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Research Article

Control of *C. serratus* of Stored Tamarind using some Plant Materials in Zamfara State, Nigeria

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ABSTRACT

Control of storage insect pest of *Tamarindus indica* in Zamfara State were conducted in order to suggest an appropriate control of the insect pest. Infested tamarind fruit sample was collected from all markets selected and conveyed to the laboratory for insect pest isolation, culture and specimens processing. Formulations of treatments namely garlic, ginger, clove, and lime peel powders at 1g, 2g, 3g, 4g, and 5g/100g of fruit alongside control, were evaluated for insecticidal activity on taste insect in entomology laboratory. All the treatments administered were found to be effective in controlling pests. But treatment 1 (ginger) was significantly higher 4.00g followed by clove 3.00g and garlic 2.67g P>0.05 on *Caryedon serratus*. Spices (ginger, clove, garlic, and lime peels) were found to be effective in controlling *C. serratus*, ginger was found to be more effective. the plant is accessible, affordable and therefore is recommended for use in controlling *Caryedon serratus* insect pest of stored tamarind.

Key words: Control, *Caryedon serratus*,*Tamarindus indica*

INTRODUCTION

Caryedon serratus is generally known as groundnut bruchid or groundnut borer, is a species of leaf beetle in the family Bruchidae of the order Coleoptera genus *Caryedon* species. *C. serratus* (Olivier). It is found in Africa, the Caribbean, Europe, and Northern Asia (excluding China), Oceania and South America. The species is found in many parts of tropical Asia and Africa breeding on common trees such as *Tamarindus indica L, Cassia fistula. Acacia arabica* as well as on harvested groundnut (Arnett, *et al.,* 2002). According to Sakhare *et al.* (2018), *C. serratus* is regarded as the only species that can penetrate pods to infest kernels, the losses vary from 19.0 to 60.0 percent.

Tamarindus indica (L) is a leguminous tree in the family Fabaceae it is indigenous to tropical Africa (Diallo *et al.,* 2007). The genus *Tamarindus* is a monotypic taxon, *T. indica* is known as tamarind (the trade and English name) having only a single species. It has been cultivated for so long in the Indian subcontinent and some times reported to be indigenous to India where it is known as 'tamar-i-hind' meaning date of India (Abubakar *et al.,* 2008). It grows wild in Africa as diverse as Sudan, Cameroon, Nigeria, and Tanzania. In Arabia, it is found growing wild in Oman especially Dhofar, where it grows on the sea-facing slopes of mountains. It reached South Asia likely through human transportation and cultivation by 400 BC (Raghavan, 2006). *T. indica* is widely distributed throughout the tropical belt, from Africa to South Asia, Northern Australia, and throughout Oceania Southeast (Asia, Taiwan, and China) (Julia, 1987).

Pavela (2009), defined botanical pesticides as an important group of naturally occurring, often slow-acting crop protectants that are usually safer in humans and the environment than conventional pesticides and with minimal residual effect. These pesticides contain mixtures of biologically active substances, with no resistance in pests and pathogens. Therefore, the use of the plant as pesticides has been recommended evermore as a suitable alternative of plants protection with minimum negative risk (Isman, 2006; Pavela, 2007).

Stored products of agricultural and animal origin are attacked by more than 600 species of beetle pests, 70 species of moths and about 355 species of mites causing qualitative and quantitative losses (Rejendran, 2002).

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Post-harvest losses are recognized as major constraints in Africa, with storage damage some times as high as 40% (Stevenson, 2014). Storage pests are organisms that cause economic and/or nutritional damage to stored produce through their breeding activities. However, some of the insect pests do not breed on the product but their presence in the store becomes harmful as they generate filth, noxious smell and general contamination such as hair debris, excreta, and other waste products (Onu and Ikechi, 2015; Lucia and Assennato, 1994). Postharvest loss is defined as degradation in both the quality and quantity of food products from harvest to consumption. Quality losses include those that affect the nutritive and caloric component, the acceptability, and the edibility of a given product. These losses are more common in developed countries (Kadder, 2002).

Tamarind is economically valuable and multipurpose; almost every part of the tree is useful, but the tree is best known for its fruit, and the marketability of tamarind fruit has increased consistently (Elsiddiq *et al*., 2006). In Nigeria, particularly in northern parts inhabited by the Hausa-Fulani tribes where it is known as "*Tsamiya*" the pulp is used as a sweetener in sorghum and millet porridge (Jimoh and Onabanjo, 2012). *Tamarindus indica* possesses great potential to address various nutritional, health, socioeconomic and environmental constraints (Ebifa *et al.*, 2017). The continued demand for tamarind fruit both for domestic and industrial usage is hampered by deforestation and the incidence of storage pests affecting the quality and quantity of tamarind fruit. Hence, this research is worthwhile in addressing the knowledge gap concerning the control of insect pests of tamarind fruit in storage which can improve availability and quality for meeting the continued demand of tamarind. It is noteworthy that the research will evaluate the efficacy of some plant materials on the *C. serratus* under ambient condition, suggest an appropriate control strategy for the pest.

MATERIALS AND METHODS

The study area

The study area is Zamfara State located in Northwestern Nigeria and occupies 39,762 square kilometers (National Bureau for Statistics, 2010). Zamfara state shares borders with Sokoto State and Niger Republic in the north, Katsina State in the east while Kaduna, Niger and Kebbi States to the south (Zhigila *et al*., 2016). It lies within the latitude $12^0\ 10^1\ 00$ N and longitude $6^0\ 15^1\ 00$ E. According to N.B.S (2010), the State has an estimated population of 3,278,873 (National Population Commission, 2006). Zamfara state is mainly populated by Hausa and Fulani people, with few Gwari, kumuku, Kambari, Dukawa Bussawa, and Zabarmawa ethnic communities. Other tribes include the Igbo, Yoruba, Kanuri, Nupe, and Tiv. The State is basically an agricultural state with over 80 percent of the people engaged in various forms of agriculture. Major agricultural products include millet, guinea corn, maize, rice groundnut, cotton, tobacco, and beans.

The climate of Zamfara according to Garba and Dalhatu (2015) is characterized by two climatic seasons; dry season which lasted from (November to April) and the rainy season which commences from May and ends in October. It also has mono-modal rainfall with an annual mean of 1000 mm. The temperature of the area is tropically warm rising up to 38^0C (Zhigilla *et al*., 2016). The relative humidity is below 70% (Odjugo, 2010). The vegetation of the area falls under the Sudan savanna agro-ecological zone. According to Garba and Dalhatu (2015), consist of short grass forming a matrix for thorny shrubs and scrubs.

Bioassay

Fresh uninfested tamarind sample was also sourced from the market and kept in refrigerator for 72hour to ensure the fruit is free from any infestation, air-dried to prevent mold. This tamarind fruit was then divided and put into 500ml glass jars, adult *C. serratus* male and female 3 pairs from identified insect pests were released into glass jars containing tamarind and cover with muslin cloth tied with rubber bands and kept in the Entomology laboratory under ambient condition to observed oviposition and further developmental stages. Eggs were found attached on the surface of the fruits thereafter, hatched to lavae by boring the fruit and feed on the kernel. A culture of pupa was maintained by removing parent's stock from the glass jars containing tamarind with forceps to give room for the emergence of even-aged adult *C serratus* for bioassay.

Laboratory bioassay using plant powder (garlic, ginger, clove and lime peel) to taste for insecticidal activity on isolated and identified storage tamarind insect pest was carried out as treatments. The consideration for the use of powder from such plants is that they are considered as effective against some pests, easily biodegradable, safe for consumers and in pest control operation as they minimized pesticide residue and above all, they are less expensive than synthetic pesticides (Shadia, 2011). The experimental layout was done in the Entomology laboratory Biological science Department Usmanu Danfodiyo University Sokoto. Each plant materials were sourced locally from the market and identified before separately air-dried, crushed to powder and then sieve using 2mm mesh size. The powdered materials were kept in polythene bags until required. Samples of clean uninfested tamarind fruit were obtained and placed in a freezer for 72 hours to disinfect any unnoticed prior infestation by cooling. The fruit was then air-dried to avoid moldiness and then divided into 100g, each placed in 50ml glass jars (Kohler and Triebskorn, 2013). Each of the jar containing the fruit was treated with 1g powder of garlic in three replications while the last jar containing 100g of fruit will be maintained as control. The same procedure was followed for increasing the dosage of garlic to 2g, 3g, 4g, and 5g using an electric digital weighing balance to measure both tamarind fruit and treatment powder (Malgwi and Oaya, 2014). Containers with the contents of plant powder were shaken gently to ensure a thorough mixture of treatment powder with tamarind fruit and 3 pairs of adult *Caryedon serratus* was introduced to each glass jar and covered with muslin cloth in line with (Onu and Ikechi, 2015). A similar procedure was followed when using ginger, clove and lime peel as treatments. Insect mortality was recorded at 24 hours intervals from the time of exposure (Simon, 2008). The treatments were set up in the Entomology laboratory under ambient temperature.

Data collection

Treatments namely, garlic, ginger, clove, and lime peels were laid in entomology laboratory, insect mortality

was observed and recorded for a 24hours interval (24hours, 48hours and 72hour) respectively by visual observation.

Data analysis

Data were analyzed using inferential statistics, probit regression and one-way analysis ANOVA, mean separation using Duncan multiple range test at 5% level of significance. Probit regression was calculated using the regression equation.

$Y = a + b X + e$
Where
a = y intercept
b = the slope of the line
e = error term

RESULTS

Efficacy of some plant materials on the *C. serratus* under ambient condition

Ginger gave a highest LD_{50} (5.130g) at 24 hours of application with LCL of 3.766g, UCL of 11.504g and LD_{90} (10.988g), LCL of 7.444g UCL of 32.085g respectively. The least LD_{50} of 2.849g, LCL of 1.578g UCL of 4.562g and LD_{90} of 8.628g LCL of 6.072g and UCL 20.447g at 72 hours after application as indicated in the table below.

Table 1 revealed that, LD_{50} is higher 4.408g with LCL of 3.384g UCL of 7.199g and LD_{90} 9.237g LCL of 6.715g, UCL 20.447g at 24 hours after application of treatment with least LD_{50} of 1.531g, LCL 1.776g and UCL of 2.097g and LD_{90} of 4.190g LCL of 3.446g, UCL of 5.582g at 72hours of initial application. Table 1 below showed that treatment 3 has the highest LD_{50} of 9.304g, LD_{90} of 17.356g at 24 hours after application and least LD_{50} of 7.246g and LD_{90} at 72hours of application. Result on Table 1 indicated a high LD_{50} of 9.047g and LD_{90} of 19.796g at 48hours after application and least LD_{50} of 5.164g, LCL of 3.585g UCL of 18.103g and LD_{90} of 12.296g LCL of 7.806g UCL of 60.900g as shown below.

Mortality of *C. serratus* Treated with Different Plants Powder Maintained at 24 – 72hours Interval.

Table 2 the result shows a significant ($P<0.05$) difference between treatments means. Treatment 1 has the highest significance ($P<0.05$) 4.00, 48hours after application. The least treatment mean was observed on treatment 4, at 2g in 24hours and 1g 72hours after application and treatment 3, at 3g, 4g 74hours after application.

DISCUSSION

Results of laboratory analysis of the botanicals used presently; Ginger, Garlic, Lime peel, and Clove powders as protectants for stored tamarind on *C. serratus* revealed that all the botanicals are effective in managing the pest. However, Ginger powder was observed to be more effective at 4.00g than the other treatments. Ginger applies for 48hours gave the best control of the insect pest. This plant material is affordable, accessible, and non-toxic to the environment with no residual effect. This is in line with findings on the effectiveness of botanicals as protectants on *C. serratus* as observed by Isman (2006) and Pavela (2007). These authors defined botanicals as pesticides containing mixtures of biologically active substances, with no recorded resistance in pests and pathogens. Therefore, the use of plant parts or products as pesticides has been recommended as a suitable alternative of plant protection with minimum negative risk.

Rajendra and Sriranjini (2008) reported that Garlic (*Allium sativum*) is widely known for its antimicrobial potentials. Garlic extract (oil and powder) contains active components, such as Amino acid called allicin and enzymes called allinase. These compounds are antibiotics, which are effective against some range of bacterial and fungal species and have been useful in food and storage to inhibit fungal activities. In addition to that, garlic extract also has insecticidal properties and shows considerable toxicity to a number of pest species across all life stages. Agawal *et al.* (1988) revealed that, sundried orange fruit peels and grapefruit are effective against adults of *Callosobruchus maculatus* and *Dermestes maculatus* and the $L.D_{50}$s of orange and grape peels admixed with cowpea grains on adult of *C. maculatus* were found to be 4.00g (orange peel) /100g of cowpea and 5.62g (grape peel) /100g cowpea respectively. Orange fruit peel at higher doses is also shown to depress progeny development of *D. maculatus*. Orange peel was used in Nigeria for the purpose of grain storage, 18g of powder is enough for 1kg of pulse

Table 1: Efficacy of Some Plant materials on the *C. serratus* Under Ambient Condition

Treatment	Exposure Period (hour)	LD_{50}	LCL	UCL	LD_{90}	LCL	UCL
Gingiber officinalle							
	24	5.13±0.08	3.77	11.50	10.99	7.44	32.09
	48	3.39±0.07	1.79	9.75	11.01	7.00	65.25
	72	2.85±0.07	1.58	4.56	8.63	6.07	20.45
Syzygium aromaticum							
	24	4.41±0.08	3.38	7.20	9.24	6.72	18.83
	48	2.28±0.07	1.33	3.10	6.24	4.89	9.71
	74	1.53±0.09	0.78	2.01	4.19	3.45	5.58
Allium sativum							
	24	9.30±0.09	-	-	17.36	-	-
	48	8.13±0.08	-	-	16.55	-	-
	72	7.25±0.07	-	-	17.83	-	-
Citrus aurantiifolia							
	24	6.99±0.12	5.26	18.18	10.94	7.62	34.25
	48	9.05±0.08	-	-	19.71	-	-
	72	5.16±0.07	3.59	18.10	12.21	7.81	60.90

LD_{50}= lethal dose 50, LCL= lower concentration level, UCL= upper concentration level, LD_{90}= lethal dose 90. Treatment 1= Ginger, Treatment 2= Clove, Treatment 3= Garlic, Treatment 4= Lime peel.

Table 2: Mortality of *C. serratus* Treated with Different Plants Powder Maintained at 24 - 72hours Interval.

Treatments	Concentration (g)	Mortality 24hrs	Mortality 48hrs	Mortality 72hrs
G. officinalle	1g	1.67^{cde}	3.00^{ab}	3.00^{abcd}
	2g	2.00^{bcd}	3.00^{ab}	3.00^{abcd}
	3g	2.00^{bcd}	2.67^{abc}	2.67^{bcde}
	4g	2.50^{abc}	3.67^{a}	4.00^{a}
	5g	2.33^{abcd}	3.00^{ab}	3.67^{ab}
S. aromaticum	1g	2.00^{bcd}	2.33^{bcd}	3.33^{abc}
	2g	1.33^{cdef}	3.00^{ab}	3.33^{abc}
	3g	3.00^{ab}	3.00^{ab}	3.00^{ab}
	4g	2.00^{bcd}	2.00^{bcd}	2.00^{bcd}
	5g	3.33^{a}	3.33^{a}	3.33^{a}
A. sativum	1g	1.00^{def}	1.00^{ef}	2.00^{de}
	2g	1.33^{cdef}	1.67^{cdef}	2.33^{cde}
	3g	0.33^{ef}	1.00^{ef}	1.67^{e}
	4g	1.00^{def}	1.33^{def}	1.67^{e}
	5g	1.67^{cde}	2.00^{bcde}	2.33^{cde}
C. aurantiifolia	1g	0.00^{f}	1.33^{def}	1.67^{e}
	2g	0.33^{e}	1.33^{def}	2.00^{de}
	3g	1.00^{def}	1.00^{ef}	2.00^{de}
	4g	1.33^{cdef}	1.67^{cdef}	2.67^{bcde}
	5g	1.00^{def}	2.00^{bcde}	2.67^{bcde}
Control	0g	0.00^{f}	0.58^{f}	0.58^{f}

Means followed by the same letter(s) along the same rows are statistically same ($P<0.05$).

to control pulse beetle. The result is also in line with study conducted by Sagarka *et al.* (2017) on the repellent effect of various botanicals such as; chilli powder, garlic powder, dhatura leaf powder, custard apple leaf powder, ginger powder, black pepper powder and mint leaf powder as repellants against *C. serratus* on groundnut seed. The result indicated that 5g of black pepper powder per 50g of groundnut seed has the highest repellency effect with 90.35 percent, custard apple leaf powder (86.53) and garlic powder (84.50) percent repellence effect on *C. serratus* adults respectively. Also, among four botanicals (the root of papaya, turmeric rhizome, clove, and pepper) tested for adult mortality as protectants of stored grains pest, clove powder was the most effective for adult mortality of storage grains (Said and Pashte, 2015).

Conclusions

Caryedon serratus infest tamarind in storage which the consequence is the destruction of quality of the fruit rendering it unfit for consumption. At a certain stage, it may be difficult to prevent the insect from infesting the tamarind in storage. However, the plant produce namely Ginger, Garlic, Clove, and Lime peel powders were evaluated for insecticidal activity and found to be effective on the *C. serratus*. But ginger powder was found to be most effective in controlling *C. serratus* insect pest on stored tamarind; they are effective with minimum negative risk in controlling *C. serratus*

REFERENCES

Abubakar, M., Ukwuani, A., and Shehu, R. 2008. Physiochemical screening and Antibacterial Activity of *Tamarindus indica* Pulp Extract. Asian J of Biochem 2, 134-138.

Arnett, R., Thomas, M., Skelly, P., and Frank, j. 2002. American Beetles. America: 2nd edition. CRC Press . pp 880.

Agawal, A., Sonelal, A., and Gupta, K.C 1988. Natural Products as Protectants of Pulses Against Pulse Beetle. Bulletin of Grain Technology 26: 145-164.

Diallo, B., Jolly, H., Mckey, D., and Chevallier, H. 2007. Genetic Diversity of *Tamarindus indica* Populations: Any Clues on The Origin From its Distribution. J of Biotech, 7, 1-7.

Ebifa Othieno, E., Mugisha, A., Nyeko, P., and David Kabasa, J. 2017. Knowledge, Attitudes, and Practices in Tamarind (*Tamarindus indica*) Use and Conservation in Eastern Uganda. J of Ethnobiology and Ethnomedicine, 13(1) 5.

Elsiddiq, k., Gunasena, H., Prasad, B., and Ramana, K. 2006. *Tamarindus indica L.* England: Sussex. pp 188.

Garba, J., and Dalhatu, S. 2015. Soil Erosion Constraints to Sustainable Crop Production in Central Senatorial District of Zamfara, North-Western Nigeria. J of Soil Sci and Environmental Management, 3, 42-50.

Isman, M.B. 2006. The Role of Botanical Insecticides, Deterrents, and Repellents in Modern Agriculture and an Increasing Regulated World. Annual Review of Entomology, 51: 45-66.

Jimoh, S., and Onabanjo, O. 2012. Potentials of *Tamarindus indica* (Linn) in Jam Production. Journal of Agriculture and Social Research, 12, 1-15.

Julia, F. 1987. Fruits of Warm Climate. Wipf and Stock Publishers. pp 550.

Kadder, A. A. 2002. Postharvest Technology of Horticultural Crops. Califonia: 3rd Edition.Oakland Publication. pp 535.

Kohler, H., and Triebskorn, R. 2013. Wildlife Ecotoxicology of Pesticides: Can we Track Effects to Population-Level and Beyond *Science*, 341, 759-765.

Lucia, M., and Assennato, D. 1994. Post Harvest Operation and Management of Food Grains. Retrieved May 5, 2018, from http:/www.fao.org/docrep/t0522e/t0522e04.htm

Malgwi, A.M., and Oaya, C.S. 2014. Toward Achieving Pest Management for Control of the Groundnut Bruchid (*Caryedon serratus Olivier*) On Stored Grandnut and Tamarind in Yola, Nigeria. Global J of Bio, Agr and Health Sci.3 (2) 96-104.

N, P. C. 2006. National population commission. Census data.

N.B.S. 2010. Annual Abstract of Statistic. Nigeria: National Bureau of Statistics.

Odjugo, P. A. 2010. Adaptation to Climate Change in Agricultural Sector in Semi-arid Region of Nigeria. 2nd Internatinal Comference: Climate Sustainability and Development in Semi-arid Region. Fortaleza-Caera, Brazil. pp. 1-14.

Onu, F., and Ikechi, M. 2015. Effectiveness of Neem and Garlic extract in the control of storage pest of Cereal grains. Researchgate, 1-16.

Oaya, C.S., Malgwi, A.M., and Samaila, A.E 2012. Damage Potential and Loss Caused by Groundnut Bruchid *Caryedon serratus Olivier* (Coleoptera: Bruchidae) On Stored Groundnut and Tamarind in Yola. J of Agric and Vet Sci 1(6) 58-62.

Pavela, R. 2007. Possibilities of Botanical Insecticide Exploitation in plant Protection. Pest Technology, 1: 47-52.

Pavela, R. 2009. Effectiveness of Some Botanical Insecticides against *Spodoptera littoralis* Boisduval (Lepidoptera: Noctuidae), *Myzus persicae Sulzer*.

Raghavan, S. 2006. Hand Book of Spices, Seasoning, and Flavoring 2nd Edition. CRC press. pp 30.

Rajendra, S. 2002. Postharvest Pest Losses. In: Pimentel. Encyclopedia of Pest Management. Mercel Dekker, Inc. New York. 654-656.

Rajendra, S., and Sriranjini, V. (2008). Plant products as fumigants for stored-product insect control. J of Stored Product Research 44,126-135.

Sagarka, N.B., Acharya, M.F., Patel, S.R and Dulera Jyoti. 2017. Response of *Caryedon serratus* (Bruchidae: Coleoptera) Towards Various Botanicals and Host. International J of Plants and Soil Sci.18 (4) 1-9.

Said, P.P, and Pashte, V.V 2015. Botanicals: The protectants of Stored Grains Pest, Trends in Bioscience. J of Bangladesh Agricultural University, 7(1) 3751-3755.

Shadia, E. 2011. Control Strategies for Stored Product Pests. J of Entomology, *8*, 101-122.

Scholler, M, and Flinn, P.W. 2000. Parasitoids and predators. Alternatives to pesticides in stored product IIPM.Springer, 229-271.

Siddhuraju, P. 2007. Antioxidant Activity of Polyphenolic Compounds Extracted from Defatted Raw and Dry Heated *Tamarindus indica* seed coat. Food Science and Technology, 40, 982-990.

Simon, J. Y. 2008. Toxicology and Biochemistry of Insecticides. 2nd Edition CRC press. pp 380

Scholler, M., Flinn, P.W., Grieshop, M.J., and Zdarkowa, E., 2006. Biological Control of Stored- Product Pests. Insect management for food storage and processing, 67-87.

Stevenson, P. 2014. Royal Botanic Gardens. *Kew Publisher*. Retrieved Aug 25, 2018, from http://www.kew.org/discover/blogs/using-pesticidal-plants-crop-protection.

Tamale, E., Jones, N., and Pswarayi-Riddihough, I. 1995. Technologies Related to Participatory Forestry in Tropical and Subtropical Countries. Word Bank Publication.

Tayede, P., Borde, S., and Jagtap, S. 2010. Effect of *Tamarindus indica* Linn. Against Isolated Goat Tracheal and Guinea Pig Ileum Preparation. International Journal OF Comprehensive pharmacy, *2*.

Yusuf, S.R., Ado, R.A., Sule, H., and Wudil, B.S. 2019. Infestation and Damage by *Caryedon serratus* (Olivier) Weevil on Stored *Tamarindus indica* (Linneaus) Fruits in Kano State, Nigeria. Asian Journal of Advanced Research and Reports,5(3):1-10.

Zhigila, A., Cleophas, B., Sawa, B., Sulaiman, D., and Chidibere, C. 2016. Plants Species Diversity, Abundance, and Distribution in Communities of Zamfara State, Nigeria: Implication for Conservation. Researchgate publication.. 92-98.