



Moringa Leaf Powder as Environmentally Friendly Repellent Agent for Controlling the Warehouse Insect Pest for Black Soybean Grain

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Abstract. Black soybean grain (*Glycine max* L. Merrill.) storage is susceptible to insect pests such as *Callosobruchus analis* (F.), which feeds on soybeans. Steroids/triterpenoids, phenolics, alkaloids, tannins, and terpenoids found in moringa leaf powder can be employed as insect repellents in black soybean grain warehouses. The purpose of this study was to ascertain how applying plant-based insecticides made from powdered moringa leaf will affect the amount of *C. analis* (F.) that died, the severity of the damage, and the weight loss of black soybean seeds of the Detam 4 Prida varieties. The study took place from August to October 2019 at an elevation of 878 meters above sea level in the Biology Laboratory of the Agriculture Faculty, University of Winaya Mukti. An experimental design including five treatments and five replications was employed as the research methodology. A was not given any moringa leaf powder; B, C, D, and E each received 0.25, 0.75, and 1 grams of moringa leaf powder, fine powder, and so on. 10 pairs of *C. analis* (F) per jar were used in each treatment, which involved 100 g of black soybean grain. In the storage of black soybean grain, the percentage of seed damage, weight loss, the number of eggs, larvae, pupae, and imagoes, and mortality of *C. analis* (F) were all impacted by 0.75 g of moringa leaf powder, according to the findings. According to this research, *C. analis*, a warehouse insect pest, is effectively repelled by powdered moringa leaf (F).

Keywords: *Callosobruchus analis* (F.), *Moringa oleifera* Lamk., Repellent, Warehouse Insect Pests

INTRODUCTION

During the various stages of transportation, processing, marketing, and storage following harvest, roughly 1660 insect species prey on the agricultural produce [1]. These bug pests can cause losses during storage that can amount to 30% [2]. According to available data, the most harmful and destructive insect pests for products that are stored worldwide include *Tribolium castaneum* [3]; [4], *Trogoderma granarium* [5]; [6], *Cryptolestes ferruginous* [7]; [8] and *Callosobruchus* sp [9(1)].

A prominent insect pest of economically significant leguminous grains is *Callosobruchus* sp. (Coleoptera: Bruchidae), also known as the pulse beetle [9(1)]. Mostly found in tropical and subtropical regions, *Callosobruchus* has at least 20 species, most native to Asia and Africa [10]. Several species are prevalent in the field, including *Callosobruchus maculatus* (Fab.), *C. chinensis* (L.), *C. subinnotatus* (Pic.), *C. analis* (F.), and *C. rhodesianus* (Pic.) [11]. A range of beans, including *Vigna* (*Vigna unguiculata* L. Walpers), cowpea (*V. radiata* L. Wilczek), mungbean (*V. subterranean* L.), and other leguminous seeds, including chickpea (*Cicer arietinum* L.), green gram (*Phaseolus aureus* Roxb.), black gram (*Phaseolus mungo* Roxb.), red gram (*Cajanus cajan* L.), lentil (*Lens culinaris* Medik.), soybean (*Glycine max* Mer.), pea (*Pisum sativum* L.), peanut (*Arachis hypogaea* L.), and haricot beans (*Phaseolus vulgaris* L.) [10].

C. analis (F), one of the major insect pests after harvest, harms black soybean seeds. Many losses, both in quantity and quality, result from the presence of these insect pests. Insect infestations by *C. analis* (F.) have been known to cause 70% [12], roughly 79–98% [13], and 96% [14] damage to soybean seeds. When insect pests attack soybeans, the seeds become damaged and lose weight because the beetle larvae stage creates holes in the seeds, preventing them from being digested [15]. The development, pest population density, and occurrence of pest attacks all influence the extent of the harm.

The bruchid is being controlled by synthetic pesticides [16]. Though these toxic synthetic chemicals seem to be working, there are still many reasons to be concerned about their toxicity, including toxicity issues [17], pest resurgence and secondary pest elevation [18], pesticide resistance populations developing [19], harmful effects on non-target organism populations [20], residues in food [21], high cost of most of these chemicals [22], environmental contamination [23], non-availability, and adulteration and falsification of pesticides [24]. With their various active components, natural plant products are being used as a focus point in the global search for alternatives to synthetic pesticides [16].

Moringa oleifera Lam is one of the many varieties of beneficial plants found in Indonesia, a nation highly diverse in terms of plant life. In the family Moringaceae, which consists of just one genus and roughly ten species of deciduous trees, *M. oleifera* Lam, affectionately known as "The Miracle Tree," is a member [25]. Eweigbale (Yoruba), drumstick (English), Zogallagandi (Hausa), horse-radish tree, and Okwe oyibo (Igbo) are some of their common names [25]. People have long consumed all portions of the moringa tree because they are edible. Alley cropping (biomass production), animal forage (leaves and treated seed cake), biogas (from leaves), domestic cleaning agent (crushed leaves), blue dye (wood), fencing (living trees), fertilizer (seed

cake), foliar nutrient (juice expressed from the leaves), green manure (from leaves), gum (from tree trunks), honey and sugarcane juice clarifier (powdered seeds), honey (flower nectar), medicine (all plant parts), ornamental plantings, biopesticide (soil incorporation of leaves to prevent seedling damping off), pulp (wood), rope (bark), tannin for tanning hides (bark and gum), and water purification (powdered seeds) are a few of the many uses of moringa [26; 27]. It is also well known that the plant has a broad range of therapeutic uses, including treating rheumatism, diarrhea, neurological debility, goiter, and leprosy. It can also be used as an anti-scorbutic and anti-irritant. It has been reported to possess antibacterial, antitrypanosomal, hypotensive, antispasmodic, anti-ulcer, anti-inflammatory, hypocholesterolemic, and hypoglycemic properties in the literature [28; 27].

Insecticide-producing secondary metabolites found in moringa leaves include tannins (9.36%), terpenoids (4.84%), flavonoids (3.56%), alkaloids (3.11%), carotenoids (1.16%), saponins (1.46%), and anthocyanins (0.06%) [29]. Alkaloid chemicals have two purposes for plants: they influence growth and act as toxins to ward off insects and animals that consume plants. A plant's defensive mechanism against growth stimulants and intruders is provided by triterpenoid chemicals [30]. A group of phenols with a separate flavor known as tannins are plant-active chemicals [31]. Pesticides are a function of tannin chemicals, which are found in a wide variety of plant species. A stomach poisoning effect is attributed to flavonoids, saponins, and tannins. The larvae's digestive system will be interfered with when these substances enter their body. These substances also prevent taste receptors in the larvae's mouth region from functioning. When larvae do not receive a taste stimulus, they cannot identify their food and ultimately perish [33]. Flavonoid chemicals, saponins, and tannins cause this. It is essential to investigate the dosage of moringa leaf application to learn more about the efficacy of this botanical pesticide in controlling *C. analis* (F.) and preserving the quality of soybean seeds during storage. The development of *C. analis* (F) soybean beetle powder can be inhibited, and damage and shrinkage of soybean seed weight in storage can be reduced using soursop leaf flour, starting at a dose of 0.5 g/100 g seeds. However, the failure to cause 80% mortality in the image meant that the above results could have been more effective in controlling the image [34]. Determining and obtaining the optimal dosage of Moringa leaf powder to manage *C. analis* (F) in storage was the aim of this investigation in light of.

METHOD

The study was conducted from August to October 2019 at 878 meters above sea level in the Biology Laboratorium of the Agriculture Faculty, University of Winaya Mukti. Black soybean seeds of the Detam 4 Prida kind were obtained from the Research Institute for Various Beans and Sweet Potatoes, Malang, along with blenders, aspirators, clear plastic, 350 ml glass bottles, moringa leaf powder, and a 10-micron filter.

The experimental study methodology employed a completely randomized design, including five treatments and five replications. The following treatments were: A = no moringa leaf powder; B = 0.25 g; C = 0.5 g; D = 0.75 g; and E = 1.00 g. Each treatment used ten pairs of C. analis (F) per jar, which involved 100 g of black soybean grain.

The research followed a stringent protocol, as outlined in Figure 1. One day after the application, the LD50 and imago mortality were measured. At 60 days after the application, a comprehensive set of measurements was taken, including the total number of eggs, larvae, pupae, and imagos, as well as the degree of damage and percentage of seed loss. To ensure the validity of the findings, the observational data was statistically analyzed using ANOVA and Duncan's Multiple Range Test, both widely accepted methods, at a significance level of 5%.

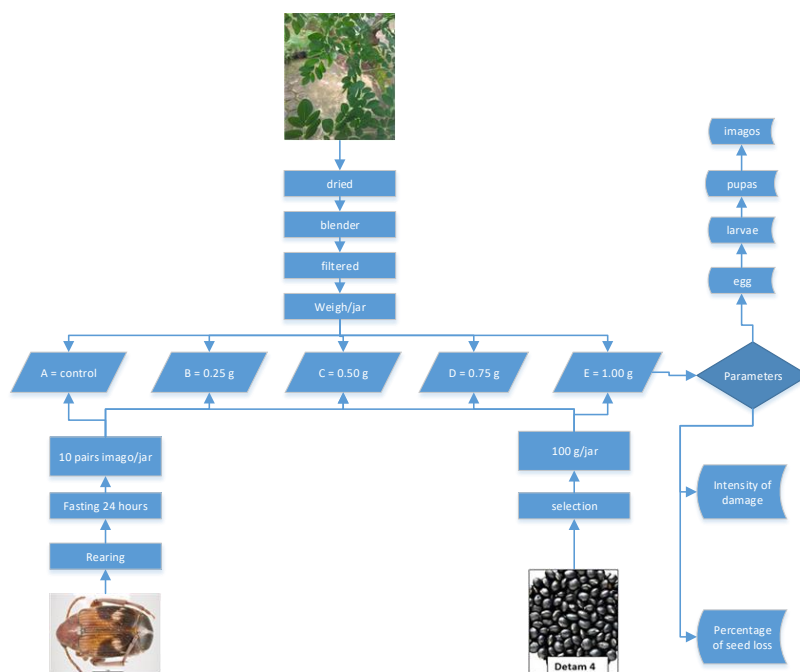


Figure 1. The Procedures and Parameters of The Research

DISCUSSION

LD50

The LD50 (Lethal Dosage 50) test results revealed variations in the amount of Moringa leaf powder tested at each dosage. In terms of therapy, D (0.75 g) was attained after 120 minutes, then C (0.50 g), E (1.00 g), A (0.00 g), and B (0.25 g) at 180 minutes (Figure 2). This indicates that all dosages of powdered moringa leaf can be utilized to protect black soybean seeds and inhibit *C. analis* (F).

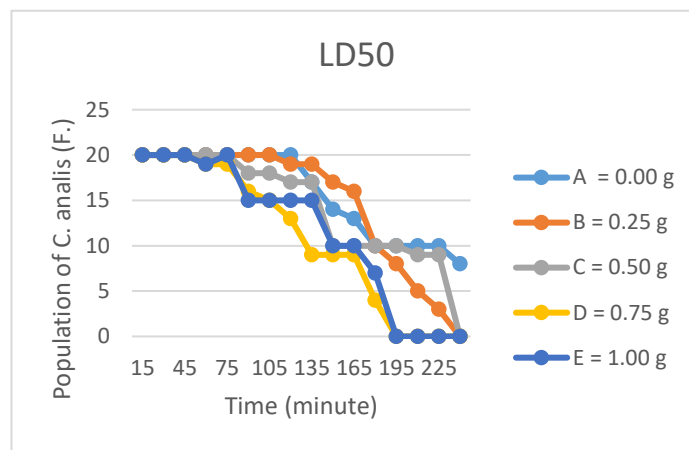


Figure 2. LD50

Mortality of Imago *C. analis* (F.)

The results of the analysis on imago mortality showed that the dosage of moringa leaf powder had a significant effect on the number of mortality *C. analis* (F.) in 5, 10, and 15 days after application (DAA) (Figure 3).

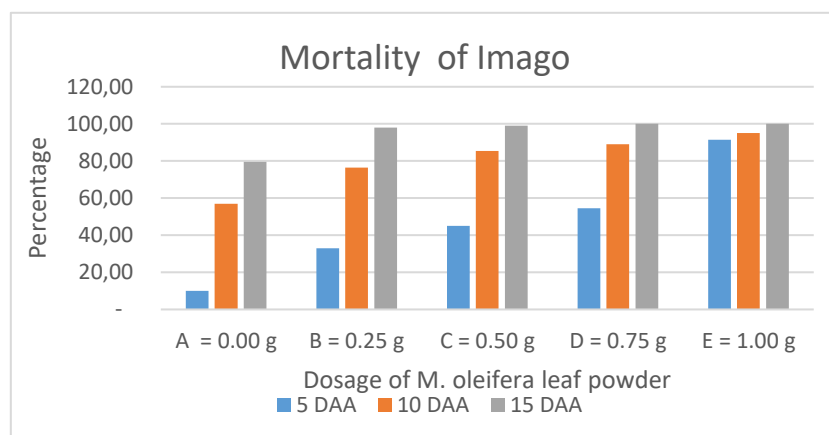


Figure 3. Mortality of Imago *C. analis* (F.)

According to Figure 3, the mortality rate of imago on E (1 gram of powdered moringa leaf) (91.50%) in 5 DAA was significantly higher than that of imago on E (10.00%) without powdered moringa leaf. The death rate of imago on E (1 gram of moringa leaf powder) in 10 DAA was significantly higher at 95.00% compared to those that did not consume moringa leaf powder, which registered at 57.00%. Compared to the group that did not receive moringa leaf powder (79.50%), the mortality rate of imago on E (1 gram of powdered moringa leaf) (100.00%) after 15 DAA was substantially higher. These results demonstrate the insect-killing properties of moringa leaf powder. Tangananoids, terpenoids, flavonoids, steroids, alkaloids, saponins, carotenoids, and anthocyanins are among the secondary metabolites found in moringa leaves that have insecticidal properties [29]. Toxic chemicals for insects that are alkaloids in plants [35]. Repellents made of these bioactive substances can stop insect pests from growing and from growing into pupae by preventing the larvae's development.

Number of Eggs *C. analis* (F.)

The examination's findings demonstrated that all treatments involving moringa leaf powder differed considerably from the control group regarding the number of eggs deposited at every observation age. (Table 1). Table 1 shows that, compared to Duncan's Multiple Range Test (DMRT) at the 5% level, the average number in each column followed by the same letter did not differ significantly. With a total of 2.60 ± 1.48 , 2.80 ± 1.44 , 4.30 ± 0.57 , and 5.00 ± 1.06 eggs laid, Treatment E (1.00 g moringa leaf powder) produced the fewest eggs of all the treatments. Terpenoids, tannins, flavonoids, steroids, alkaloids, saponins, carotenoids, and anthocyanins are among the secondary metabolites found in moringa leaves with insecticidal properties. As repellents, these bioactive substances can stop pests from getting near plants and their larvae from developing into pupae [29].

Table 1. The number of Eggs

Treatments	Average Number of Eggs of <i>C.analis</i> (F.)							
	15 DAA		30 DAA		45 DAA		60 DAA	
A (Control)	45.50 ± 13.61	d	48.20 ± 18.70	d	48.60 ± 18.32	d	49.80 ± 20.45	d
B (0.25 g)	36.00 ± 16.52	cd	36.00 ± 16.52	cd	36.50 ± 16.11	cd	36.70 ± 15.97	cd
C (0.50 g)	23.50 ± 18.53	bc	23.80 ± 18.26	bc	24.30 ± 17.78	bc	24.70 ± 17.23	bc
D (0.75 g)	9.70 ± 7.68	ab	10.10 ± 7.25	ab	10.50 ± 6.95	ab	11.70 ± 6.98	ab
E (1.00 g)	2.60 ± 1.48	ab	2.80 ± 1.44	ab	4.30 ± 0.57	a	5.00 ± 1.06	a
sd	6.32		5.76		5.57		5.53	

Number of Larvae, Pupae and Imago of *C. analis* (F.)

Based on an analysis of 60 DAA observations, the number of larvae, pupae, and imago was shown to be influenced by the amount of moringa leaf powder (Table 2). When compared to the control group, which had 2.60 ± 1.75 larvae, B (0.25 g) had an average of 0.20 ± 0.27 larvae, indicating that the dosage of moringa leaf powder was quite successful in promoting the growth of *C. analis* (F.) larvae. Pupae of *C. analis* (F.) were significantly reduced in quantity when 0.25 grams of moringa leaf powder was administered as a dosage, resulting in 0.30 ± 0.45 pupae, as opposed to 3.30 ± 2.46 pupae in the control group. However, among the other treatments, imago *C. analis* (F.) was found in lower numbers when 0.75 g of moringa leaf powder was given; this was 0.10 ± 0.22 imago, as opposed to 5.20 ± 3.92 imago in control.

Table 2. Number of Larvae, Pupae, and Imago

Treatments	Average of Larvae, Pupae and Imago					
	Larvae		Pupa		Imago	
A (Control)	2.60 ± 1.75	b	3.30 ± 2.46	b	5.20 ± 3.92	d
B (0.25 g)	0.20 ± 0.27	a	0.30 ± 0.45	a	0.80 ± 1.04	c
C (0.50 g)	0.10 ± 0.22	a	0.30 ± 0.67	a	0.30 ± 0.67	b
D (0.75 g)	0.10 ± 0.22	a	0.10 ± 0.22	a	0.10 ± 0.22	a
E (1.00 g)	0.00 ± 0.00	a	0.00 ± 0.00	a	0.00 ± 0.00	a
sd	0.40		0.58		1.04	

C. analis (F.) larvae are influenced by the saponin content of moringa plants in their growth. With a septic taste and phenolic activity, tannins are an active plant chemical [31]. Many plant species include tannin chemicals, which have an anti-pestilence function [32]. Tannins reduce the rate of growth, survival, and food consumption. Because they taste harsh, tannins, quinones, and saponins may limit larvae feeding in tests. The larvae will starve to death as a result of the bitter taste, which makes them refuse food [36].

Because alkaloids are in salt form and can break down cell membranes to damage cells, they have a bitter taste on the tongue when present in fresh leaves or fruit. Alkaloids are known to penetrate the body of a larva through absorption, break down the skin cell membrane, and potentially disrupt the neurological system of the pupa (Harrington, 2007).

Flavonoids, a group of chemicals, possess the ability to kill insects. They induce nerve weakness, breathing difficulties, and even death by damaging the nerves in many vital organs of insects. These potent plant defensive chemicals not only inhibit insect feeding but also exhibit antifungal and insect repellent properties, making them a formidable weapon in the plant's defense system [31].

Intensity of damage of *C. analis* (F.)

The results of data analysis on the percentage of damage of *C. analis* (F.) carried out at the end of the 60 DAA observation showed that all treatments of moringa leaf powder had a significant effect on the intensity of damage of *C. analis* (F.) (Table 3).

Table 3. Intensity of Damage of *C. analis* (F.)

Treatments	Intensity of Damage of <i>C. analis</i> (F.) (%)
A (Control)	14.17 ± 14.03 b
B (0.25 g)	4.57 ± 1.44 ab
C (0.50 g)	4.68 ± 1.44 a
D (0.75 g)	2.88 ± 1.36 a
E (1.00 g)	3.48 ± 2.08 a
sd	5.96

Based on Table 3, the observations of 60 DAA intensity of damage to black soybean seeds showed that all treatments were significantly different than control. However, the D (0.75 g of moringa leaf powder) had the lowest percentage of damage to the seeds respectively, about 2.88 ± 1.36 %. Alkaloids for plants are toxic substances against insects. Triterpenoid compounds in plants functioned as a defense against insect pests and growth-influencing factors [30].

Percentage of Seed Loss

The results of the analysis on the weight loss percentage data of Detam 4 Prida black soybean seeds carried out at the end of the observation, namely 60 DAA, showed that the treatment of several doses of Moringa leaf powder had a significant effect on the weight loss percentage of black soybean seeds (Table 4).

Table 4. Percentage of Seed Loss

Treatments	Percentage of Seed Loss (%)
A (Control)	17.60 ± 17.06 b
B (0.25 g)	3.24 ± 1.45 a
C (0.50 g)	2.92 ± 1.86 a
D (0.75 g)	0.52 ± 0.73 a
E (1.00 g)	1.54 ± 1.55 a
sd	3.38

Based on Table 4, showed that all treatments were significantly different from the control in the percentage of weight loss of black soybean seeds. The treatment D (0.75 g moringa leaf powder) was a lowest of percentage of seed loss than all treatments, as 0.52 ± 0.73 % respectively. Alkaloids for plants are toxic substances against insects [35]. Alkaloids contain insect repellent compounds and antifungus compounds [31].

CONCLUSION

The results showed that 0.75 g moringa leaf powder affected mortality, number of eggs, number of larvae, pupas and imagos, percentage of seed damage and weight loss of *C. analis* (F) in the storage of black soybean grain. This finding concludes that the moringa leaf powder is effective as a repellent for warehouse insect pest *C. analis* (F.).

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