



Research Article

Control of *Callosobruchus maculatus* F. (Coleoptera: Chrysomelidae) Using Organic Powders

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ABSTRACT

This study was conducted in the Entomology Laboratory of the Biological Sciences Department, Umaru Musa Yar'adua University, Katsina, Nigeria. The study aimed to determine the impact of organic powders on the cowpea beetle. The experiment was conducted using three different organic powders: wood ash, pepper, and goat droppings. Three treatments were applied to the cowpea seeds. At doses of 0.5g, 1.0 g, 2.0 g, 3.0 g, and 4.0 g, treatments one, two, and three received pepper, wood ash, and goat dropping powders, respectively. Each experimental group included a control (no treatment applied). Results of the study revealed significant difference ($P < 0.05$) between the different doses of the organic powders, resulting in to significant effect ($P < 0.05$) of adult mean mortality of *C. maculatus*. However, the findings of the study showed that there was significant adult emergence in the control groups. There was no significant difference ($P > 0.005$) in weight loss of the cowpea seeds treated with organic powders. The only weight loss observed was recorded in the control groups. The study concluded that pepper, wood ash and goat droppings powders were effective in controlling *C. maculatus*, with pepper powder achieving a high level of insecticidal activity against *C. maculatus*. The study recommends further studies on the effects of these organic powders on non-target organisms to improve their safety for human consumption.

Keywords: Adult emergence; Beetle; *C. maculatus*; Cowpea; Mortality; Organic powders

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INTRODUCTION

According to the Food and Agricultural Organization (FAO), over 90% of the world's cowpeas are produced in Africa, with West Africa serving as the primary critical production hub (Kim *et al.*, 2025). Nigeria, Niger, Burkina Faso, Ghana, Senegal, and Mali are the countries with the highest production output. While cowpeas are grown across Nigeria, however, most of the production comes from the semi-arid region of the country (Aluko *et al.*, 2016).

The quality and quantity of cowpea seeds are reduced by biotic agents due to improper storage, thereby leading to decayed and contaminated seeds during and after field harvest; insect infestations by *C. maculatus* is common to cowpea. Losses of grains

during storage, processing and marketing varies and is restricted to be as high as 50%, from harvest to consumption (Okunola *et al.*, 2019). They further stated that the quality processed food from the cowpea seeds is achieved under proper conditions and controlled environment. Food processing and storage processes involved in food/crop protection against microbes and spoilage agents are ensured for its subsequent use and consumption, stating that a p reserved food should possess and retain a palatable flavour, appearance, texture and nutrition values.

Resource-poor farmers in Africa employ a range of traditional methods involving the use of natural products such as use of ash, pepper and animal dropping. These naturally occurring products have

been used to protect agricultural products against pests for many years in some parts of the world; many authors have reported insecticidal effects of plant products against a broad range of pests (Aworh, 2023). The natural products have both medicinal and aromatic properties and contain a variety of volatile oils which have insecticidal, anti-feedant and repellent effects on insect pests (Oluwafemi, 2019). The natural products used for this study produce odours that are believed to repel weevils, thereby preventing them from attacking cowpea seeds.

There is limited information on the use of the natural products as an alternative control method for controlling weevils in storage. The use of natural products may offer a sustainable, environmentally friendly and safer alternative to synthetic insecticides (Fasoyiro *et al.*, 2017).

The most prominent methodology applied to meet this objective is the use of synthetic insecticides. However, there are several issues with using synthetic pesticides. For example, a lot of synthetic insecticides are very poisonous to mammals, have a high degree of environmental persistence, pose health risks, and have lingering impacts. Additional issues with synthetic pesticides include their eventual deadly effects on non-target creatures, difficulties resulting from inadequate application knowledge, and higher application costs (Ileke & Oni, 2019).

Environmental risk and development of resistant traits leave the synthetic insecticides inconvenient for managing stored grain pests like *C. maculatus* (Hajam & Kumar, 2022). Different botanical extracts exhibited the insecticidal activity on *C. maculatus* (Akbar *et al.*, 2022). Rahman and Talukder (2006) reported that the powdered leaves extract of eucalyptus (*Eucalyptus globules Labill.*), were blended with black gram seeds at a rate of 3% mixture had reduced insect oviposition, adult emergence and infestation rate. Treated seeds with plant oils of mustard, safflower, castor, coconut, cotton, groundnut, and soya bean provided surface protection from *C. maculatus* infestation by reducing the seed damage rate and the number of emerged adults (Tekou *et al.*, 2024) reported higher mortality of adult *C. maculatus* with the essential oils extracted from *Ocimum americanum*. Several research findings suggested that botanical extract oil treatment did not reduce the seed quality and germination rate (Carvalho *et al.*, 2023). More than 60% of the newly emerged adult mortality has been recorded by exposing them to essential oils from sweet basil.

MATERIALS AND METHODS

Rearing of *Callosobruchus maculatus*

Adult *C. maculatus* were obtained from infested cowpea seeds from a local store. The insects were sieved out from the infested cowpea seeds. Fresh, healthy cowpea seeds, Dan zango used as food media for the insects were obtained from Katsina Central Market, Katsina State, Nigeria. The seeds were disinfested from any insects, mites or microorganisms in an oven at 40°C for 4 hours. A sample of 250g of the disinfested cowpea seeds were placed in each of five rearing bottles of 50cm³ capacity after which 50 pairs of the adult *C. maculatus* were added. (25 pairs male and 25 pairs female) The rearing bottles were covered with muslin cloth and secured with rubber bands to prevent escape of the insects and allow gaseous exchange and were then kept in incubator at 28 ± 2°C and 70 ± 5% R.H. using reference text. The adult cowpea beetles were sieved out after 7 days of oviposition period leaving the cowpea seeds only. The bottles containing the seeds were maintained under the constant condition until the emergence of adults. The newly emerged adults were used for the experiments Suleiman and Suleiman (2013).

Preparation of Test Materials

Wood pieces fresh *Azadirachta indica* (neem), pepper *Capsicum annum* and goat dropping were separately flushed under running water to remove dust and other impurities. They were then air dried in the laboratory for 30 days. Wood pieces were placed in an earthen pot and burned to ash over a gas cooker. Goat dropping and pepper were separately milled in a clean electric blender. (Model 8010ES) The grounded powders were sieved using 3mm sieve to obtain a fine powders. The powders were then separately packed into air tight containers until required for use. Halima (2023).

Determination of Adult Mortality of *Callosobruchus maculatus*

Twenty grams (20.0g) of the healthy and disinfested cowpea seeds (Dan zango) were measured and placed in each of four Petri dishes. Dosage of 0.5, 1.0, 2.0 and 4.0g (equivalent to 2.5, 5.0, 10.0 and 20.0% w/w, respectively) of Pepper, woodash and goat dropping powder were added to the first, second, third and fourth Petri dishes, respectively, while no powder was added to the fifth Petri dish which served as a control group. The cowpea seeds and the powders were mixed thoroughly to ensure that they were evenly mixed and distributed and then 20 beetles were introduced into the treatment

groups.(10 males and 10 females) The same experiment was repeated for pepper and wood ash powders. The petri dishes were arranged in a completely randomized design (CRD) with three replications and kept in an incubator under controlled conditions of $28 \pm 2^\circ\text{C}$ and $70 \pm 5\%$ r.h. following Ogori *et al.* (2016). In each treatment, observations on mortality after 24, 48, 72 and 96 hours were made and recorded using the following formula: . Rabiou (2023).

Adult Mortality (%)

$$= \frac{\text{Number of Dead Beetles}}{\text{Total Number of Beetles Introduced}} \times 100$$

Examination of Adult Emergence of *Callosobruchus maculatus*

All beetles (dead and alive) were removed from both treated and untreated seeds immediately after assessment of adult mortality (96 hours after treatment). The cowpea seeds were maintained in the incubator until the emergence of newprogenies. The emerging progenies from each petridish were removed, counted, and recorded every day for 7 days from the day of the first emergence in untreated cowpea (Sani and Suleiman, (2013)

Fecundity/Number of Eggs Laid

After 14 days of infestation and exposing the beetles to the treatments, samples of 10 seeds of cowpea from each of the treated and control petri dishes were randomly taken and the number of eggs deposited on them were counted and recorded (Sani & Suleiman, 2013)**Assessment of Weight Losses in Cowpea Seeds**

Weight loss in cowpea seeds was assessed immediately after examination of adult emergence. Content of each petri dish was sieved to remove dust and an insect (dead or alive) and then the seeds were re-weighed. The difference between initial and final weight was transformed into percentage weight loss as follows:

Weight Loss (%)

$$= \frac{\text{Initial Weight (g)} - \text{Final Weight (g)}}{\text{Initial Weight (g)}} \times 100$$

Data Analysis

Data generated from this study were analyzed using General Linear Model (GLM) Package of Statistical Analytical System (SAS, 2023) for the Analysis of Variance (ANOVA). Significantly different means were separated using Duncan's Multiple Range Test (DMRT). All analyses were carried out at $p < 0.05$ level of significance.

RESULTS

Adult Mortality of *Callosobruchus maculatus* on Cowpea Seeds Treated with some Organic Powders

Results obtained in this study show that a varying adult mortality of *C. maculatus* was recorded among different concentrations of the test powders at the end of 96 hours of exposure. Highest mortality (93.55 ± 1.02) was observed in seeds treated with 20.0% pepper followed by 10.0% of the same powder (87.43 ± 1.13), while the least (60.45 ± 1.20) was recorded in 2.5% wood ash (Figure 1). It was also noticed that pepper had the highest mortality across all concentrations of the test powders while goat droppings had the least except at 2.5% where it was slightly higher than wood ash (Figure 1). No mortality was recorded in the control and as such, significantly different ($p < 0.05$) mortalities were obtained among the treatments at each dosage applied.

Adult Emergence of *Callosobruchus maculatus* in Cowpea Seeds Treated with Some Organic Powders

A total of 55, 56 and 62 individuals of *C. maculatus* emerged in the control group of goat dropping, pepper and wood ash powders, respectively. However, there was no emergence of the beetles in the cowpea seeds treated with the selected organic powders at 7 days of post treatment.

Weight Loss in Cowpea Seeds Treated with Some Organic Powders Caused by *C. maculatus*

No weight loss was observed in cowpea seeds treated with all the three organic powders regardless of concentration applied. But, in the respective controls, there were varying weight losses which were not significantly different ($p > 0.05$) as 61.90, 57.25 and 55.65%.

Table 1: Adult *Callosobruchus maculatus* mortality in Cowpea Seeds Treated with Wood Ash, Pepper and Goat Dropping Powders Applied at Varying Doses

Organic powders	Dose (g)	Adult Mortality (%) Exposure Period (HRS)				F-value	p-value
		24	48	72	96		
Pepper	0.5	20.67±1.28	35.35±1.43	58.33±1.54	80.45±1.22	1.54	0.0113
	1.0	25.44±1.13	39.00±1.29	62.55±1.39	85.66±1.17		
	2.0	27.52±1.09	39.70±1.10	65.40±1.32	87.43±1.13		
	3.0	30.00±1.04	42.45±1.08	70.30±1.26	90.23±1.06		
	4.0	40.72±0.99	45.55±1.01	73.80±1.11	93.55±1.02		
Wood Ash	0.5	16.12±1.35	22.60±1.26	45.00±1.24	60.45±1.20	2.406	0.0234
	1.0	18.38±1.31	25.62±1.18	46.21±1.21	62.70±1.16		
	2.0	25.67±1.12	28.44±1.15	49.30±1.16	69.66±1.06		
	3.0	32.55±1.07	35.67±1.05	55.48±1.09	77.00±1.03		
	4.0	35.83±1.00	49.50±1.03	62.66±0.78	81.20±0.83		
Goat Dropping	0.5	16.33±1.24	20.65±1.18	45.50±1.09	60.60±1.36	2.402	0.0251
	1.0	18.80±1.17	28.50±1.10	49.45±1.05	62.56±1.28		
	2.0	25.75±1.12	40.22±0.97	55.30±1.02	69.42±1.21		
	3.0	28.45±1.07	45.55±0.92	62.55±0.74	75.62±1.18		
	4.0	31.22±1.02	50.77±0.73	65.66±0.69	77.00±1.15		
Control	0.00	0.00	0.00	0.00	0.00		

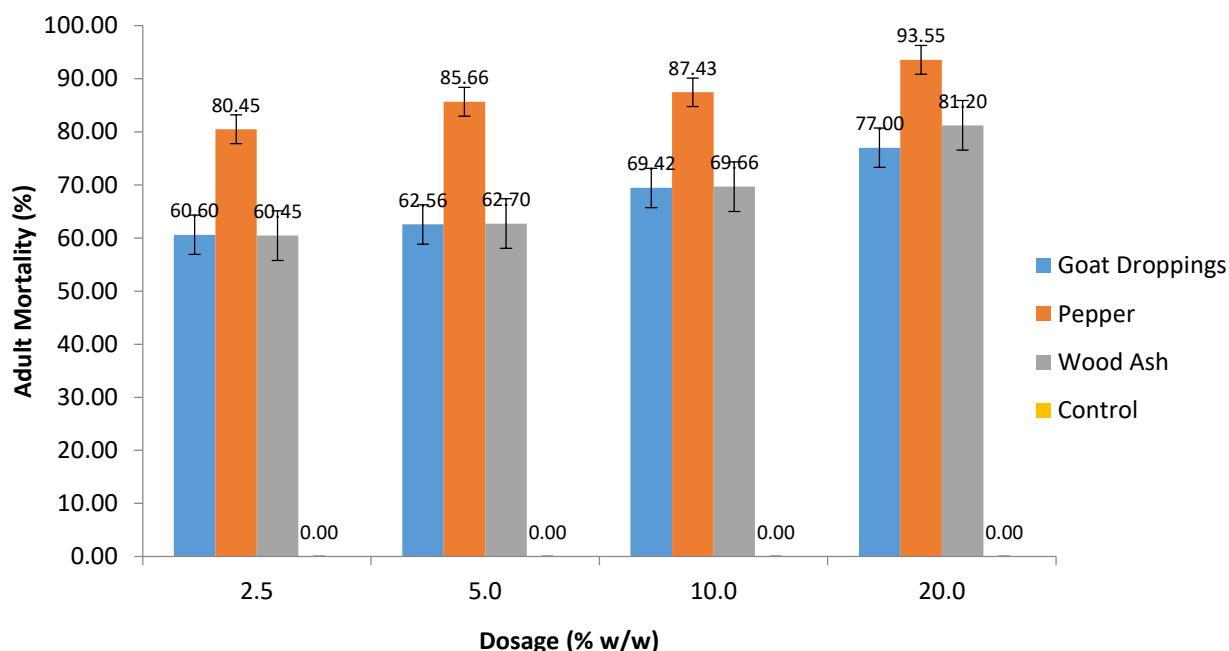


Figure 1: Adult mortality of *Callosobruchus maculatus* in Cowpea Seeds Treated with Wood Ash, Pepper and Goat Dropping Powders Applied at Varying Doses

Table 2: Adult emergence in Cowpea Seeds Treated with Wood Ash, Pepper and Goat Dropping Organic Powders after 30 Days Post Treatment

Organic Powders	Dose (g)	Number of insects placed	Adult emergence after days post emergence	% Adult emergence (Mean±SD)	PercentageF-value	P-value
Pepper	0.5g	20	0	0	2.045	0.0034
	1.0g	20	0	0		
	2.0g	20	0	0		
	3.0g	20	0	0		
	4.0g	20	0	0		
Pepper control group	0	20±1.03	36±0.82	64±0.68		
Wood ash	0.5g	20	0	0	2.421	0.046
	1.0g	20	0	0		
	2.0g	20	0	0		
	3.0g	20	0	0		
	4.0g	20	0	0		
Wood ash control group	0	20±1.14	42±0.78	67±0.65		
Goat dropping	0.5g	20	0	0	2.003	0.012
	1.0g	20	0	0		
	2.0g	20	0	0		
	3.0g	20	0	0		
	4.0g	20	0	0		
Goat dropping control group	0	20±1.10	35±0.85	63±0.70		

Table 3: Weight Loss in Cowpea Seeds Treated with Wood Ash, Pepper and Goat Dropping Organic Powders after 30 Days Post Treatment

Organic Powders	Dose (g)	Initial (g)	WeightFinal (g)	Weight%Weight (Mean±SD)	LossF-value	P-value
Pepper	0.5	20	20	0	2.443	0.0192
	1.0	20	20	0		
	2.0	20	20	0		
	3.0	20	20	0		
	4.0	20	20	0		
Control	0	20±1.18	11.13±1.27	55.65±0.95		
Wood Ash	0.5	20	20	0	2.025	0.0256
	1.0	20	20	0		
	2.0	20	20	0		
	3.0	20	20	0		
	4.0	20	20	0		
Control	0	20±1.16	12.38±1.19	61.9±0.89		
Goat Dropping	0.5	20	20	0	1.911	0.0306
	1.0	20	20	0		
	2.0	20	20	0		
	3.0	20	20	0		
	4.0	20	20	0		
Control	0	20±1.13	11.50±1.22	57.25		

DISCUSSION

The results indicated that all the three organic powders have significant effects against *C. maculatus*. The result indicated cowpea seeds treated with pepper powder had the high number of mortalities when compared to wood ash and goat dropping

powders respectively. This indicated that pepper powder had positive effect in the control of *C. maculatus* while understorage, which is supported by the finding of Ajayi and Adedire (2003) who reported that when organic powders like pepper powder stays

for a long-time during storage, it brings out other chemical component that affect *C. maculatus*' activities thereby controlling stored cowpea. The researchers added that pepper is a spice used in food seasoning and therefore it does not pose a health hazard either to consumers or the environment. In areas where pepper thrives well, it is advised that farmers grow the crop not only for commercial use and as spice but also as a good protectant of products against *C. maculatus*. Pepper powder may as well be used for controlling the storage pest since they pose minimal risk to consumers and the environment. Adedire (2018) agreed with the finding in this work stating that organic powders may affect the taste of the seeds consequently not accepted in the market. Although, researches had indicated that, pepper, wood ash and goat dropping powders were not toxic to human life and is advised to be used as protectant against *C. maculatus*. The results of this study were in conformity to some degree with the report of some workers, like Mukanga *et al.* (2010), Adedire *et al.* (2011) and Ileke and Oni (2019) who observed that certain powders are effectively toxic against storage insect pests including *C. maculatus*. The resultant mortality rates of *C. maculatus* in this investigation could be attributed to the toxic effects of the chemicals in the tested pepper, goat dropping and wood ash powders. Although, all the three powders promised to have entomocidal effects because of their toxicity against *C. maculatus*, their toxicity varied probably because of the different phytochemical contents, especially in the pepper powder which reduced significantly the number of *C. maculatus*. This was due to the fact that, it had active ingredients for terminating all the number of *C. maculatus* at 72 hours (Ashamo *et al.*, 2021).

There was no adult emergence of *C. maculatus* in the cowpea seeds treated with the three powders. This aligns with the work of Augustine and Balikai (2021) who asserted that there is rapid emergence of *C. maculatus* for the untreated pulses especially cowpea seeds

Literatures have shown that pepper, wood ash and goat dropping powders have insecticidal action against *C. maculatus* and other stored product insect pests (Yusuf *et al.*, 2019). The entomocidal studies indicated that, there was significant difference in weight loss in control groups over treatment groups throughout the period of the experiment. However, among the various treatment groups, it was observed that percentage weight loss was significantly lower ($P < 0.05$) in the seeds treated with pepper plant extract across the treated seeds. The superiority of

wood ash and goat dropping over pepper powder in reducing weight of cowpea could be as a result of active ingredient found in pepper leading to immediate death of *C. maculatus*. Although Ojo *et al.* (2013) opined that the reduction in weight loss caused by *C. maculatus* in treated cowpea seeds sometimes goes beyond physical effect of the powders, but could also be as a result of egg/larval mortality or reduction in hatching of the eggs (Ojo *et al.*, 2013).

The finding of this study shows that, there was no weight loss of cowpea seeds treated with pepper, wood ash and goat dropping powders after 30 days of post treatment. The result showed significant difference ($P < 0.05$) in the weight loss of cowpea seeds in the control groups. This aligns with the work of Suleiman and Sani (2017) who reported that, the most important damage caused by *C. maculatus* includes weight loss, loss in market value, decrease in germination ability of seed and decrease in nutritional value, particularly proteins. Furthermore, the findings of this study supported by Ojebode *et al.* (2020) who reported that *C. maculatus* is a very destructive insect pest of cowpea seeds as it caused loss of weight, nutritional and commercial values and viability of stored grains.

CONCLUSION

The study concluded that wood pieces of fresh *Azadirachta indica* (neem), pepper *Capsicum annum* and goat dropping were effective in controlling *C. maculatus* with pepper powder in achieving high level of entomocidal activity against cowpea beetle. The present investigation indicates that farmers can use organic powders for protecting cowpea grains against *C. maculatus* after harvest. The use of pepper powder at the dose of 4.0g has proven to be effective in the control of *C. maculatus* in preserving cowpea grains against *C. maculatus*.

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