PRINT ISSN 1119-8362
Electronic ISSN 1119-8362

Full-text Available Online at
https://www.ajol.info/index.php/jasem
http://ww.bioline.org.br/ja

J. Appl. Sci. Environ. Manage.
Vol. 25 (2) 257-260 February 2021

Anti-reproductive efficacy of *Adansonia digitata* Powder against *Dinoderus porcellus* Associated with Yam Chips Spoilage in Jos Metropolis, Nigeria

***JOHN, WC; RICHARD, K; ISHAYA, M; OLORI-OKE, O; KYAHARLE, BS; CHOMINI, MS**

Federal College of Forestry, Jos, Plateau State, Nigeria.
**Corresponding Author: Email: jwaltee@gmail.com; Tel: +2348064487369*

ABSTRACT: This study assessed the reproduction inhibition effects of *Adansonai digitata* plant part powders against *D. porcellus* affecting yam chips. Reproduction of adults *D. porcellus* were monitored with various doses of *Adansonai digitata* plant part powders and untreated yam chips as negative control (0 g). The finding of the research indicated that all treatments exhibited anti-reproduction potential and strong inhibition of *D. porcellus* emergence. The result of analysis of variance showed significant difference between the treated samples and the control (untreated) after 37 days. *Adansonai digitata* stem bark powders (10 g) was able to achieve no reproduction (0.00) after 37 days exposure. Based on this results, combining yam chips with 10 g of Adansonai digitata stem bark powders could ensure adequate management of *D. porcellus* destroying yam chips and yam tubers as a whole.

DOI: https://dx.doi.org/10.4314/jasem.v25i2.19

Dates: Received: 12 December 2020; Revised: 26 January 2021; Accepted: 12 February 2021

Keywords: Adansonai digitata, *D. porcellus,* yam chips, Stem bark powder, Leaf powder

In the last decade, the challenges of insect pest infestation is evolving and has led to serious food shortages. To mitigate these, efforts are geared towards alternative to synthetic pesticides which has been implicated in several health hazards due to their toxicity and recalcitrant nature (Hikal *et al.,* 2017). *Adansonia digitata* L offers the potentials for biopesticide against insect pest control through it phytochemicals which has medicinal properties (Zagga *et al.,* 2018). *Adansonia digitata* also known as Baobab is called the tree of life in Africa due to it several traditional functions (Sanchez et al., 2011). The plant parts provide food, clothing and numerous medicinal benefits such as anti-inflammatory, antioxidant, analgesic, anti-dysentery anti-diarrhea activity in many developing countries like Nigeria (Zagga *et al.,* 2018). Yam and yam products constitute more than 80% of the total carbohydrate consumption in Nigeria (Loko *et al.,* 2019). Among the yam species, *D. rotundata* (white yam), *D. alata* (water yam) and *D. cayenesis*, (yellow or guinea yam) are the most produced and consumed in Nigeria (Amusa et *al.,* 2003). They are generally accepted by Nigerians irrespective of sociocultural differences. Yam plays a major role in the livelihood of most human beings in developing nations. Its cultivation and marketing provides jobs and sources of foreign exchange for millions of people in producing countries (Waziri et al., 2016).

The high water content of yam tubers makes it vulnerable to attack (Osunde and Orhevba, 2009), leading to 85 % postharvest losses (Umogbai, 2013). To prevent storage losses, yam tubers are sliced, precooked and sun dried making it adequate for preservation and use during scarcity. However, yam chips infestation by *Dinoderus porcellus* and other pests causes huge damages by transforming the chips in powder (Babarinde *et al.,* 2013). Studies by Adesuyi (1979); Osuji (1980); Babarinde *et al*. (2013) and Loko *et al*. (2019) implicated *D. porcellus* as the major dominant and dangerous postharvest pest of yam chips. Based on this, the study is focused on the efficacy of *Adansonia digitata* against *Dinodurus porcellus* affecting yam in Jos metropolis.

MATERIALS AND METHODS

Sample Collection and Identification: The leaf and stem bark of *Adansonia digitata* were collected in Federal College of Forestry Jos, Plateau state Nigeria. Fresh leaves and stem bark of *Adansonia digitata* were collected in clean polythene bag, identification and authentication was done at the Herbarium of Federal College of Forestry Jos. Infested and healthy tubers of white yam *(Dioscorea rotundata*) were collected in a sterile polythene bag from Yam market, Gangare, Jos. Isolated insect pests from the infected yam chips were

**Corresponding Author: Email: jwaltee@gmail.com; Tel: +2348064487369*

identified using insects atlas at Entomology Laboratory of Federal College of Forestry Jos.

Preparation of Adansonia digitata Powder: Leaf and stem bark of *Adansonia digitata* collected were washed under running water and dried under shade. Fine powders of the plant parts were grinding separately using pestle and mortar. Finally, the resultant powders were sieved to obtain fine particles (Loko et al., 2017). The fine powder were package in separate clean black polythene bags and kept dry place in the laboratory.

Yam Chips Processing: The procedure of Babajide *et al*. (2006) was followed. Unwanted element on the yam tuber surfaces were remove by washing under running tape water. The tubers were peeled and cut into slices. Pre-cooking was done for 2 hours at temperature of 50°C using water bath. Maceration of yam chips was also done for 24 hours to enhance softening. This was followed by straining and drying in hot air oven at 60°C for 72 hours. The samples were decontaminated at 105°C for 2 hours to destroy unseen insects and their eggs and exposed on the bench for 1hour, after which storing in polythene bags was done aseptically.

Dinoderus Porcellus Culture: The collected *Dinoderus porcellus* from infested yam were reintroduced and feed on healthy yam chips in a plastic container as described by Onzo et al. (2015). The container was covered with a muslin cloth, to provide enough aeration and keep insects under check. After three weeks of exposure, emerging adult beetles were removed from the culture containers and used for the experiments.

Test for Anti-Reproduction Activity of Adansonia Digitata: Yam chips (50 g) contained in plastic bowls were mixed with different grams (5g, 10g and 15g) of powders of each plant parts. The untreated yam chips were used as negative control. Twenty newly emerged adults of *Dinoderus porcellus* (both sex) were introduced into each experimental containers. The adult's insects were allowed to lay eggs before being removed. After 21 days of exposure, emerging adults were counted and collected at two days intervals. Counting continued until 37 days after the beginning of the set up.

Experimental Design: The 4 treatments including control were arranged in a Completely Randomized Design CRD with each treatment replicated three times.

Data Analysis: Data collected was analyzed using analysis of variance (ANOVA) to check for significant difference between the different treatments at 5% significant difference. The means was separated using Duncan test.

RESULTS AND DISCUSSION

The results on Table 1 revealed the mean effects of different doses of *Adansonia digitata* leaf on *D. porcellus* reproduction ability after 37 days of exposure. The leaf powder of *Adansonia digitata* showed significantly different from those of the control after 37 ($p \leq 0.05$). Also, the efficacy of the treatments indicated there was significant difference between the various doses use at $p \leq 0.05$. Increase in dosage level and extended exposure days led to increase in reproduction inhibition. Maximum *D. porcellus* reproduction inhibition mean value of 0.33 was observed using 15 g *Adansonia digitata* leaf powder after 25 days.

The control (untreated) exhibited least reproduction inhibition mean value of 7.33 when compared with the treated after 37 days of exposure to leaf powder of the plant. This implies that the phytochemical constituents of the plant part used inhibited the reproduction ability of the insects introduced (Ogbaga *et al.*, 2017). The study supported finding of Krishnappa *et al*. (2012) who demonstrated *A. digitata* larvicidal and repellent potential against mosquito larvae. Table 2 showed mean effects of *A. digitata* stem-bark powder on reproduction potential of *D. porcellus* after 37 days of exposure. The *p* value indicated there was significant difference ($p \geq 0.05$) between the treated yam chips and the control (untreated). A 5 g dose of *A. digitata* stem-bark powder exhibited higher reproduction inhibition value of 2.00 compared to the 0 g (control) which gave 5.33 after 37 days (Table 2).

The reproduction inhibition potential of 10 g stem bark powder of *Adansonia digitata* resulted in no emergence of *D. porcellus* adult after 37 days exposure. According to Estelle et al. (2018) the reproduction defect exhibited by the adult insects may be attributed to physiological and behavioral mutation due to contact with the botanical. Also, the incident may affect oviposition of *D. porcellus* (Kedia *et al.*, 2015). The results of mean synergetic effects of *A. digitata* leaf and stem bark powders on reproduction potential of *D. porcellus* at different day's interval on Table 3 continued the trend. The *p* value indicated there was significant difference ($p \geq 0.05$) between the treated yam chips and the control (0 g).

Table 1: Mean effects of *A. digitata* leaf powder on reproduction potential of *D. porcellus* at different day's interval

Treatment	REPRODUCTION POTENTIAL								
	Day 21	Day 23	Day 25	Day 27	Day 29	Day 31	Day 33	Day 35	Day 37
5g	0.33^{a}	1.33^{ab}	2.00^{a}	2.00^{ab}	2.00^{ab}	2.33^{ab}	2.67^{ab}	2.67^{b}	3.67^{b}
10g	0.67^{a}	1.00^{ab}	0.67^{b}	1.00^{bc}	1.00^{b}	1.33^{bc}	1.33^{bc}	1.33^{bc}	1.33^{c}
15g	0.00^{a}	0.00^{b}	0.33^{b}	0.33^{c}	0.33^{b}	0.33^{c}	0.33^{c}	0.33^{c}	0.33^{c}
0g	1.00^{a}	2.00^{a}	2.33^{a}	2.67^{a}	3.33^{a}	4.00^{a}	4.33^{a}	5.67^{a}	7.33^{a}
SE	0.37	0.53	0.41	0.47	0.55	0.58	0.53	0.44	0.33

Means on the same column with the same superscript do not differ significantly from each other (P = 0.05). Where: SE = Standard error

Table 2: Mean effects of *A. digitata* stem-bark powder on reproduction potential of *D. porcellus* at different day's interval.

Treatment	REPRODUCTION POTENTIAL								
	Day 21	Day 23	Day 25	Day 27	Day 29	Day 31	Day 33	Day 35	Day 37
5g	0.33^{a}	0.67^{ab}	0.67^{ab}	1.00^{ab}	1.67^{ab}	2.00^{ab}	2.00^{b}	2.00^{b}	2.00^{b}
10g	0.00^{a}	0.00^{b}	0.00^{b}	0.00^{b}	0.00^{b}	0.00^{b}	0.00^{c}	0.00^{c}	0.00^{c}
15g	0.00^{a}	0.00^{b}	0.00^{b}	0.00^{b}	0.00^{b}	0.00^{b}	0.00^{c}	0.00^{c}	0.00^{c}
0g	0.67^{a}	1.33^{a}	2.00^{a}	2.33^{a}	3.33^{a}	3.33^{a}	4.00^{a}	4.67^{a}	5.33^{a}
SE	0.24	0.37	0.44	0.67	0.75	0.67	0.58	0.53	0.53

Means on the same column with the same superscript do not differ significantly from each other (P = 0.05). Where: SE = Standard error

Table 3: Mean synergetic effects of *A. digitata* leaf and stem bark powders on reproduction potential of *D. porcellus* at different day's interval

Treatment	REPRODUCTION POTENTIAL								
	Day 21	Day 23	Day 25	Day 27	Day 29	Day 31	Day 33	Day 35	Day 37
5g	0.67^{a}	1.00^{ab}	1.67^{ab}	2.00^{ab}	2.00^{ab}	2.00^{ab}	2.00^{b}	2.00^{b}	2.33^{b}
10g	0.00^{a}	0.33^{b}	0.33^{b}	0.67^{b}	0.67^{ab}	0.67^{b}	0.67^{b}	0.67^{b}	0.67^{b}
15g	0.00^{a}	0.00^{b}	0.33^{b}	0.33^{b}	0.33^{b}	0.33^{b}	0.33^{b}	0.33^{b}	0.33^{b}
0g	0.67^{a}	1.67^{a}	2.33^{a}	2.67^{a}	3.00^{a}	4.33^{a}	5.33^{a}	6.33^{a}	7.67^{a}
SE	0.67	0.37	0.44	0.58	0.69	0.82	0.58	0.76	0.73

Means on the same column with the same superscript do not differ significantly from each other (P = 0.05). Where: SE = Standard error.

Table 4: Mean comparative effects of *A. digitata* leaves powder; stem-bark powder and leaves powder + stem-bark powder on reproduction potential of *D. porcellus* at dosages after 37 days

Dosage	Stem bark	Leaf	SB+L	SE
5.0g	2.00^{b}	3.37^{a}	2.33^{b}	0.53
10.0g	0.00^{c}	1.30^{a}	0.67^{b}	0.32
15.0g	0.00^{b}	0.33^{a}	0.33^{a}	0.27
0.0g	5.33^{a}	7.33^{b}	7.33^{b}	0.73

Means on the same roll with the same superscript do not differ significantly from each other (P = 0.05). Where: SE = Standard error, SE+L=Stem bark + leaf.

The result of mean comparative effects of different parts of *A. digitata* on Table 4 showed that the stem back had the highest effect on adult *D. porcellus* reproduction when compared with leaf and combination of stem bark and leaf powders at different dosage. Ten gram (10 g) dose of *A. digitata* stem bark powder gave highest reproduction inhibition value of 0.00, no new adults of *A. digitata* emerged after 37 days when yam chips were treated with 10 g stem bark powder. The study of Mussa *et al*. (2018) indicated that variation in various plant parts activities is due to differences in phytochemical and mineral content. This finding is similar to the work of Datsugwai and Yusuf (2017) which revealed methanolic leaf and stem bark extract inhibited the growth of *S. aureus* and *E. coli*. The activity of the various plant parts on the insect reproductions could be related to their ovicidal and larvicidal properties, which inhibited the hatching of eggs and development of larvae into adults (Jadhav and Jadhav, 1984; Estelle et al., 2018)

Conclusion: The finding of this study revealed the reproduction inhibition activity of leaf, stem bark and leaf + stem bark powders of *Adansonia digitata* at various doses used were positive. Hence, beetle attack on yam chips can be controlled by application of *Adansonia digitata* powder, this will increase yam product productions and shelve life thereby ensuring food security and aff ecting market value of yam chips positively. However, further research is needed to unveil the mechanism of action of *Adansonia digitata*.

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