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ORIGINAL RESEARCH ARTICLE

Efficacy of *Moringa oleifera* Seed and Leaf Powders as Natural Insect Repellents in the Preservation of Sun-Dried *Mormyrus* Fish in Mubi-Nigeria

Jacob, M. G., Duwal, S. D*. and Edward, A.
Department of Fisheries and Aquaculture, Adamawa State University, Mubi-Nigeria

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***Corresponding Author:**
E-mail: dennis804@adsu.edu.ng;
Phone: +2348132222186

ABSTRACT

Insect infestation poses a major threat to the quality and shelf life of sun-dried fish, causing physical damage and nutritional losses. The search for eco-friendly alternatives to chemical preservatives has led to the exploration of plant-based bio-pesticides. This study investigated the potential of *Moringa oleifera* seed and leaf powders as natural insect repellents for preservation in sun-dried Mormyrus fish in Mubi, Adamawa State, Nigeria. Freshly dried Mormyrus fish samples were collected from fishers at Kiri Reservoir and transported to Mubi for experimentation. Moringa leaves and seeds were shade-dried, ground into fine powders, and applied at varying concentrations. Five treatments were established: T1 (control, no treatment), T2 (25 g moringa leaf powder MLP), T3 (50 g MLP), T4 (25 g moringa seed powder MSP), and T5 (50 g MSP), each replicated three times. One hundred grams of sun-dried fish were stored per carton (15 cartons in total) for 90 days under ambient conditions. Four insect species were identified during the storage period: *Necrobia rufipes* adults, *N. rufipes larvae*, *Dermestes maculatus* adults, and Diptera larvae. The control (T1) recorded the highest infestations with 5.67 adult *N. rufipes* and 23.66 Diptera larvae, whereas T5 (50 g seed powder) recorded the lowest numbers (2.67 adult *N. rufipes* and 7.00 Diptera larvae). The highest mortality of *N. rufipes* larvae (310.33) occurred in T5, while adult D. maculatus mortality (2.33) peaked in T3 (50 g leaf powder). The application of *M. oleifera* seed and leaf powders effectively reduced insect infestation and increased pest mortality in sun-dried Mormyrus fish. These findings suggest that moringa-based powders are promising eco-friendly alternatives for fish preservation. Future research should explore the synergistic effects of moringa with other botanical extracts and evaluate its long-term efficacy as a biological control agent.

Introduction

Fish is one of the most affordable sources of animal protein in Africa, therefore fisheries play an essential role in the production of fish particularly in Africa. On average, Nigerians consume approximately 8 kg of fish per person per year. While this remains below the global per capita average of around 21 kg., fish still

plays an important role as provider of animal protein in remote areas (Food and Agriculture Organisation, 2024). Mormyrus or Elephant Snout fishes are freshwater tropical fishes. They are curious-looking fish, highly variable in the shape of their head and the extent of their unpaired fin. This fresh water fish constitutes an important part of fish distribution in Nigeria and the marketing trends predict an increase in consumer demands as it is very affordable and available (Ali *et al*., 2021). They however require immediate preservation after they are caught to avoid spoilage (Ali *et al*., 2021) which has made fishers device means of overcoming it by processing using either salt, smoke or even sun drying. Sun drying happens to be the most immediate available and cheap means of preservation after catch. About 20% of total fish caught are sun dried and mostly consumed in the domestic market annually (Food and Agriculture Organisation, 2021). Despite this preservation techniques, sun dried fish is prone to heavy insect infestation (Sadiq *et al*., 2021). Sun dried fish are contaminated by both insects and insecticides comprising about 60% of the total dried products that is considered to be unfit for human consumption. Insecticides are misused, overused or unnecessarily used by farmers and retailers who have very limited or no information about how to apply them or their health implications when present in foodstuffs. Hence, harmful levels of pesticide residues or metabolites are left adsorbed unto the foodstuffs to which they are applied. There is an increasing awareness of the negative health effects that manufactured chemical pesticides have on humans, as well as animals and plants.

Compared to synthetic chemical pesticides, botanically derived products are generally considered safer for humans and animals and cause fewer disruptions to ecosystems (Raimi and Salami, 2025). Recent studies confirm that natural plant-based pesticides tend to degrade faster and exhibit lower persistence in the environment compared to synthetic pesticides (Carr and Perfetti, 2020).

The Moringa tree is a deciduous perennial tree that is regarded as one of the world's most useful trees since almost every part of it is useful; an alkaloid and triterpenoids have been reported in Moringa (Agra-Neto *et al*., 2014). It is necessary to investigate the insecticidal properties of *M. oleifera* leaf and seed powder extract in the storage of sundried mormyrus fish (SMF) through local sourcing to reduce cost for fish sellers and household and also promote sustainable research to develop insecticides based on bioactive natural chemical compounds from indigenous plant sources. Therefore, this study was aimed at evaluating the effects of moringa seed and leaf powders on commonly identified insects of stored SMFs.

Materials and Method

Location

The study was conducted in the Department of Fisheries and Aquaculture, Adamawa State University, Mubi, North East Nigeria. Mubi is located on latitude (10^{o} 06′ – 10^{o} 29′ N) and longitude (13^{o} 07′ – 10^{o} 30′ E) and also found on altitude 696 m above sea level, with annual mean rainfall between 700 mm and 1050 mm (Adebayo et al., (Adebayo *et al*., 2020).

Plant collection:

The seeds and leaves of *M. oleifera* were purchased separately from Mubi main market, Adamawa State, Nigeria. Thereafter, handled and processed according to Vyas and Mistry (1996).

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Moringa Leaf Powder (MLP) Preparation:
Moringa leaves were air dried under shade (to avoid photochemical breakdown of the active ingredients) before grinding to powdery form using mortar and pestle. The ground leave was sieved to a consistent powdery form. This was labeled as MLP and stored in cool and dried place before the experiment

Plate 1: Moringa Leaves and Powder

Moringa Seed Powder (MSP) Preparation:
Fully matured pods (drum stick) of moringa were sun dried before de-pulping. The de-pulped seeds were ground to powdery form using an electric blender and the powder was labelled as MSP then stored in an air tight container until its use.

Plate 2: Moringa Seeds and Powder

Fish Procurement:
Fresh Samples of momyrus fish were obtained from Kiri Reservoir, Adamawa State, after which it was cleaned and sundried. The sundried mormyrus fish (SMF) was stored in cartons before transportation by road to Mubi.

Experimental Setup: Data collection:
The samples were inspected after 3 months to determine the number of live and dead insects from each carton. The results were recorded accordingly.

Data Analysis:
All data obtained were analysed using analysis of variance ANOVA (SPSS, 1990) and the means separated

Results and Discussion
Insect Identified across the Treatments
The result of insects identified from SMF stored with moringa parts (leave and seed) is presented in Table 1. The following insects were identified; Adult of *Necrobia rufipes,* larvae *of N. rufipes*, Adults of *Dermestes maculatus,* larvae of *D. maculatus* and and larvae of *Diptera*. This could be attributed to the fact that these insects infect this fish because of its dryness and potential mold growth as well as high protein necessary for their survival, growth and reproduction. This report agrees with that of Akinwumi (2021) who reported that the insects commonly found on sun dried fish are flesh flies (*Sarcophagidae*), beetles (*Dermestes*, *Cornestes*, and *Necrobia* spp.), and mites (*Lardoglyphus* and *Lyrophagus* spp).

Five treatments were designed in a Completely Randomised Design form and each treatment replicated three times; the treatments were: T1 = SMF only (control); T2 = SMF with 25g of MLP; T3 = SMF with 50g of MLP; T4 = SMF with 25g of MSP; and T5 = SMF with 50g of MSP. Each sample was stored in a carton making a total of 15 experimental cartons. Each carton was assigned an average of 100g of SMF and labelled accordingly. The powders were weighed using a sensitive scale and divided into 25g of MLP, 50g of MLP, 25g of MSP, and 50g of MSP and carefully applied to the SMF in the cartons according to the labels and replications. The samples were then left in the laboratory at room temperature until observation.

Table 1: Insect Identified Across all Treatments

Insect	Control	25MLP	50MLP	25MSP	50MSP
N. rufipes (Adult)	+	+	+	+	+
N. rufipes (larva)	+	+	+	+	+
D. maculatus (larva)	+	+	+	+	+
D. maculatus (Adult)	+	+	+	+	-
*Diptera (*larva**)**	+	+	+	+	+

Note: + = Positive, - =Negative, MLP = Moringa leaf powder, MSP = Moringa seed powder

Population of Live Insects in Fish Samples
Higher numbers of adult *N. rufipes* (5.67) and *Diptera* larva (23.66) were observed in the control (T1) and higher numbers of *N. rufipes* larva (46.66) and adult *D. maculatus* (5.66) where observed in T4 (25gMSP). T5 had lower

numbers of adult *N. rufipes* (2.67) and *Diptera* larva (7.00). There was no presence of adult *D. maculatus* in T5 (0.00). T5 (50MSP) recorded a low number of live and dead insects especially adult *N. rufipes.* This could be attributed to the fact that MSP contains active constituents that had repellent effects on *N. rufipes* and thereby reducing their survival in this treatment (Castilhos *et al*., 2018). This finding corroborates with Paul *et al*. (2009) and Fotso *et al*. (2018), who reported that powdered moringa seed could adequately protect stored products against storage insects and pests.

Table 2: Population of Live Insect in Sundried Mormyrus Fish Samples

Insect	Control	25MLP	50MLP	25MSP	50MSP	SEM
N. rufipes adults	5.67^{a}	3.00^{b}	3.00^{b}	4.00^{b}	2.67^{b}	0.73
N. rufipes larva	22.66^{b}	32.33^{ab}	30.66^{b}	46.66^{a}	41.66^{a}	9.34
D. maculatus adult	3.33^{b}	1.33^{bc}	2.33^{b}	5.66^{a}	0.00^{c}	0.81
Diptera larva	23.66^{a}	16.66^{ab}	24.66^{a}	9.66^{b}	7.00^{b}	4.54

Note: Values with the same superscript within the same row are not significantly different (P>0.05).

Higher numbers of live *N. rufipes* larva (46.66) larva were observed in T4 (25MSP), this could be as a result of the phytochemicals derived from MSP that suppressed progeny development of *N. rufipes*. Similar reports of insecticidal activity were observed by Prabhu *et al*. (2011) who recorded that the phytochemicals derived from *M. oleifera* seeds extracts effectively prevented adult emergence in fish protected against *D. maculatus* and *N. rufipes.*

It was observed that there was no emergence of *D. maculatus* adults and lower numbers of adult of *N. rufipes* (2.67) in T5 (50gMSP). This could be attributed to the repellent propertie and high larvicidal effect of MSP on adults of *Dermestes* and adult of *N. rufipes.* This is in agreement to the findings of Ojiako *et al*. (2013) who stated that *M. oleifera* seed extracts were effective in repelling *Megalurothrips sjostedti* and *A crassivora*.

Plate 3: Adult *N. rufipes*

Plate 4: Adult (left) and larva (right) of *D. maculatus*

Plate 5: Larva of *Diptera* spp.

Population of Dead Insect in Fish Samples

The number of dead insects obtained from treatments is presented in Table 3. The highest number of dead *N. rufipes* larva (310.33) was observed in T5(50gMSP) while the highest number of dead Adult *D. maculatus* (2.33) was observed in T3(50gMSP). Highest number of

dead *N. rufipes* larva (310.33) was observed in T5 (50gMSP). This implies that the MSP had great mortality effect on *N. rufipes* larva. While the highest number of dead Adult *D. maculatus* (2.33) was observed in T3 (50gMLP). This could be attributed to the insecticidal properties of MLP, due to presence of phytochemicals like catechol tannins, gallic tannins, steroids, triterpenoids, flavonoids, saponins, anthraquinones, alkaloids. The result obtained in this experiment is similar to the findings of Atindo *et al*., 2021 who reported the larvicidal effects of *M. oleifera* extracts have been reported against other storage pests.

Table 3: Population of Dead Insect in SMF Stored with Moring after 3 Months

Insect	Control	25MLP	50MLP	25MSP	50MSP	SEM
N. rufipes adults	-	-	-	-	-	-
N. rufipes larvae	68.33^{c}	79.00^{c}	34.66^{c}	200.67^{b}	310.33^{a}	39.85
D.maculatus adults	0.33^{bc}	1.00^{b}	2.33^{a}	1.00^{b}	0.00^{c}	0.33
D. maculatus larvae	66.88^{c}	70.33^{c}	100.66^{c}	320.33^{b}	400.88^{a}	41.20
Diptera larvae						

Note: Values with the same superscript within the same row are not significantly different (P>0.05).

Conclusion

This study concluded that moringa leaf and seed powder has significant repellant and insecticidal effect on the survival of insects of stored sundried mormyrus fish. It is therefore recommended that moringa seed at 50g per 100g of sundried mormyrus fish can effectively prevent spoilage and provide healthy fish for consumption. The authors also recommend the need to explore new aspects for eco-friendly sustainable fish storage.

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