sharp contrast to its secondary status on smoked Tilapia (27.6%). This reversal is one of the most notable findings of this study and points to a strong substrate-mediated influence on pest species composition. C. consobrinus ranked second on dried Tilapia with 19 individuals (28.8%), while N. rufipes remained the least abundant with only 2 individuals (3.0%).

At the cage level, Cage 1 recorded the highest total pest infestation on dried Tilapia (n = 22; pest density = 2.20), with *D. maculatus* contributing 16 of these records. Cage 2 was the least infested, with only 10 individuals and a pest density of 1.00 pests per fish; notably, *C. consobrinus* was entirely absent from this cage, and *N. rufipes* was represented by a single individual. *D. maculatus* was found in all four cages with counts ranging from 8 (Cage 3) to 16 (Cage 1), further demonstrating its consistent preference for dried fish substrates across all storage units. *C. consobrinus* was absent from Cage 2 but present in Cages 1, 3, and 4 with counts of 6, 4, and 9 individuals, respectively. The complete cage-by-cage data for dried Tilapia are presented in Table 2.

Table 2: Abundance and Percentage Composition of Pest Species Recorded on Dried Tilapia spp. Across Four Storage Cages

Cage	No. of Fish	*D. maculatus*	*C. consobrinus*	*N. rufipes*	Total Pests	Pest Density†	% Dm	% Cc	% Nr
1	10	16	6	0	22	2.20	72.7	27.3	0.0
2	10	9	0	1	10	1.00	90.0	0.0	10.0
3	10	8	4	1	13	1.30	61.5	30.8	7.7
4	10	12	9	0	21	2.10	57.1	42.9	0.0
Total	40	45	19	2	66	1.65	68.2	28.8	3.0

† Pest Density = total pests per cage ÷ number of fish per cage. Dm = *Dermestes maculatus*; Cc = *Camponotus consobrinus*; Nr = *Necrobia rufipes*.

Comparative Analysis of Pest Infestation: Smoked and Dried Tilapia

A direct comparison of pest infestation across the two processing types reveals both quantitative and qualitative differences of ecological and economic significance. In terms of overall pest burden, smoked Tilapia (n = 116; pest density = 2.90 per fish) sustained 75.8% more pest individuals than dried Tilapia (n = 66; pest density = 1.65 per fish). This difference was principally driven by the mass colonisation of smoked fish by *C. consobrinus*, which alone accounted for 77 individuals on smoked Tilapia but only 19 on dried Tilapia. *D. maculatus*, by contrast, was more abundant on dried Tilapia (n = 45) than on smoked Tilapia (n = 32), while *N. rufipes* remained low in number across both substrates (smoked: n = 7; dried: n = 2). When only the tissue-destructive species (*D. maculatus and N. rufipes*) are considered, dried Tilapia yielded 47 individuals compared to 39 on smoked Tilapia, indicating that despite its lower overall pest count, dried fish was more heavily burdened by the species capable of causing direct structural damage to stored product. These cross-substrate differences in species abundance are illustrated in Fig 2.

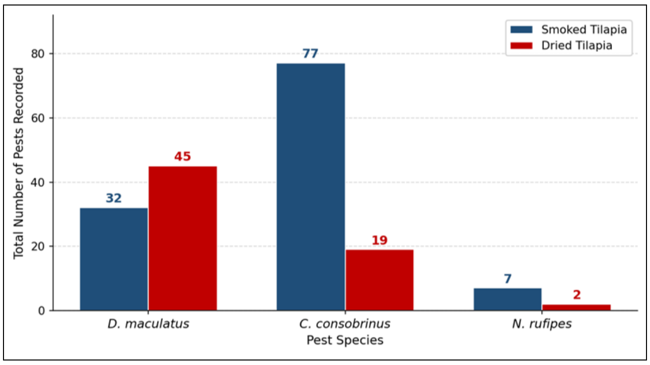

Fig 2: Comparison of Total Pest Species Abundance on Smoked and Dried Tilapia spp.

Fig 2: Grouped bar chart comparing the total number of individuals of each pest species recorded on smoked Tilapia (blue, n = 116) and dried Tilapia (red, n = 66). Values above bars denote exact counts. Note the dominant species reversal between the two processing types.

Discussion

The present study recorded three arthropod pest species, *Dermestes maculatus*, *Camponotus consobrinus*, and *Necrobia rufipes*, infesting both smoked and dried Tilapia spp. under cage storage conditions. These findings are consistent with previous reports documenting *D. maculatus* and *N. rufipes* as the primary insect pests of traditionally processed fish in West Africa (Abolagba & Melle, 2008; Okpala *et al*., 2016) [1, 29]. The detection of *C. consobrinus* as the numerically dominant pest on smoked Tilapia extends existing knowledge by highlighting the significant role of sugar ants as contaminants in processed fish storage environments in the Nigerian Middle Belt (Omotosho *et al*., 2019) [31].

The predominance of *Dermestes maculatus* on dried Tilapia (68.2%; Table 2) is consistent with the well-established biology of this species. *D. maculatus*, commonly known as the hide or carpet beetle, is widely recognised as the principal insect pest of dried fish across sub-Saharan Africa (Benson & Iyeke, 2015; Akintola & Fakoya, 2017) [9, 5]. Its larvae are highly destructive, boring into dried fish flesh to feed on protein and lipid fractions, and are capable of causing weight losses of 30–40% in inadequately stored product (Kumolu-Johnson & Ndimele, 2011) [21]. The greater abundance of *D. maculatus* on dried Tilapia (n = 45; mean 11.25 per cage) compared to smoked Tilapia (n = 32; mean 8.00 per cage) can be attributed to the physicochemical characteristics of the dried substrate: very low moisture content (15–20%), a firm texture, and an intact protein matrix that provides optimal oviposition surfaces and larval feeding sites for dermestid beetles (Meke *et al.*, 2020) [23]. This preference was consistent across all four dried fish cages (Table 2), including Cage 2 where *C. consobrinus* was entirely absent, confirming that *D. maculatus* colonisation is driven by substrate quality rather than competitive exclusion.

In contrast, the smoking process produces a fish product with higher surface moisture, a softer texture, sweeter and a surface chemistry enriched with volatile phenolic compounds, polycyclic aromatic hydrocarbons, and carbonyl groups derived from wood smoke condensates (Olopade *et al.,* 2016) [30]. These properties appear to reduce *D. maculatus* colonisation intensity while simultaneously attracting *C. consobrinus*, which is attracted to smoked Tilapia at 66.4% (Table 1; Fig 2). Ant attraction to smoked food products has been linked to the olfactory stimulation of sugar- and amino acid-derived Maillard reaction products formed during the smoking process (Roura *et al*., 2011) [39]. *Camponotus species* are opportunistic omnivores that respond strongly to nitrogen-rich volatile matrices emitted by thermally processed protein foods (Fellers & Fellers, 1976; Omotosho *et al*., 2019) [15, 31]. Although *C. consobrinus* does not bore into fish flesh in the manner of *D. maculatus*, its persistent presence in all four smoked fish cages is a significant hygiene concern: foraging ants physically disturb stored fish, introduce formic acid secretions that accelerate oxidative rancidity, and may mechanically transmit microbial contaminants to the product surface (Abolagba & Melle, 2008) [1].

Necrobia rufipes (red-legged ham beetle, Coleoptera: Cleridae) was the least abundant species on both smoked (n = 7; 6.0%) and dried Tilapia (n = 2; 3.0%). Despite its low prevalence in this study, *N. rufipes* is a globally significant secondary pest of cured and dried fish, capable of causing severe losses under prolonged storage conditions (Okpala *et al*., 2016) [29]. Its low numbers here may reflect the relatively short duration of the storage experiment, as *N. rufipes* populations typically build up over extended periods of several weeks to months (Akintola & Fakoya, 2017) [5]. Notably, N. rufipes adults are predatory on the larvae of *D. maculatus* and other stored-product insects, meaning its abundance may be partly self-regulated by the available prey base (Halstead, 1963) [16]. The complete absence of N. rufipes from Cage 2 on smoked Tilapia, which also recorded the lowest *D. maculatus* count (n = 4) — is consistent with this predator-prey dynamic.

The overall pest density was markedly higher for smoked Tilapia (2.90 pests per fish) than for dried Tilapia (1.65 pests per fish). However, a critical analytical distinction must be made: when only tissue-destructive species (*D. maculatus* and *N. rufipes*) are considered, dried Tilapia yielded 47 damaging individuals compared to 39 on smoked Tilapia. This indicates that dried fish sustained the heavier burden of structurally damaging infestation despite its lower overall pest count — a finding that challenges the assumption that lower total pest numbers necessarily imply less product damage (Kumolu-Johnson & Ndimele, 2011; Meke *et al*., 2020) [21, 23]. The elevated total pest count on smoked Tilapia was driven by *C. consobrinus*, whose damage mechanism, while real, is qualitatively distinct from the internal tissue destruction caused by dermestid beetles.

These findings carry significant practical implications for post-harvest fish management in Nigeria and the wider West African sub-region. Evidence-based interventions include: (i) the use of airtight polythene packaging or hermetic storage containers to physically exclude ovipositing *D.*

maculatus adults from dried fish (Meke *et al*., 2020) [23]; (ii) application of food-grade plant-based repellents such as neem (Azadirachta indica) leaf powder, which has demonstrated efficacy against *D. maculatus* in stored dried fish (Adeyemi & Afolabi, 2012) [3]; (iii) structural sealing of storage facilities and routine sanitation to prevent ant colony establishment near smoked fish stocks; and (iv) hygiene protocols including prompt removal of fish offal and scales, which serve as initial attractants for both dermestid beetles and scavenging ants (Omotosho *et al*., 2019) [31]. Longitudinal studies spanning extended storage durations and multiple seasons are recommended to better characterise *N. rufipes* population dynamics and the temporal variation in pest pressure on both processing types.

Conclusion

This study investigated the insect pests associated with smoked and dried *Tilapia* species stored under cage conditions in Idah Local Government Area of Kogi State. Three major arthropod pest species were identified, namely *Dermestes maculatus*, *Camponotus consobrinus*, and *Necrobia rufipes*. The findings revealed that both smoked and dried *Tilapia* are susceptible to pest infestation during storage, although the degree and pattern of infestation differed between the two processing methods.

Smoked *Tilapia* recorded a higher overall pest population and pest density than dried *Tilapia*, largely due to the dominance of *Camponotus consobrinus*. In contrast, dried *Tilapia* was more heavily infested by *Dermestes maculatus*, which is recognized as one of the most destructive storage pests of dried fish. Although dried fish had a lower total pest count, it harboured a greater number of tissue-destructive pests capable of causing significant quantitative and qualitative losses.

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