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COMPARATIVE EFFECT OF ALLIGATOR PEPPER (*Aframomum melegueta* Roscoe) and NUTMEG (*Myristica fragrans* Houtt.) POWDERS ON THE CONTROL OF FISH BEETLE (*Dermestes maculatus* Degeer).

*[1]Oladejo, A.O.; [1]Musa Ishaya; [1]Sikiru, G.K..; [1]Olori-Oke, O.O.; [1]Ayorinde James; [2]Mudi A. and [3]Adedire, O.

[1]*Department of Pest Management Technology, Federal College of Forestry, Jos Nigeria*
[2]*Department of Crop Production Technology, Federal College of Forestry, Jos. Nigeria*
[3]*Department of Statistics, Federal College of Forestry, Jos. Nigeria*
* folabiola60s@gmail.com Cell No. +2348068040088

ABSTRACT

Fish has become an easy source of protein worldwide and over the years, fishery has been a source of income and livelihood for millions of people around the world, especially in Africa. Yet preserving it has become a problem as a result of pest infestation especially infestation by *Dermastes maculatus* (D). The study was carried out to investigate and compare the effects of *Myristica fragrans* and *Aframomum melegueta* seed powders against adult *Dermestes maculatus* in cat fish. The experiment was conducted using a Complete Randomized Design (CRD). The fish was treated with 0.0g (control), 2.5g, 5.0g, and 7.5g *M. fragrasn* and *A.melegueta* seed powders. Ten unsexed adults *D. maculatus* (male and female in ratio 1:1) were introduced into each treatment, covered with 1mm muslin cloth and rubber band. Application of *A.melegueta* seed powder at 5g and 7.5g showed percentage mean mortality of 70 and 83.3% at 96 hours and 86.67% and 96.67% at 120 hours respectively after treatment. While application of *M. fragrans* seed powder at the same dosage and durations 48, 72, 96 and 120 hours showed percentage mean adult mortality of 60%, 73.3% and 83.3%, 86.67% respectively. This result shows that both plant seed powders are effective against *D. Maculatus* but, *A.melegueta* performed better than *M. fragrans.* However, efficacy depends on the dosage and time exposure interval.

Keywords: *Aframomum melegueta, Myristica fragrans , Dermestes maculatus, Cat fish, mortality*

Introduction

The importance of fish cannot be over emphasized; it is one of the cheapest sources of animal proteins and is often used to correct protein deficiency in human diets in the tropics (Azam *et al*., 2004). The African catfish (*Clarias gariepinus* Burchell) is the popular, widely cultivated and mostly smoked fish in Nigeria (Aderolu and Akpabio, 2009). Recently, FAO, (2021) reported that global captured fish (including aquatic production) from fresh water ecosystem including lakes, rivers, to be about 7.5 million tons. In Nigeria alone, fish contributed to about 20-25% per capital animal intake and could be as high as 80% in coastal and riverine communities (FAO, 2000; FDF, 2005).

Reduction in the quality and quantity of fish during storage has been attributed to *Dermestes maculatus.* This accounted for about 43-67% dry weight loss due to pest infestation (Melanie *et. al*., 2007). There is therefore, an urgent need to protect smoked stored fish from spoilage considering the crucial role it plays in insuring food security, income generation and employment opportunities. Most often, preservatives used are synthetic chemical compounds which are costly and have

detrimental effect on the handler and his surrounding environment.

Many Nigerian medicinal plants and spices have been cited as pest control agents of stored grains, legumes and smoked fish (Adedire and Lajide, 2000). Extracts from plant parts using appropriate solvents can concentrate the active components and enhance the insecticidal activities. In current piece of works, the trails using various plant species from over 50 families have been found to posses' insecticidal components. However, the different plants species under investigation are often used locally. Within individual countries as culinary spices or in traditional medicine, some researchers inferred that the materials are therefore safe to use as an insecticide without any adverse effect on the ecosystem (Isman and Ukeh, 2006; Jacobson and Gregory, 2006).

Nutmeg plant and Alligator pepper are examples of such plants. Nutmeg spice is widely used in cuisines around the world for its unique taste and flavor. The most important commercial species is the common true or fragrant nutmeg, *Myristica fragrans* (*Myristicaceae*), native to the Mollucas (or spice island) of Indonesia (Dotschkal, 2005). The seeds of *M.fragrans* contain a volatile oil which comprises of pinene and campene. The volatile fractions contain dozens of *terpenes* and *phenyl-propanoids,* including *D-pinene, limonene, D-borneol, L-terpineol, geranoil*, *safrol* and *myristicin* (Abourashed and El-alfy, 2016). *Myristicin* (basic constituent) have insecticidal property and thus it has been recommended to be effective for pest control *(*McKenna *et al*., 2004*;* Ehrenpreis *et. al*., 2014). An aqueous decoction of nutmeg is toxic to cockroaches and its oil has insecticidal activities against the larvae of *Lycoriolla ingunua* and *Collosobruschus chinensis* (Charlotte, 2018).

Alligator pepper (*Aframomum melegueta)* is a perennial deciduous herb. It's phytochemical analysis revealed presence of alkaloids, cardiac glycosides, tannins, phenol, flavonoids, sterols, oil and resins (Akinwumi, 2011). The presence of phenolics compound indicates that this plant is an antimicrobial agent and have been used in disinfections and remain the standard for which other bactericides are compared (Okwu, 2005). It is on this note that this work centered on investigating the effect of *Myristica fragans* and *Aframumun melegueta* on larva and adults of fish beetle (*D. maculatus).*

Materials and Methods

Study Area

This study was carried out in Entomological Laboratory of Federal College of Forestry Jos. The College lies around latitude 9^{o} 51' to 9^{o} 57'N and longitude 8^{o} 53' to 8^{o} 54'E in the Northern Guinea Savannah zone of Nigeria with a height of about 1200m above the sea level. The mean annual rainfall for the location ranges between 12000cm and 1250m and the mean temperature of 23^{o}C – 25^{o}C as obtained from University of Jos, Metrological station, (2013).

Collection and Preparation of materials

Fish Smoking: Twelve fresh cat fish (*Clarias gariepinus*) of about 0.5kg each were purchased from Fishery department, Federal College of Forestry, Jos. The fish were washed thoroughly with clean water and smoked using a traditional way of smoking. The smoked fish was oven-dried at 60^{oo}C for about 2 hours to avoid the growth of moulds and carefully packed into sterile plastic polythene bag (Adedire and Lajide, 2000).

Preparation of powders: About 35grams each of Alligator pepper (*Aframomum melegueta*) and that of Nutmeg (*Myristica fragans*) seeds were purchased from Katako market, Jos. The seeds were dried using sun dryer. Thereafter, they were pulverized differently using electric harmer blender. The crude powder were then

bottled separately and tagged with their names for easy identification.

Determination of Phytochemical Constituents.

Freshly prepared powders of *A. melegueta* and*M. fragans* were subjected to standard phytochemical analyses for different constituents such as tannins, phloblatannins, alkaloids, flavonoids, saponins, anthraquinones, steroids, glycosides, phenol and oils as described by Jigna and Sumitta, (2006); Thomas and Krishnakumari, (2015).

Culturing of *Dermestes maculatus*.

Some adult *D. maculatus* were obtained from infested smoked dried catfish in fish market, Jos. The insects were identified using morphometric method. The insects were paired sexually and introduced into some Laboratory treated smoked fish in plastic jar in order to mate, a moist cotton wool socked in water was place beside the infested fish to aid oviposition. The top of the jar was covered with 1mm muslin cloth to prevent escape. Copulation commenced after 24 – 48 hours, and larvae of the insect were seen from the tissues after 14 days and at about 21 days the adult emerged to give F1 generations. The F1 adults were picked and kept in plastic jars covered with 1mm muslin cloth under temperature 30 ± 2^{o0}C and relative humidity 65±5% (Akinwumi *et. al.*, 2007).

Application of treatments and Experimental design

About 0.5kg cat fish was placed into 12 (sterile 1litre) plastic jars, varying quantities [0.0g (Control); 2.5g; 5.0g and 7.5g] of Alligator pepper and Nutmeg powders were measured and introduced into each of the jars. Ten unsexed adult *D. maculatus* (male and female in ratio 1:1) were introduced into each treatment jar and covered with 1mm muslin cloth. The cloth was then held tightly with rubber ring band to allow aeration and prevent entry of other insects. This process was replicated 3 times each. The experiment was laid out in a Complete Randomize Design (CRD) on a laboratory bench under room temperature and relative humidity which fluctuate between 30^o – 35^oC and 65 – 75% RH respectively. Activities and mortality of the adult *D. maculatus* was observed at regular intervals of 24, 48, 72, 96 and 120 hours after application. Adult mortality was observed daily when no response was observed after probing them with forceps/brush in accordance with Ileke and Oni, (2011).

Data Collection

Adult beetle mortalities data were collected from each treatment (0.0g to 7.5g) at 24 hours interval for 120 hours after application. At each observation, dead beetles were removed, counted and recorded. The fish weights were taken at the beginning and at the end to determine losses.

Statistical Analysis

Data collected were transformed to percentages and their means were subjected to analysis of variance to determine whether there is any significant difference between the treatments or not, then Fixer's Least Significant Differences (LSD) test was used to separate the mean that is responsible for the difference, using SPSS software version 23. The different plant powders were compared using paired sample T-test.

Result and Discussion

Table 1 showed that phytochemical screening of *Aframumun melegueta* and *Myristica fragans* seed powders revealed the presence of a wide range of phytochemical constituents including phenols, tannins, saponins, flavonoids, alkaloids, volatile oils and anthraquinones supporting the reason for their wide range of biological activities.

Table 1. Phytochemical profile of *Aframumun melegueta and Myristica fragans* seeds.

Phytochemical Composition	*A.melegueta*	*M. fragans*
Tannins	++	-
Anthraquinones	+	++
Steroids	+	+
Terpenoids	+	+
Saponins	++	+++
Flavonoids	++	++
Alkaloids	+	++
Phenol	+	+
Cardiacglycosides	+	+
Phlobatannins	-	+
Phenol	+	+
Resins	-	+++
Volatile oils	-	++

***Key**: - Absent; + Present; ++ More present; +++ Highly present*

Table 2 showed the mean percentage values obtained from fish weight loss. This indicated that fish weight loss decreases as the quantities of the powders increases in both botanicals, with the control (0.0g) recording the highest loss values. However, the percentage weight losses in Nutmeg treatments were a bit higher than Alligator pepper. Notwithstanding statistical analysis show no significant difference between the two plant powders but there was significant different between the control of both plant powders and the treated ones. This could be attributed to phytochemical constituents of the powders which have pesticidal and anti-feedant properties against the insects which led to their mortality (table 3).

Effects of Alligator pepper on *D. maculatus* on *Clarias gariepinus* at different time intervals.

Paired sampled T-test showed that there was no significant difference between the effects of alligator pepper and nutmeg powders (T_{19} = 1.14, P < 0.05) on *D. maculatus* and there was strongly correlated (r = 0.991, P < 0.05) between the two powders. However, alligator pepper had higher (96.67%) mortality effects on the pest than nutmeg (86.67%) powder (Table 3 and 4).

The general performance of the different doses of both powders on *D. maculatus* at different time intervals shows that as the quantity of the powders increases, the mortality decreases with the control (0.0g) having the least mortality (table 3 and 4). At 72 hours and dosage 5.0g and 7.5 g, both powders had above 50% mortality, these increases until we have 86.67% and 96.67% at 120 hours in Nutmeg and Alligator pepper respectively. This result agrees with Egwenyeng and Nnorsi, (1998) who reported the pesticidal activity of the seed powder and solvent extract against larvae and adult of the beetle *D. maculatus.*

Although the exact mechanism behind the observed action of Alligator pepper is not known, data on the phytochemical composition of these plant powders provides an insight into

the mechanism of their actions. The preponderance of tannin in high quantity may suggest a role in their pesticidal potencies, also the presence of volatile oils in nutmeg seeds could be seen to demonstrate the ability of acting as suffocating materials with the possibility of preventing respiration. This agrees with the findings of Udo, (2011) who reported that plant oils can act as a suffocating material to storage insects.

It was also observed that Saponins and Cardiacglycosides are present in both plant powders; this could be linked to the insecticidal interaction with cholesterol which results in impairing ecdysteriod synthesis as reported by Chaieb, (2010). On the other hand, Alphonsus, (2005) reported evidence for the insecticidal effects of purified Cardiacglycosides from *Digitalis purpurea* against camel tick (*Hyalomma dromedarii*) and by extension to other insect pests.

The characteristic smell or taste of the powders may have prevented the beetle from its normal feeding, or higher doses of the different plant powders (nutmeg and alligator pepper) may have blocked spiracle of the insects. This result confirmed the findings of Owusu-Akyaw, (1991); Sofowora, (1993) and Thomas and Krishnakumari, (2015); that phytochemical constituents such as flavonoids, tannins, alkaloids, volatile oils and several other aromatic compounds or secondary metabolites of plants serve as defense mechanism against predation by microorganisms, insects and other herbivoures. Also Mila *et al.,* (1996), reported that tannins posses strong activities against several pathogens and arthropod pests. Karamanoli *et al.,* (2011), complemented this report by explaining that tannins exert its action by a combination of mechanisms that include iron chelation and enzyme inhibition. Terpenoids are known to have a pungent odour and act as a deterrent to the insect (Martini *et al*., 2003).

Table 2. The mean percentage fish weight loss after the experiment.

Quantities (grams)	Treatments	
	Alligator pepper (%)	Nutmeg (%)
0.0 (Control)	14.67 [a]	14.67 [a]
2.5	7.37 [b]	7.24 [b]
5.0	7.03 [b]	6.83 [b]
7.5	5.27 [b]	3.28 [b]
SE±	3.24	3.28

Means with the same superscript letter within a column are not significantly different

Table 3**. Percentage Mean mortality of *Dermestes maculatus* at different durations after treatment with Alligator pepper powder.**

Treatment (Grams)	Mean mortality (%)				
	24hrs	48hrs	72hrs	96hrs	120hrs
0.0(control)	0.00 [c]	0.00 [d]	0.00 [d]	13.33 [d]	16.67 [d]

2.5		23.33 [b]	23.33 [c]	30.00 [c]	33.33 [c]	43.33 [c]
5.0		30.00 [b]	46.67 [b]	56.67 [b]	70.00 [b]	83.33 [b]
7.5		43.33 [a]	46.67 [a]	66.67 [a]	86.67 [a]	96.67 [a]
T-test	1.14[ns]					
Correlation (r)	0.991					

Means with the same superscript letter within a column are not significantly different

Table 4**. Percentage Mean mortality of *Dermestes maculatus* at different durations after treatment with Nutmeg powder.**

Treatment		Mean mortality (%)				
(Grams)		24hrs	48hrs	72hrs	96hrs	120hrs
0.0(control)		0.00 [c]	0.00 [c]	6.67 [c]	13.33 [d]	23.33 [d]
2.5		23.33 [b]	30.00 [b]	33.33 [b]	36.67 [c]	43.33 [c]
5.0		26.67 [b]	40.00 [a b]	53.33 [a]	60.00 [b]	73.33 [b]
7.5		40.00 [a]	46.67 [a]	63.33 [a]	83.33 [a]	86.67 [a]
T-test	1.14[ns]					
Correlation (r)	0.991					

Means with the same superscript letter within a column are not significantly different

Conclusion

Based on the results of this study**,** data obtained shows that both nutmeg and alligator pepper have noticeable and direct effect against fish beetle (*D. maculatus*). However, efficacy depends on the dosage and the exposure interval; at 120 hours and 7.5g dosage, both plant powders had significant control effects of 86.67% and 96.67% respectively on the fish beetle. It is therefore recommended that a standardized method of quantity formulation be established.

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