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Potential of Sodom apple [*Calotropis procera* (Aiton) W.T.Aiton] leaf powder for the control of Cowpea weevil [*Callosobruchus maculatus* (Fabricius, 1775)] infestation on Stored cowpea [*Vigna unguiculata* (L.) Walp.] seeds

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ABSTRACT

A study was carried in the Laboratory of the Department of Agronomy, Faculty of Agriculture, Federal University of Kashere to determine the potential of Sodom apple (*Calotropis procera*) in the control of Cowpea weevil (*Callosobruchus maculatus*) on Stored cowpea (*Vigna unguiculata*). Cowpea weevils were collected from infested cowpea seeds, which was purchased at food stores and open market in Kashere town. Fresh leaves of Sodom apple were collected in and around Kashere town; these were washed and chopped into pieces to facilitate drying and were dried in a well-ventilated area and under shade for 4 weeks. The dried botanical samples were ground into powder using wooden mortar and pestle and sieved using a wire mesh. The experiment consisted of four treatments and were replicated 3 times: T1 = control which included cowpea seeds and cowpea weevil, T2 = which consisted of the 2g powdered of Sodom apple, cowpea seeds and cowpea weevil, T3 = which consisted of the 4g powdered of Sodom apple, cowpea seeds and cowpea weevil and T4 = which consisted of the 6g powdered of Sodom apple, cowpea seeds and cowpea weevil. The experimental design used was Completely Randomized Design (CRD) replicated four times. Data was collected on adult mortality, number of holes of cowpea seeds, and weight loss of cowpea seeds. It was observed that Kannanado and the 6g of Sodom apple leaf powder caused significantly ($p \leq 0.05$) higher mortality in cowpea weevil than the other varieties and Sodom apple powder rates. Similarly, there significant ($p \leq 0.05$) difference in cowpea seed damage (emergence holes) across all levels of Sodom apple and varieties. Conversely, there was no significant ($p > 0.05$) difference in cowpea seed weight loss irrespective of variety and Sodom apple level, underscoring the protective nature of Sodom apple to cowpea from being damaged. Based on this study,

Kannanado variety of cowpea and the 6g of Sodom apple leaf powder is recommended to farmers for cowpea storage.

Keywords: Sodom apple, stored cowpea, cowpea weevil, *Callosobruchus maculatus*, Kannanado

1. INTRODUCTION

Seed legumes are important major sources of plant protein (Duranti, 2006) in the tropics having varied industrial applications, which depend on the knowledge of their nutritional importance and functional properties (Akinyemi *et al.*, 2013). Many workers such as Onwuliri and Obu (2002), and Akinyemi *et al.* (2013) have reported the nutritional composition, as well as functional properties of seed legumes. Legumes contain more proteins than cereals and about ten times as much protein as most root and tuber crops. They serve as a cheap source of protein to a large proportion of the population in poor countries of the tropics (Oparaeke *et al.*, 2005).

For rural and urban dwellers in developing countries, especially where animal protein is scarce and/or expensive, seed legumes serve as sources of protein by being the least expensive and non-processed protein source (Singh, 1985; Rachie and Silvestre, 1997). Nigeria is the leading cowpea producer with more than 60% of the overall production in the world (Nwagboso *et al.*, 2024). In spite of the role that cowpea plays, it often comes under attack by insect pests both in the field and in stores (Singh, 1990; Ahmed *et al.*, 2009; Adebisi and Tedela, 2012; Taroesele *et al.*, 2015).

Asawalam and Dioka (2012) reported that the major insect pests infesting stored cowpea belong to the Chrysomelidae family, especially the cowpea weevil (*Callosobruchus maculatus*), which is a field-to-store key insect pest of cowpea. The cowpea weevil has high fecundity as well as being a voracious feeder causing serious postharvest losses of stored cowpea seeds (Caswell, 1981) (Photo 1).



Photo 1. Cowpea weevil [*Callosobruchus maculatus* (Fabricius, 1775)].

Cowpea weevil causes substantial quantitative and qualitative losses manifested by seed perforation and weight loss, reduction in market value and germination ability of seeds (Ahmed *et al.*, 2009; Jehajo and Shah, 2023).

The damages and losses caused by insect pests are the fundamental limitation to cowpea seed production and storage in major cowpea-producing countries (Singh, 1985; Muhammad *et al.*, 2017). Cowpea weevil is the key insect pest infesting stored cowpea (Ofuya and Credland, 2006; Gbaye *et al.*, 2011) both in the field and in stores (Peng *et al.*, 2015; Anikwe, 2017).

To control the activities of *C. maculatus* on cowpea, farmers heavily rely on synthetic pesticides, which leaves behind attendant problems (Ogunolu and Idowu, 1994), which include pest resistance, environmental pollution and being harmful to non-target organisms (Bohinc *et al.*, 2013; Bouayad *et al.*, 2013; Mohapatra *et al.*, 2015; Buba and Muhammed, 2024). Monetary losses due to continuous use of synthetic pesticides run into billions of US Dollars every year (Suleiman and Yusuf, 2011).

In finding suitable and more sustainable alternatives to synthetic pesticides, botanicals are being investigated and used with promising results (Buba and Muhammed, 2024). These botanicals are naturally occurring, which are pest specific that are derived from plants and highly degradable, leaving no residues in the environment (Adebisi and Tedela, 2012).

Additionally, pests hardly develop resistance against them (Ahmed *et al.*, 2007). Although more than 2000 plant species are known to have insecticidal active compounds (Talukder, 2006; Yusuf *et al.*, 2011; Tijjani *et al.*, 2016), only a fraction have received attention from researchers (Akinyemi *et al.*, 2015).

Insecticidal activities of more botanicals are needed to be investigated and developed for a possibility of utilizing them as biological control agents against storage insect pests, especially the cowpea weevil in stored cowpea seeds. This study is aimed at exploring the potentials of Sodom apple (*C. procera*) leaf powder on *C. maculatus* and quality of stored cowpea. Sodom apple has shown huge promise as a pesticide, possessing varying active ingredients (Aremu *et al.*, 2023; Rehman *et al.*, 2023)

2. MATERIALS AND METHODS

2. 1. Study area

The study was carried in the Laboratory of the Department of Agronomy, Faculty of Agriculture, Federal University of Kashere, Located at Lat 9°46'E and Long 10°57'E with an altitude 431m above sea level (Degri and Buba, 2022).

2. 2. Source of experimental material

Cowpea weevils were collected from infested cowpea, which was purchased at food stores and open market in Kashere town; it was taken to the laboratory and kept in well aerated containers.

2. 3. Preparation of the powdered extracts of spices

Fresh leaves of *C. procera* (Photo 2) were collected in and around Kashere town, these were washed and chopped into pieces to facilitate drying and were dried in a well-ventilated area and under shade for 4 weeks. The dried botanical samples were ground into powder using wooden mortar and pestle and sieved using a wire mesh.



Photo 2. Fresh leaves of Sodom apple [*Calotropis procera* (Aiton) W.T.Aiton].

2. 4. Culture of cowpea weevil

Three transparent plastic containers were filled with cowpea weevil infested cowpea and their openings were secured with fitting muslin cloths and rubber bands; covering the containers to allow for adequate ventilation for the insects as well as preventing them from escaping and disallowing other organisms from gaining access into the containers. This constituted the culture from which parent stock of cowpea weevils were obtained. The culture was maintained for 28 days, enough for mating between adult males and females, oviposition, emergence and perpetuation of first generation (F_1) insect species.

From the insect culture, 100 adults of cowpea weevil were picked and put in 3 containers on un-infested stored cowpea weighing 1 kg each. These were allowed to mate for seven days and oviposit. They were afterward removed and discarded, the containers were left for further seven days and left undisturbed in the laboratory for pristine adults of cowpea weevil to emerge. This is the first filial (F_1) generation of uniform age cowpea weevil and were used for the experiment.

2. 5. Treatments

Three treatments were obtained, and a further control treatment, which were replicated 3 times:

T_1 = 0 g (control which included cowpea seeds and cowpea weevil.

T_2 = which consisted of the 2g powdered of Sodom apple, cowpea seeds and cowpea weevil.

T_3 = which consisted of the 4g powdered of Sodom apple, cowpea seeds and cowpea weevil.

T_4 = which consisted of the 6g powdered of Sodom apple, cowpea seeds and cowpea weevil.

2. 6. Experimental design

The experimental design used was Completely Randomized Design (CRD) replicated three times with four treatments.

2. 7. Data collection

2. 7. 1. Number of holes of cowpea seeds

The number of holes bored by the weevil was counted and recorded.

2. 7. 2. Mortality of cowpea weevil

The mortality was recorded by counting the dead weevils at 4 days intervals.

2. 7. 3. Weight loss of cowpea seeds (%)

The percentage weight loss was obtained by subtracting the final weight of Cowpea seeds from the initial weight of cowpea seeds and dividing by initial weight and multiplying by hundred, thus:

$$\text{Percentage weight loss} = \frac{\text{Initial weight} - \text{final weight}}{\text{Initial weight}} \times 100$$

2. 7. 4. Data analysis

Data collected was subjected to Analysis of Variance (ANOVA) using SPSS version 20 and where significant, means were separated using the Least Significant Differences (LSD) at the 0.05 level of significance.

3. RESULTS

3. 1. Adult mortality of cowpea weevils on stored cowpea treated with Sodom apple powder

Table 1 shows the effects of varieties of cowpea and Sodom apple leaf powder on adult mortality of cowpea weevil at days 4, 8, 12, 16 and 20. At days 4 and 8, there were a significant ($p \leq 0.05$) differences between all the means.

Table 1. Effects of varieties and Sodom apple leaf powder on adult mortality of cowpea weevil in stored cowpea seeds

Treatment	ADM4	ADM8	ADM12	ADM16	ADM20
Variety					
Yambareru	1.00	1.00	1.75	3.09	4.00
Kanannado	0.75	1.59	2.25	2.83	4.00

Iron Beans	0.42	1.42	2.00	2.75	3.50
LS	*	*	NS	NS	NS
LSD	0.134	0.165	0.525	0.628	0.487
Sodom apple leaf powder (g)					
0g	0.56	1.44	2.00	2.67	3.44
2g	0.67	1.22	2.00	3.11	4.11
4g	1.00	1.67	2.44	3.67	4.89
6g	0.67	1.00	1.55	2.11	2.89
LS	NS	*	*	*	*
LSD	0.628	0.207	0.210	0.225	0.232
Interaction					
V × SAP	NS	NS	NS	NS	NS
Key: ADM = Adult Mortality of Cowpea Weevils at 4, 8, 12, 16 and 20 Days, LS = Level of Significance at 5% Level of Probability, NS = Not Significantly Different at 0.05 Level of Significance, V = Varieties, SAP = Sodom apple leaf powder.					

At day 4, Yambareru significantly ($p \leq 0.05$) produced a higher mean of (1.00), followed by kannando which produced a mean of (0.75) and iron beans, which produced the lowest mean of (0.42). Conversely, at days 12, 16 and 20, there were no significant ($p > 0.05$) differences among the means due to varieties on adult mortality of cowpea weevil. At days 8, 12, 16 and 20 there were a significant ($p \leq 0.05$) difference among the treatment means due to Sodom apple leaf powder on adult mortality of adult cowpea weevil.

3. 2. Number of emergence holes on Sodom apple-treated stored cowpea seeds by cowpea weevils

Table 2 shows the effects of varieties of cowpea and Sodom apple leaf powder on emergence holes of cowpea seeds due to infestation by cowpea weevil at days 4, 8, 12, 16 and 20 after treatment. At days 4 kanannado and iron beans produce the highest mean of 0.58 while yembereru gave the lowest mean of 0.67. At day 12, 16 and 20 there were significant ($p \leq 0.05$) differences among the varieties on emergence hole on the cowpea seed. Results from this table showed that except at day four where emergence of cowpea weevil was not significant ($p > 0.05$), significant ($p \leq 0.05$) differences were recorded between all the means of emergence recorded for the other days.

Table 2. Effects of Varieties and Sodom Apple Leaf Powder on the Number of Holes per Seed of Cowpea.

Treatment	EH 4	EH 8	EH 12	EH16	EH 20
Variety					
Yambareru	0.08	0.67	2.00	2.83	4.08
Kanannado	0.58	1.33	2.50	3.25	4.00
Iron Beans	0.58	1.17	2.50	3.00	4.17
LS	*	*	*	*	*
LSD	0.106	0.233	0.244	0.320	0.040
Sodom apple leaf powder (g)					
0g	0.11	1.00	2.00	2.89	4.11
2g	0.56	1.00	1.89	2.44	3.67
4g	0.44	1.00	2.11	2.44	3.56
6g	0.55	1.22	3.00	4.33	5.00
LS	*	NS	*	*	*
LSD	0.125	0.211	0.228	0.307	0.328
Interaction					
V × SAP	N.S	N.S	N.S	N.S	N.S
Key: EH = Emerged Holes on Cowpea Seeds, LS = Level of Significance at 5% Level of Probability, NS = Not Significantly Different at 0.05 Level of Significance, V = Varieties, SAP = Sodom apple leaf powder.					

3. 3. Seed weight loss of Sodom apple treated stored cowpea infested by cowpea weevil (%)

Table 3 shows the initial and final weight of cowpea seeds during the experiment due to varieties and Sodom apple leaf powder. The calculated weight loss, shows no significant ($p>0.05$) difference among the means that were compared.

Table 3. Percentage weight loss of stored cowpea infested with cowpea weevil treated with Sodom apple leaf powder

Treatment	Initial Weight (g)	Final Weight (g)	% Weight loss
Variety			
Yambareru	20.00	19.83	0.17
Kanannado	20.00	19.93	0.07
Iron Beans	20.00	19.85	0.15
LS	NS	NS	NS
LSD	0.001	1.662	1.60
Sodom apple leaf powder (g)			
0	20	19.89	0.11
2	20	19.80	0.2
4	20	19.92	0.08
6	20	19.88	0.12
LS	NS	NS	NS
LSD	0.001	0.192	0.19
Interaction			
V × SAP	NS	NS	NS
Keys: g = grams, LS = Level of Significance at 0.05, NS = Not Significantly Different at 5% Level of Probability, V = Variety, SAP = Sodom apple leaf powder			

4. DISCUSSION

The present study established the mortality-causing effect of Sodom apple on cowpea weevil on stored cowpea. The 6g of Sodom apple proved more effective in controlling the cowpea weevil than the other rates of Sodom apple leaf powder used. This is probably due to fact that the 6g was the highest rate of Sodom apple powder used and so provided enough active constituents over the other rates. This result may emphasize the notion that the higher the level of Sodom apple powder applied to control cowpea weevil pest, the better the performance. A similar observation was reported by Adebiyi and Tedela (2012) who stated that higher rates of botanicals tend to suppress the effects of insect pests both in the field and in storage. The study revealed that varietal difference in cowpea affected cowpea weevil mortality where it was

observed that there was higher rate of mortality from Yambareru variety of cowpea over the Kannanado and Iron beans. This can be as a result of the genetic makeup of these varieties are not the same hence, they will not exhibit similar level of resistance to the weevils. This observation was reported by Tiroesele *et al.* (2014) and Hamman *et al.* (2012) that different varieties of cowpea exhibit different levels of resistance or tolerance to insect pest attack.

Number of emergence holes and weight loss due to infestation of cowpea weevils on stored cowpea did not show any significant difference across all varieties of cowpea and level of Sodom apple. These results show that the presence of Sodom apple had hampered the activities of cowpea weevil on time, not allowing them feed on stored cowpea. It can be said that in spite of variety, there was ample protection of stored cowpea against the cowpea weevil.

This agrees with the work of several researchers who reported quick protection conferred on stored commodities due to botanical insecticides (Adebisi and Tedela, 2012; Ekeh *et al.*, 2013; Buba *et al.*, 2023; Buba and Muhammed, 2024). Ability of botanical pesticides to confer protection against damage to stored commodities is due to the presence of active ingredients as reported severally (Kraiss and Cullen, 2008; Yousef *et al.*, 2022). Likewise, researchers have reported that Sodom apple contains flavonoids, tannins, alkaloids, phytates and saponins (Aremu *et al.*, 2023; Rehman *et al.*, 2023), hence, the insecticidal properties.

5. CONCLUSION

From the results of the study, it was observed that Kannanado and the 6g of Sodom apple leaf powder significantly reduced the population of cowpea weevil than the other varieties and Sodom apple rates. Based from this study, Kannanado variety of cowpea and the 6g of Sodom apple leaf powder is recommended to farmers for cowpea storage. Additionally, further research should be conducted to identify the active ingredient in Sodom apple responsible for mortality in cowpea weevil.

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