



Extracts of *Senna sophera* (L.) Roxb., *Syzygium cumuni*, and *Annona squamosa* Linn. as Biopesticides against Army Worm (*Spodoptera exigua*) Larvae

CAMILLE JOY E. CASAMINA and DARWIN F. REYES*

Natural and Applied Sciences Department, College of Arts and Sciences, Nueva Ecija, University of Science and Technology, Cabanatuan City, Nueva Ecija 3100 Philippines.

*Corresponding author E-mail: dfreyes@ineust.ph.education

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ABSTRACT

Pests are one of the constraints in agricultural crops, such as the army worm (*Spodoptera exigua*), that is considered as one of the most harmful pests in the vegetative phase. In this work, ethanolic leaf extracts of common plants *Senna sophera* (L.) Roxb., *Syzygium cumuni*, and *Annona squamosa* Linn. in Llanera, Nueva Ecija, Philippines were prepared and the phytochemical constituents were locally found. Direct spraying of the extracts was done to test the effectiveness of the biopesticides. Results showed that the extracts have varying effectivity as biopesticide against *Spodoptera exigua* and can be related to the chemical constituents present in the extracts. Considering the results from this investigation, the easy availability and effectiveness of these natural pesticides can be developed as alternatives to conventional synthetic pesticides.

Keywords: Biopesticides, Army worm, Direct spraying, Phytochemicals, Pests.

INTRODUCTION

The Philippines had experienced an outbreak of onion or beet armyworm, *Spodoptera exigua*, in 2016. Until now, this remains a pest problem in onion farms in the mainland Luzon that poses a big threat to the agricultural industry of the country¹. *Spodoptera exigua* is a polyphagous species that is a known pest to different agricultural products by feeding on leaves and stems, creating holes, and boring holes in fruits. These damages are serious that caused outbreak levels and economic

damage in various continents².

To control these pests, farmers and agricultural workers use synthetic pesticides that have negative effects such as pest resistance, resurgence and the emergence of secondary pests³. Reports on the resistance of these organisms to various insecticides have been published⁴. Among these insecticides are tebufenozide, metaflumizone, chlorpyrifos, chlorfluzuron, spinosad, chlorpyrifos, trizophos, methomyl, betasiflutrin, siromazin, carbosufan, thiodikarb,



and abamectin. Due to these concerns, studies on natural and environment-friendly alternatives such as plant extracts as biopesticides are in urgent need of development. These greener alternatives eliminate the ecological and health threats posed by chemical pesticides⁵.

In this study, extracts of common plants algarroBILLA (*Senna sophera* (L.) Roxb.), java plum (*Syzygium cumini*), and sugar apple (*Annona squamosa* Linn.) found locally in Llanera, Nueva Ecija, Philippines are explored as biopesticides against *Spodoptera exigua*. Biopesticides are characterized as naturally-derived materials from animals, plants, and microorganisms that are usually biodegradable in short periods of time. Further, plants are excellent sources of biopesticides that can be attributed to the various secondary metabolites that have various biological activities⁶. Other advantages are reduced risk of pest resistance, lower development costs, higher target specificity, lower environmental persistence, and generally improved compatibility with biological controls⁷. Since ancient times, plant extracts as

insecticides have been successfully applied to control insects, fungi, and weeds⁸. Phytochemical constituents of the plant extracts were determined qualitatively and the plant extracts were applied via direct spraying to assess its effectiveness as biopesticides against *Spodoptera exigua*. An efficient and environmentally-friendly biopesticide for controlling and management of this pest is significant due to the migratory dispersal nature of this species that results in pesticide resistance and unwanted consequences⁸. This investigation is a response to the threats imposed by invasive species that resulted in loss of profit to the agricultural sector.

MATERIALS AND METHODS

Sample Collection and Preparation of Extracts

Senna sophera (L.) Roxb., *Syzygium cumini*, and *Annona squamosa* leaves were collected from trees in Llanera, Nueva Ecija. The samples were washed, dried and powdered. The larvae of *Spodoptera exigua* were collected from an onion farm in Bongabon, Nueva Ecija.

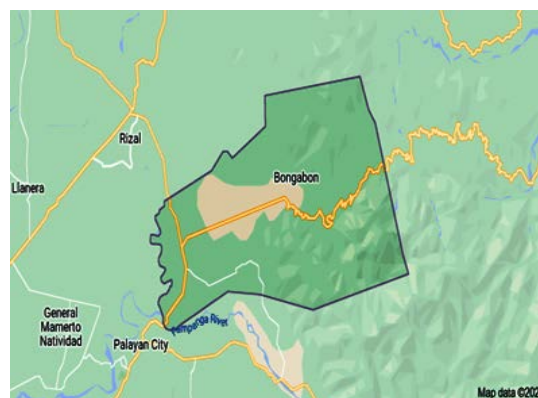


Fig. 1. Location sites of Llanera and Bongabon in Nueva Ecija, Philippines where the plant and insect specimens were obtained, respectively

The ethanolic extraction of the plant was carried out by soaking 20 g of the powders of leaves in 200 mL of ethanol for each plant and was allowed to stand for 72 h at room temperature. The extracts were filtered through Whatman filter paper No. 1 and were evaporated in a fume hood for two days. They were transferred into sterile bottles and kept in the refrigerator until further used⁸.

Phytochemical screening

Phytochemical analysis for the qualitative

detection of active phytochemical constituents was performed on the three leaves (*Senna sophera* (L.) Roxb., *Syzygium cumini*, and *Annona squamosa*) extract based on the reported protocols^{9,10,11}. Alkaloids are detected using a Mayer's test, the glycosides using a Keller-Kiliani test, the terpenoids using a Salkowki test, flavonoids using a 2.0% sodium hydroxide solution, tannins using a ferric chloride test, saponins by a permanent foam appearance, and phenols using a ferric chloride solution.

Biopesticidal activity of the plant extracts

To test for the effectiveness of the plant extracts against *Spodoptera exigua* larvae, various concentrations (2.0%, 5.0%, 10.0%, and 20.0%) of the extracts were applied by direct spraying procedure. The larval mortality was then recorded after an hour of treatment. Experiments were conducted in triplicates containing 10 larvae per replicate and compared with a control assay. The control used is a commercially available pesticide with lambda cyhalothrin as the active ingredient. Lambda cyhalothrin is a pyrethroid insecticide important in controlling pests such as aphids, Colorado beetle, and thrips¹².

The three different plant-based treatments used were ethanolic extract of *Senna sophora* (L.) Roxb., *Syzygium cumini*, and *Annona squamosa* leaves. Each treatment was investigated at four

concentrations (2.0%, 5.0%, 10.0%, and 20%). The calculation for the percent mortality was done using the Abbot's formula^{13,14}:

$$\text{Corrected \%} = \left(1 - \frac{n \text{ in } T \text{ after treatment}}{n \text{ in } Co \text{ after the treatment}} \right) \times 100$$

Where n = pest population, T = treated, and Co = control.

The LC₅₀ values are calculated using Probit analysis statistical method¹⁵.

RESULTS

1. Phytochemical screening of the three plant extracts (Table 1).
2. Biopesticidal activity of the plant extracts against *Spodoptera exigua* (Table 2).

Table 1: Phytochemical screening of *Senna sophora* (L.), *Annona squamosa*, and *Syzygium cumini* extracts

Secondary metabolites	<i>Senna sophora</i> (L.)	<i>Annona squamosa</i>	<i>Syzygium cumini</i>
Alkaloids	+	+	+
Flavonoids	+	+	-
Glycosides	+	+	+
Phenols	-	-	-
Saponins	+	+	+
Tannins	+	-	+
Terpenoids	+	+	+

(Key: + = positive test; - = negative test)

Table 2: Average percent mortality of *Spodoptera exigua* after application of the plant extracts via direct spraying method

Plant	Concentration (%)	Percent mortality after 1 hour treatment
<i>Senna sophora</i> (L.) Roxb.	control	100
	2.0	46.7
	5.0	56.7
	10.0	76.7
	20.0	100
<i>Annona squamosa</i>	control	100
	2.0	63.3
	5.0	76.7
	10.0	93.3
	20.0	100
<i>Syzygium cumini</i>	control	100
	2.0	46.7
	5.0	53.3
	10.0	63.3
	20.0	93.3

3. Toxicity analysis of the plant extracts against *Spodoptera exigua*

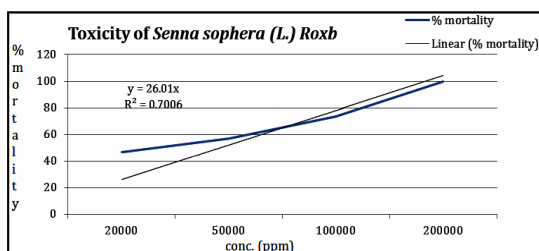


Fig. 2. LC₅₀ Graphical Method of leaf extract of *Senna sophera (L.) Roxb*

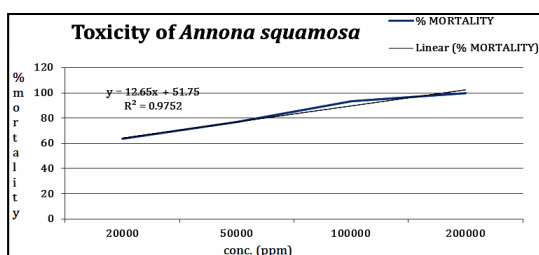


Fig. 3. LC₅₀ Graphical Method of leaf extract of *Annona squamosa*

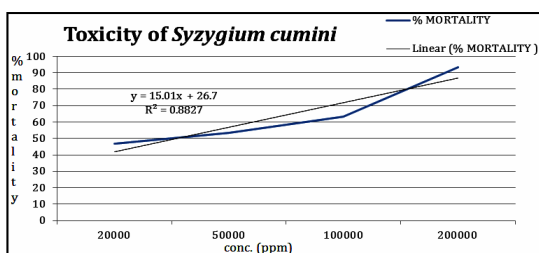


Fig. 4. LC₅₀ Graphical Method of leaf extract of *Syzygium cumini*



Fig. 5. Biopesticidal assays of the three plant extracts against *Spodoptera exigua*

DISCUSSION

Phytochemical screening of the three plant extracts

Phytochemical screening was done for the identification of secondary metabolites. The results were presented in Table 1, and it revealed the presence of various secondary metabolites of the tested plant extracts. Various phytochemicals such

as alkaloids, glycosides, saponins, and terpenoids were detected in all plant extracts. Tannins were not detected in *Annona squamosa* while flavonoids were not detected in *Syzygium cumini*. Phenols were not detected in all plant extracts. Reports on phytochemicals to be successfully applied as biopesticides against various insect and non-insect species have been reported¹⁶. Phytochemicals such as alkaloids, terpenoids, and flavonoids have been reported to interfere with the respiratory system and nervous system of houseflies¹⁷. Further, alkaloids and flavonoids are compounds known to inhibit the action of acetylcholinesterase enzyme which is an important enzyme in insects and mammals. Inhibition of acetylcholinesterase causes the accumulation of acetylcholine which in turn results in chaos in the impulse delivery system to the muscular system. All these result in muscle spasms and paralysis to insects¹⁷. Furthermore, the presence of terpenoids, tannins, and saponins in the plant extracts are recommended to be components of biopesticides due to their effects on the insects' nervous or muscle systems, hormonal balance, reproduction, and respiratory system¹⁸.

Biopesticidal activity of the plant extracts against *Spodoptera exigua*

Table 2 shows the average percent mortality of *Spodoptera exigua* after the application of the three plant extracts in different concentrations, versus a control group where in a commercially available pesticide was used. It is evident that the biopesticidal activities significantly increase in increasing concentrations of the plant extracts. The biopesticidal activities of *Senna sophera (L.) Roxb.*, *Annona squamosa*, and *Syzygium cumini* can be attributed to the presence of the different phytochemicals such as alkaloids, flavonoids, glycosides, saponins, tannins, and terpenoids that have lethal effects on the pests¹⁹. These results revealed the efficacy of the plant extracts as pesticides against *Spodoptera exigua*. High concentrations of the plant extracts are comparable with the mortality caused by the commercially available pesticides. These results agreed on the effectiveness of plant extracts as biopesticides that were applied to other species under the genus *Spodoptera*^{4,20,21,22,23}.

In terms of toxicity, the LC₅₀ of the leaf extract of *Senna sophera (L.) Roxb.* (Fig. 2) obtained from the calculation is 14899.1495ppm or 1.49%.

The calculated toxicity is >1%, which indicates it is less toxic. The LC₅₀ of the leaf extract of *Annona squamosa* (Fig. 3) obtained from the calculation is 7454.15ppm or 0.75%. The calculated toxicity is <1%, which indicates toxic. And the LC₅₀ of the leaf extract of *Syzygium cumini* (Fig. 4) obtained from the calculation is 26320.37ppm or 2.63%. The calculated toxicity is >1%, which indicates less toxic.

CONCLUSION

The extracts obtained from the solvent extraction procedure for three local plants, *Senna sophora* (L.) Roxb., *Annona squamosa*, and *Syzygium cumini*, contained different phytochemicals that can be attributed to the effectiveness on the mortality of *Spodoptera exigua*. The effectiveness of the plant extracts increases in increasing concentration of the plant extracts. The toxicity assay shows that *Annona squamosa* is the toxic extract, the other extract *Senna sophora* (L.) Roxb and *Syzygium cumini* are less toxic. Future studies

on the extraction of other parts of the plants such as fruits, stems, barks, and roots as sources of phytochemicals with potential biopesticidal activities may be conducted. Application of the plant extracts as biopesticides in actual farm set-up may be done to test the activities of the plant extracts and compare the results with the lab-based assays to be able to improve the biopesticidal properties of the plant extracts. Furthermore, this investigation presented the applicability of these local plants as sources of biodegradable and environment-friendly pesticides as alternatives to synthetic chemicals for pest control and management.

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