

A Review on the Insecticidal Properties of Some Plant Materials used against *Dermestes maculatus* infestation on stored Smoked Fish in Nigeria.

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Abstract

Dried smoked fish is one of the major sources of protein supplement in many parts of the world, but it is prone to insect pest infestation during packaging, transportation and storage. Synthetic insecticides are used by many researchers and smoked fish sellers against insect pest of smoked fish, however its toxicity to non-target animals and humans disrupt its continuous use. In Nigeria some part of various plant species have been tested against *Dermestes maculatus* infestation on smoked fish. The results showed that the varying concentrations of the plant materials possessed both ovicidal and larvicidal effects on *D. maculatus*. They also reduced emergence of adults and increased adult mortality. Some of these plant materials also have higher and moderate repellency potentials. The results also revealed the effectiveness of the plant materials to the insect probably due to the presence of active compounds which might impair respiration of the insect pest by blocking the spiracles there by leading to suffocation and eventually death of the insects. This clearly revealed the potentials of plant materials as protectants against *D. maculatus* and could serve as an alternative to conventional insecticides for the protection of dried fish against the *Dermestes maculatus* beetles.

Keywords: *Dermestes maculatus*, infestation, insecticide, Plant materials, Smoked fish,

Introduction

Fish is an important source of food and income to many people in the developing world, in Africa 5 percent of the population (about 3.5 million people) depend wholly or partially on the fisheries sector, mostly artisanal fisheries for their livelihood (Adewuyi *et al.*, 2013). Fish is one of the most important sources of food and income to many people in developing countries (Osarenren and Ojor, 2014). Fishing industry is vital to Africa supporting annual exports worth about \$3bn. (El sheikh *et al.*, 2014). Over the years, the fishery sector has been a source of income and livelihood for millions of people around the world, and Nigeria accounts for 30-40% post-harvest losses of landed fish catches thus, prompting the subjection of landed fish catches to a variety of processing methods, such as smoking and drying. However, according to (Anyanwu *et al.*, 2016) smoked dried fish is prone to insect infestation during storage mainly by *Dermestes maculatus* and *Necrobia rufipes*. Cured fish with low moisture content provides food for beetles, particularly the larvae and to a lesser extent, the adults of *Dermestes* sp. and *Necrobia* sp.

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(Adeyeye *et al.*, 2015). Zakka *et al.* (2009) reported that *Dermestes* sp and *Necrobia rufipes* are considered to be the major pests on cured fish as well as hide and skins, eating away the muscles, and leaving the skeletons when cured fish are stored for long period of time

Synthetic chemical insecticides have been an important part of pest management for many years. Interest is however growing fast in the possible role of plants and minerals as traditional protectants of stored products and as alternatives to the use of highly persistent synthetic chemicals with their attendant dangers and high cost. (Nwaehujor and Olatunji, 2011). The use of synthetic insecticides was found to be toxic to humans, animals and the environments. All these problems have initiated the development of new types of selective insect-control alternatives to conventional fumigants. (Moravvej *et al.*, 2010). Abolagba *et al.* (2011) reported the toxic effect of pesticide on fish against dermestes beetles and observed that the Pesticides used, 2,2-dichlorovinyl dimethylphosphate (DDVP1000 EC), benzene hexachloride (lindane/gammalin20R) and "otapiapia", a locally mixed pesticide, at various concentrations (2%, 5%, 10% and 20%) of each pesticide applied to the fish samples, even after four weeks of exposure to atmospheric air these pesticides were still present in the fish. In order to eliminate much of the shortcomings associated with the use of synthetic insecticides and provide an effective storage techniques; in recent year, there have been increasing and concerted effort at developing plant based toxicants that are environmentally friendly. (Adesina *et al.*, 2016).

The use of plant materials for protection of field crops and stored commodities against insect's attack has a long history; Many plant species have been used traditionally where leaves, roots, twigs and flowers have been mixed with various commodities in different parts of the world for use as protectants (Dales, 1996). According to (Olufade *et al.*, 2014) 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.

Different spices and herbal plant products in the form of essential oils (EO), powders, pellets, extracts or distillates could be harnessed as potential toxicants, deterrents, anti-feedants, repellents, and fumigants for exclusion of stored-product pests, and have been used (Ukeh *et al.*, 2012).

This paper is aimed at reviewing the previous researches conducted on the use and efficacy of plant materials against dried fish beetle *Dermestes maculatus*. It will also help the fish mongers on the very possible need to use these plant materials against smoked fish insect pests during storage.

Different types of plants has been tested by various researchers and their insecticidal efficacy against the hide beetle (an insect pest of stored smoked fish) have been reported, some of these plants were listed in Table 1.

Repellency Effect

Much research has been done on the effectiveness of plant materials for the control of insect pests of stored fish products. Nowsad *et al.* (2009) worked on the effectiveness of neem, garlic and red chili against adult dermestes beetle on sun dried fish, and reported that all the three

plant extracts had repellent action on adult *Dermestes sp.* with the highest mean repellency observed in neem extract of 62.67% followed by red chili with 38.44% and garlic with 31.11%. Five plant extracts *Albizia lebbek*, *Anacardium occidentale*, *Citrullus colocynthis*, *Citrullus vulgaris* and *Khaya senegalensis* shown to have 100% repellency effects on *D. maculatus* larvae after 24 hours exposure period (Akpotu and Adebote, 2013). Roy *et al.* (2014) reported the use of herbal substance on the drying and reconstitution performance of Bombay duck, and observed that both Turmeric and Chili powders have strong repellency effects against *Dermestes* infestation. Mbaye *et al.* (2014) reported the repulsive effects of *Crataeva religiosa* (Forst.) against *Dermestes spp.* and observed that sprinkling the leaves powder of *C. religiosa* on the smoked-dried fish, shows repulsive effect of the powder by grouping of larvae and adults of *Dermestes spp.* toward the edges of the treated jar to escape the action of the powder.

Table 1: List of some plants tested and evaluated for their insecticidal properties.

s/n	Scientific Name	Common Name	Family	Part used
1	<i>Piper guineense L.</i>	Black pepper	Piperaceae	seeds
2	<i>Monodorum myristica Du.</i>	African Nut-meg Neem	Annonaceae	seeds
3	<i>Azadirachta indica A. Juss.</i> <i>Capsicum frutescens L.</i>		Meliaceae Solonaceae	Seeds/leaves
4	<i>Zingiber officinale Ros</i>	Chilli Ginger	Zingibaraceae	Fruit/seeds
5	<i>Citrus sinensis L.</i>	Orange	Rutaceae	stem
6	<i>Occimum caninum Sim.</i>		Labiataeae	peels/ Fruits
7		Sweet basil		
8	<i>Allium sativum L.</i>	Garlic	Liliaceae	Bulb/ Fruits
9	<i>Nicotiana tabacum L.</i>	Tobacco	Solanaceae	leaves
10	<i>Jatropha curcas L.</i>	Physic nut	Euphorbiaceae	Leaves, seeds bark.

Ovicidal Effects

Some plant products have been shown to possess strong ovicidal properties. For instance Okonko and Okoye, (2001) reported that no eggs were laid on the fish samples treated with 0.5, 0.75 and 1.0g *Dennetia tripetala* and *Piper guineense* powders after 7 days. This means that the extracts affected eggs production since the repulsive action of the powders prevented mating among the male and female dermestid which led to the inability of the females to lay eggs. Baba *et al.* (2015) investigated the potential of Neem plant products namely Neem Kernel Oil (N K O), Neem Kernel Powder (N K P) and Neem Leaf Powder (N L P) as protectant against Dermestid beetles (*Dermestes maculatus* Deg.) and observed that the rate of oviposition of the insects was drastically suppressed by both N K O and N K P at the rate of 1ml and 5g per 35g of dried fish.

Don-pedro, (1985) reported the toxicity of some citrus peels to *Dermestes maculatus* and observed that orange peel at high doses to suppressed progeny development of *D. maculatus*.

Fasakin and Aberejo, (2002) reported that *Piper guineense* and *Monodora myristica* powder prevented oviposition of *Dermestes maculatus*.

Larvicidal Effects

Jatau *et al.* (2014) evaluate the efficacy of five local spices namely: (*Capsicum annum*) (*Piper guineense*), (*Occimum caninum.*), (*Monodora myristica.*) and (*Zingiber officinale.*) at different application rate of the disinfected dried fish and reported that *Piper guineense* caused 100% mortality of the larvae at all the concentrations before pupation, while *Occimum caninum* gave the second best results with 50.00, 63.33 and 100% mortality while the remaining three spices resulted in less than 50% mortalities at all the rate of application.

Jose and Adesina, (2014) investigated the susceptibility of *Dermestes maculatus* (De Geer, 1774) to *Secamone afzellii* leaf powder on smoked-dried fish and showed that the plant powder caused significant larval mortality compared to the untreated fish at 24, 48, 72 and 120 h. after infestation at the rate of 1.5g, 2.0g, 2.5g and 3.0g leaf powder per 15g of dried smoked fish.

In their work on the efficacy of the plant powder of *Phyllanthus fraternus* under tropical storage condition against larvae of the leather beetle *Dermestes maculatus*. Adesina *et al.* (2014) reported that powder significantly affected the larval stages of the insects with higher mortality.

Abdel-maksoud *et al.* (2014) also reported that the chloroform extract of *Cinnamomum cassia* was the most effective at the lethal concentration 25, 50,75,90,95 and 99 levels against *Dermestes maculatus* larvae, realizing complete mortality after a period that did not exceed 16 days.

Similarly Zhang, (2012) also evaluated the efficacy of extracts from *Illicium verum* against *Dermestes maculatus*, and reported highest larval mortality of 95% 72 hour post treatment at a dose of 32/cm³.

Effects on Adults Emergence of *Dermestes maculatus*

The effect of various plant products on emergence of adults of *D.maculatus* has also been reported. Akinwumi *et al.* (2006) reported that each of the powders of *Dennetia tripetala* *Eugenia aromatica*. *Piper guineense*. and *Monodora myristica.*, effectively prevented adult emergence in fish protected against *D. maculatus* and *N. rufipes*. The suppression rate of adult emergence of *N. rufipes* and *D. maculatus* ranged between 99.60%-100% compared to 3.0-5.13% in the control. Also the powder of *Clorodendrum capitatum* was found to reduce adult emergence ranging from 28.8%-26.7% and with the highest emergence reduction percentage obtained from fish admixed with 5g plant powder 26.7%. (Adesina *et al.*, 2016).

Effects on Adults Mortality

Various findings revealed that different plant materials affected longevity and survival of adults of *D.maculatus* during storage. According to Akunne *et al.* (2014) admixture of twenty gram (20g) of *Piper guineense* seeds with 60g *Clarias gariepinus*, cause the highest mortality of 3.25-5.33 of Adult *D.maculatus*, while 10g of the seed powder yielded 4.04- 4.33 mortality rate. The effect of nutmeg powder (*Monodora myristica*) against the adult hide beetle *Dermestes maculatus* was investigated by Abdullahi *et al.*, (2010) where smoked cat fish treated with nutmeg powder at the rate of 10g/100g of smoked cat fish showed a significant effect on mortality of the dried fish beetle with 100% mortality rate within 3 days. Muftau, (2012) also

reported that treatment of *D. maculatus* with neem seed oil resulted in 100% mortality within the 10 days of infestation.

Owoade, (2008) also exposed *Dermestes maculatus* larvae to three different concentrations of *Piper guineense*, *Aframomum melegueta*, *Zingiber officinale* and *Capsicum annum*, for over 25 days. Mortalities monitored for five days showed that 100% of the beetles exposed to *P. guineense* died at the end of 24 hours, and by the end of 72 hours, 100% mortality were recorded in all three concentrations in *P. guineense* and *A. melegueta* gave the second best result (53.3%). The spices were shown to have slowed down or extended time of development of the larvae to the adult, especially at the two concentrations of 20g and 25g. Also according to Akinwumi, (2006). The efficacies of the powders of four plant materials, *Dennettia tripetala*, *Eugenia aromatic*, *Monodora myristica* and *Piper guineense* at different concentrations on smoked *Clarias gariepinus* for the control of *Dermestes maculatus* resulted in high mortality of both the adults and larvae at all concentrations when compared to the control, and was effective in inhibiting progeny development in treated fish.

Akinwumi, (2007) reported the total mortality of the adults *D. maculatus* beetles by the extracts of four plants at 7 days after treatment. (Muftau, 2002). reported 100% adult mortality rate was recorded at high doses of neem seed oil within the first 10 days. In an experiment to evaluate the insecticidal efficacy of *Piper guineense* on fish beetle (*Dermestes maculatus*), Nwogor, (2015) observed that *Piper guineense* powder at 2.0g gave mortalities of 83.33% and 76.67% for larva and adult of *D. maculatus*. (Akpako and Agbor, 2015) investigate the use of *Monodora myristica* as surface protectant against *Dermestes maculatus* on stored *Clarias gariepinus*, observed that that the plant powder at 1.5g caused 100% mortality of the beetle at 9 days after treatment, 3.0g of the plant powder caused 100% mortality at 7 days, while that of 5.0g and 10.0g caused total mortality of the insects at 5 and 6 days after treatment.

Crude oil extracts obtained from the seeds and leaves of some plants which are commonly used as spices and food condiments in the tropics namely: *Piper guineense*, *Monodora myristica*, *Aframomum melegueta*, *Tithonia diversifolia* and *Nicotina tabacum* were evaluated as protectants against different developmental stages of fish beetle (*Dermestes maculatus*) and the results showed that oil extracts from *P. guineense*, *M. myristica* and *A. meligueta* were significantly effective in killing all the adults, pupae and eggs of *D. maculatus* (Fasaki, 2003). Olayinka-Olagunju, (2014) Investigated the effects of two eco-friendly insecticides (*Dennettia tripetala* and *Piper guineense*) against *Dermestes maculatus* on smoked fish and the results showed that 94.45 Adults *D. maculatus* died at 2.00g in *D. tripetala* and also 80.89 in *P. guineense*.

Akinwumi, (2011) Investigated the efficacy of the separate mixtures of four tropical spicy and medicinal plants: *Dennettia tripetala* Baker (Pepper fruit), *Eugenia aromatica*. (Clove), *Piper guineense*. (Black pepper) and *Monodora myristica*. (African nut-meg) with household vegetable oil, He observed that each of the four oil mixed powder treatment evoked significant mortalities of the two insects compared with the control at 1, 3 and 7 days post treatment. The reason for the insecticidal potential of the plant materials may be due to the ability of either powdered, extracts or oils from the plant blocking the respiratory tracts of the insects, as such suffocate the beetles and eventually lead to death.

Conclusion

Various synthetic insecticides have been found effective in controlling dried smoked fish against infestation but were reported to have hazardous effects to humans and domestic animals. This problem led to scientist and many researchers to search for alternative insecticides. These include natural Bio pesticides from plants which are less harmful and eco-friendly. Different researchers reported that the use of plant materials are safer and can be used against insects of smoked fish over a long period of time the results obtained from the review confirmed that plant materials are effective in controlling *D. maculatus*, some of these plant materials have repellent activity while others are of ovicidal, larvicidal and mortality effect on the beetle. The findings of these researchers also revealed the effectiveness of plant materials in controlling stored product pests probably due to the presence of active compounds within the plant materials which may impair respiration of the insect pest of dried fish *D. maculatus*, there by blocking the spiracles leading to suffocation and eventually death of the insects.

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