Extraction, Phytochemical Analysis, GC-MS Characterization and Larvicidal Activities of Leaf Extracts of *Leucas aspera and Xanthium strumarium* on *Spodoptera* Larva

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Abstract

The indiscriminate use of synthetic insecticides in agriculture has led to ecological imbalance and resistance in pests like Spodoptera species. The present study investigates the extraction, phytochemical composition, characterization and larvicidal activities of leaf extracts of Leucas aspera and Xanthium strumarium against Spodoptera larvae, a major agricultural pest. Aqueous and ethanol extracts were prepared from fresh leaves using Soxhlet extraction. Preliminary phytochemical screening revealed the presence of bioactive compounds such as alkaloids, flavonoids, tannins, saponins and terpenoids. Characterization of the extracts was carried out using Gas Chromatography–Mass Spectroscopy (GC-MS) and Fourier Transform Infrared Spectroscopy (FT-IR) to identify functional groups associated with insecticidal activity.

Larvicidal bioassays were conducted using two concentrations (50 and 100 µg) under laboratory conditions and both extracts demonstrated significant dose-dependent mortality of Spodoptera larvae. Among the two, Xanthium strumarium extract showed higher larvicidal potential. These findings suggest that Leucas aspera and Xanthium strumarium leaf extracts possess potent phytochemicals with promising biocontrol potential and can be considered as eco-friendly alternatives to synthetic pesticides in integrated pest management (IPM) programs.

Keywords: Bio-pesticides, Phytochemical, Larvicidal Activity, FT-IR, GC-MS Analysis.

Introduction

Synthetic pesticides were immediately embraced due to their effectiveness and efficacy in managing serious crop diseases such as rusts and blights[19]. The indiscriminate use of synthetic pesticides has led to several adverse effects including environmental degradation, harm to non-target organisms, contamination of food and feed with pesticide residues, pest resurgence, genetic variation in plants and negative impacts on biodiversity[12]. Pest management using plant-based products was practiced for a long time until the advent of technology and the development of synthetic pesticides[15,16]. Due to the health benefits of tomatoes, tomato plants are still widely cultivated in Tamil Nadu, particularly in the Erode region.

Detection of hazardous chemical pesticide residues in tomato and increased consumer awareness on food safety have resulted in ban of certain pesticides in agricultural production. Plant-based pesticides are gaining popularity in organic agriculture[4]. Consequently, the use of natural products studies established that botanical pesticidal constituents comprise of a variety of isolated secondary metabolites that have physiological effects (repellence, larvicidal effect, anti-feeding, acute toxicity, developmental disruption and growth suppression) on agriculturally important pests and diseases. Plants with bioactive compounds extract (water, solvents) have been used to manage different crop pests and human infections with notable success[2,10].

The plant parts are dried and ground into fine powder and extracted with organic solvents that will maximize extraction of the targeted compounds. The extracts are then concentrated, formulated and evaluated for efficacy under laboratory, controlled or field conditions. Some of the botanical compounds with pesticidal activity that have successfully been isolated and commercialized include azadiractin from neem (*Azadirachta indica*) and pyrethrin from pyrethrum (*Tanacetum cinerariifolium*) garlic (*Allium sativum*), turmeric (*Curcuma longa*) rosemary (*Rosmarinus officinalis*), ginger (*Zingiber officinale*) and thyme (*Thymus vulgaris*)[3,5].

Natural products are best option because they are less harmful to environment. Several extracts and compounds from different plants families have been evaluated for new and promising larvicides[10]. Commercialized pesticides from plants are some of the least toxic especially to non-targets organisms and they effective, are reliable and acceptable in sustainable crop protection[8].

In this view, effect of leaf different extracts of *L. aspera* and *X. strumarium* has been evaluated for their phytochemicals and larvicidal activities by FT-IR and GC-MS analysis in the management of the insect pest *Spodoptera*. Given their eco-friendly nature and reduced toxicity to non-target organisms, botanical pesticides are ideal for sustainable agriculture.

This study explores the larvicidal potential and phytochemical composition of Leucasaspera and *X. strumarium* leaf extracts against *Spodoptera* larvae, a significant pest of tomato and other crops.

Material and Methods

Collection of Plants: Fresh leaves of *L. aspera* and *X. strumarium* were collected in March 2024 from agricultural fields in the Erode region.

Preparation of the extracts: Leaves were washed, surface-sterilized, shade-dried, oven-dried (60°C, 1 hr) and ground to powder. Each 100 g sample was extracted with water, ethanol and petroleum ether using a Soxhlet apparatus for 8 hours. Extracts were concentrated using a rotary evaporator and stored at 4°C. The collected leaves were thoroughly washed with tap water and rinsed with distilled water to remove dust particles. The leaves were then surface-sterilized with a 10% sodium hypochlorite solution and rinsed with sterile distilled water. After that, it was shade-dried at room temperature for 15 days and then the leaves were packed in brown cover and kept in an oven at 60°C for an hour to make grinding easy.

After an hour, the leaves were ground using an electrical blender. The powdered plant materials were then packed in a ziplock pouch. One hundred gram of powder was extracted with different organic solvents like water, ethanol and petroleum ether for 8 hours using the Soxhlet apparatus and solvent was evaporated under vacuum in a rotary evaporator and the dried powder was stored at 4°C for further use.

Phytochemical analysis: The different extracts of *L. aspera* and *X. strumarium* were used for qualitative phytochemical analysis for flavonoids, alkaloids, phenols, sterols, glycosides, saponins and tannins[7,18].

Test for flavonoids: To 2 mL of crude extract taken in a test tube, 3-4 drops of 1% sodium hydroxide solution was added. Development of intense yellow colour, which becomes colourless on the addition of dilute hydrochloric acid, indicates the presence of flavonoids.

Test for alkaloids: Two mL of extract was stirred with 2 mL of 2N hydrochloric acid and Mayer's reagent (1.36 g mercuric chloride and 5 g of potassium iodide) and 100 mL of distilled water was added to it. Development of yellow coloured precipitate indicates the presence of alkaloids.

Test for phenols: Two mL of extract was treated with a few drops of ferric chloride solution. Development of green colour indicates the presence of phenols.

Test for steroids: Two mL of extract was dissolved in 2 mL of chloroform and filtered. The filtrate was treated with 2 mL of concentrated sulphuric acid, shaken and allowed to stand. Development of a golden yellow colour indicates the presence of steroids.

Test for cardiac glycosides: Extract was hydrolysed with dilute HCl and then subjected to test for glycosides. 2 mL of the extract was treated with ferric chloride solution and immersed in a water bath for 5 minutes. The mixture was cooled and extracted with equal volumes of benzene. The layer of benzene was separated and treated with ammonia solution. The colour change from green to pink colour in the ammonia layer indicates the presence of cardiac glycosides.

Test for saponins: Two mL of extract was diluted with distilled water and made up to 20 mL. This was shaken in a graduated cylinder for 20 minutes. Development of 1 cm thick layer of foam indicates the presence of saponins.

Test for tannins: Two mL of crude extract in 1% gelatin solution containing sodium chloride was added. Development of white colour precipitate indicates the presence of tannins.

Fourier Transform Infra-Red Spectra: IR spectrum was recorded in a spectrophotometer (Thermo Scientific NICOLED-iS5). The active principle was mixed with KBr and pellet technique was adopted to record the spectra[11].

Gas Chromatography-Mass Spectrometry (GC-MS) analysis: The GC-MS analysis was carried out using Varian 3800 gas chromatography equipped with mass selective detector coupled to front injector type 1079. The chromatography was fitted with DB 5 MS capillary column (30 m × 0.25 mm i.d., film thickness µM). The injection temperature was set at 280°C and the oven temperature was initially at 45°C, then programmed to 300°C at the rate of 10°C/min and finally held at 200°C for 5 min.

Helium was used as a carrier gas with a flow rate of 1.0 mL/min. One microliter of the sample (diluted with acetone 1:10) was injected in the split mode in the ratio of 1:100. The percentage of the composition of the compound was calculated by the GC peak areas.

GC-Mass spectrometry (GC-MS) analysis of compounds was performed using Varian 3800 gas chromatography equipped with Varian 1200 L single quadrupole Mass spectrometer. GC conditions were the same as reported for GC analysis with the same column 1000 amu. The compounds were identified based on the comparison of their retention indices (RI), retention time (RT), mass spectra of WILEY, NIST library data of the GC-MS system and literature data[1].

Test Organism: The larvae used for the study were collected from the host plants in the broad bean *Vicia faba* fields and brought to lab. They were reared on artificial diet under laboratory conditions. Studies were carried out using larvae of *Spodoptera* against the aqueous, ethanol, petroleum ether extract of all the selected plant species. The percentage control was calculated after a period of 24h by using bioassay studies.

Larvicidal Bioassays: Aqueous extracts, ethanol extract, petroleum ether extract crude extract of *L. aspera* and *X. strumarium* were prepared at Zoology department, Sri Vasavi College Erode. Two different concentrations (50%, 100%) of the extract were prepared and each mixed with one gram of overripe bean as larval food. Ten II, IV, V, VI instar larvae of uniform size and age were released in glass Petri dishes, All Petri dishes were marked with respective concentrations of extract. Each concentration was replicated fifteen times. If in any experiment, the check mortality was found more than 10%, the experiment was discarded and repeated again. The mortality of *Spodoptera* larvae feeding on the medium with extract was recorded after 24 hours. The whole experiment was repeated three times for each concentration. Minor observations on the inhibition were also recorded for 24 hours of larval exposure to the compound[10].

Results and Discussion

Phytochemical analysis: Plants have the potential to produce a range of secondary metabolites including alkaloids, terpenoids, flavonoids, phenols, glycosides, sitosterols and tannins. These phytochemicals are known to protect the plants from the attack of insect-pests. However, the production of phytochemicals varies among different plant species. Additionally, factors such as the age of the plant and the plant part (root, stem, leaf, fruit, flower, seed, or bark) have been reported to influence the production of phytochemicals. The phytochemicals produced in response to insect-pest attack, affect feeding, larvicidal effect and oviposition of insects on the plants. Application of bio-pesticides has been reported to have positive impacts on bollworm population management.

Variation in the larvicidal of plant extracts obtained using different polarity solvents was also observed in present studies. However, chemical analysis of methanol and petroleum ether extract is needed to support this hypothesis. Furthermore, the knowledge of the composition of extraction solvent and its dissolution abilities and binding with phytochemicals should be focused on closer insight into plant-based larvicidal development.

Further, solvent extract was subjected to preliminary phytochemical analysis for the confirmation of major group of compounds flavonoids, alkaloids, phenols, sterols, glycosides, saponins and tannins. In present studies in *L. aspera* extracts showed positive results for the presence of flavonoids, alkaloids, sterols, saponins, tannins and flavonoids, alkaloids, phenols, sterols, glycosides and tannins in the preliminary analysis of phytochemicals from *X. strumarium* herb.

Previous reports[13] studied the *P. daemia* subjected to phytochemicals quantitative analysis of the leaves showing the presence of flavonoids, steroids, alkaloids, terpenoids, saponins, phenols, carbohydrates, amino acids, tannins and cardiac glycosides. Wahedi et al[20] reported that the aqueous and ethanol extracts of *Cymbopogon citratus* and *Annona senegalensis* were phytochemicals. Further alkaloids, flavonoids, saponins, steroids, tannins, terpenoids and glycosides were present in both species. However, there is paucity of information on the identification of probable biopesticide phytochemical constituents, which could be responsible for the larvicidal activities of the solvent extract of *L. aspera* and *X. strumarium* (Table 1). Both plant species showed positive results for flavonoids, alkaloids, steroids, tannins and saponins. *X. strumarium* also contained glycosides and phenols. These compounds are known to influence feeding behavior, larval development and reproductive cycles in insects.

FT-IR analysis: Herbal extract have been shown to interact with a large number of important phytochemical, thereby regulating a range of biopesticide activities. The structural diversity exhibited by these molecules might be responsible for different infractions. Therefore, it has become more and more important to interpret the structural information represented by these complex molecules in order to understand their structure-function relationship.

In the FT-IR spectrum of the plants crude extracts of *L. aspera, X. strumarium* was determined. The FT-IR spectrum of the crude extracts band started from 3927.07 cm-^{1} and 3929.00 cm^{-1} and down to 470.63 cm-^{1} and 474.49 cm^{-1}. Among between them, five and three are major peaks 3427.51, 2353.16, 1645.28, 1541.12 cm-^{1} and 1386.82 cm-^{1} and 3410.15, 1643.35 and 1384.89 cm-^{1}. Absorbance and functional groups are interpreted as follows: 3927.07 cm^{-1} indicates N-H stretching, 2353.16 cm^{-1} indicates C-H stretching, 1645.28 cm^{-1} indicate C=O stretching, 1386.82 cm^{-1} indicates O-H bending and 470.63 cm^{-1} indicates C=O stretches.

Table 1
Preliminary phytochemical analysis of *L. aspera* and *X. strumarium*

S.N.	Phytochemicals	*L. aspera*	*X. strumarium*
1	Flavonoids	+	+
2	Alkaloids	+	+
3	Phenols	-	+
4	Steroids	+	+
5	Glycosides	-	+
6	Saponins	+	-
7	Tannins	+	+

Some major compounds were amine, alkane, caboxylic acid, alcohol and ester. The FT-IR spectrum of *L. aspera*, *X. strumarium* is shown in figures 1a and 1b. Previous reports[11] studied the methanolic leaf extract of *P. daemia* identified by FT-IR analysis absorbance and functional groups interpreted as follows: 3385.04 cm^{-1} indicates N-H stretching, 2922.55 and 2854.24 cm^{-1} indicate C-H stretching, 1631.88 cm-1 indicates C=C stretching and 1030.27 cm^{-1} indicates S=O stretching. In the present investigation, some major functional groups compounds were amine, alkane, caboxylic acid, alcohol and ester (Fig. 1a and b). These indicate the presence of amines, alkanes, carboxylic acids and esters-compounds linked with insecticidal activity.

GC-MS analysis: The GC-MS analysis of crude extracts of leaves of *L. aspera* was analysed. From the GC-MS study, a total of 5 major compounds were identified. Peak area and mol. wt. were determined. Mass spectrum of the biopesticide compounds with their retention time (RT) is shown in the figures 2a and 2b. Some major compounds were hydroxyl groups, phenyl, sulfo acid, hexadecanoic acid, methyl (butyl), alkane etc. The GC-MS analysis of crude extracts of leaves of *X. strumarium* was analysed.

From the GC-MS study, a total of 7 major compounds were named. Molecular weight and peak area were identified. Some major compounds were diketones, amide derivative, phenyl, phytosterol, carboxylic acid, oxy butane, alkane etc. Earlier report[13] supported GC–MS analysis of phytochemical constituents of methanolic fraction of *Annona muricata* leaf as 3-dihydro-3,5-dihydroxy-6-methyl- (6.59%), methyl ester (8.20%), n- hexadecanoic acid (5.0%), methyl ester (12.61%), oleic acid (2.71%), β-sitosterol (2.38%), octadecanoic acid (7.44%), quercetin, 5TMS derivative (4.04%).

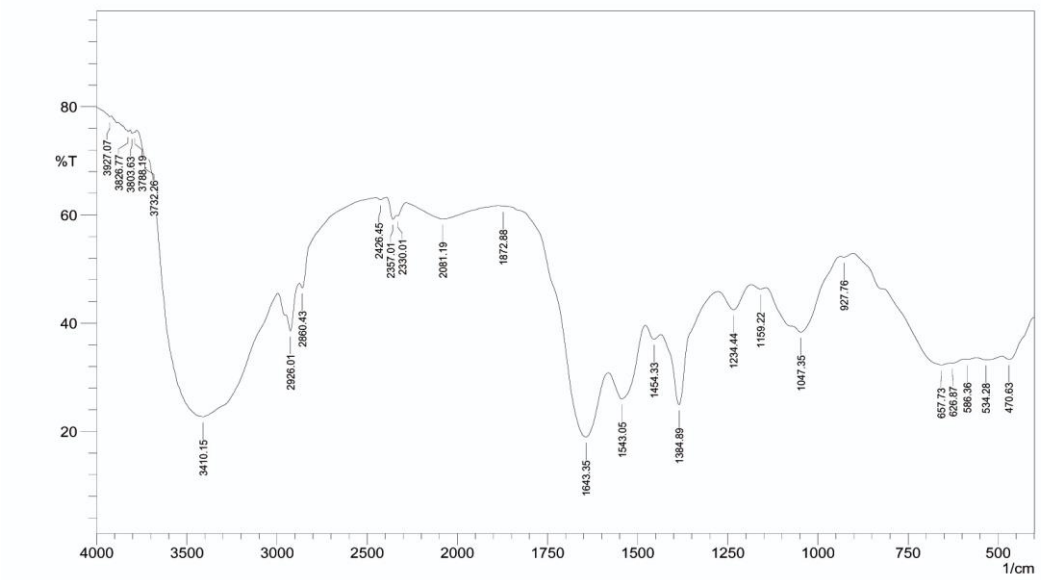

Fig. 1a: FT-IR absorption and functional group of leaves of *L. aspera*

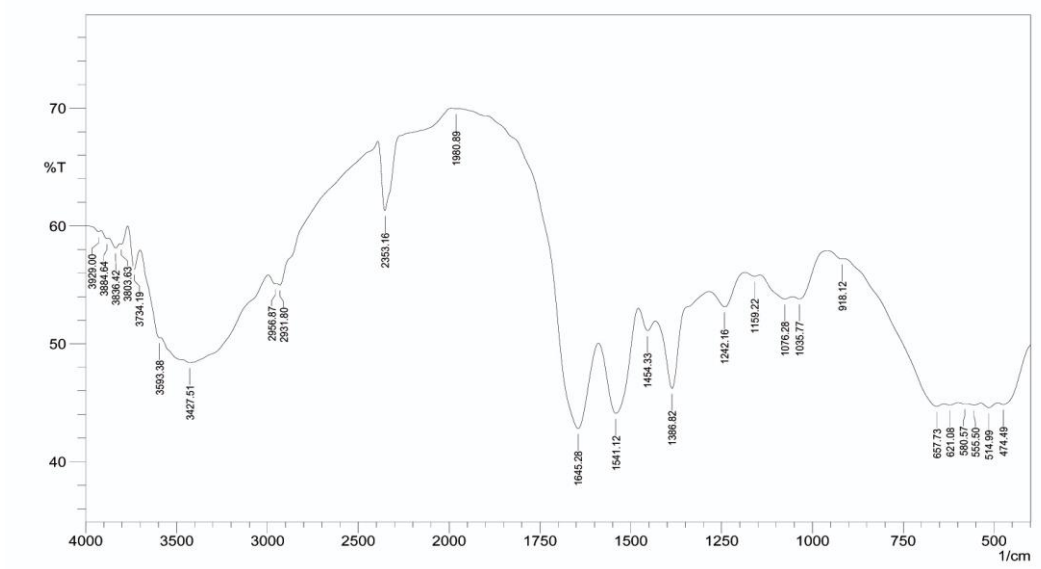

Fig. 1b: FT-IR absorption and functional group of leaves *X. strumarium*

Table 2a
Larvicidal activity larvae of *Spodoptera* control on broad bean with various concentrations of aqueous extract from *L. aspera* and *X. strumarium*

Plant species	*Spodoptera*	50µg			100µg		
		24	48	72	24	48	72
L. aspera	II Instar Larva	12.33^{j}	14.40^{j}	19.93^{i}	28.40^{g}	27.80^{j}	26.30^{i}
	III Instar Larva	19.43^{g}	19.16^{i}	19.34^{i}	36.30^{f}	37.90^{i}	39.43^{h}
	IV Instar Larva	35.40^{f}	34.60^{f}	36.40^{f}	41.00^{e}	45.20^{f}	48.40^{e}
	V Instar Larva	42.07^{e}	45.47^{e}	47.60^{e}	53.00^{c}	54.07^{c}	58.70^{b}
	VI Instar Larva	54.67^{c}	52.90^{d}	49.40^{d}	41.73^{e}	42.47^{h}	43.23^{g}
X. strumarium	II Instar Larva	21.90^{i}	23.37^{h}	29.33^{h}	52.53^{c}	51.83^{d}	56.80^{c}
	III Instar Larva	28.30^{h}	28.33^{g}	31.30^{g}	48.83^{d}	44.10^{g}	49.63^{d}
	IV Instar Larva	61.13^{b}	66.27^{b}	69.47^{b}	69.43^{a}	66.63^{a}	65.93^{a}
	V Instar Larva	69.37^{a}	71.43^{a}	72.17^{a}	57.57^{b}	59.37^{b}	57.63^{c}
	VI Instar Larva	52.70^{d}	54.07^{c}	54.17^{c}	48.73^{d}	47.70^{e}	45.83^{f}
Significance		0.00	0.00	0.00	0.00	0.00	0.00
F Value		4328.255	3419.110	3961.986	1276.619	1013.800	944.625

Table 2b
Larvicidal activity larvae of *Spodoptera* control on broad bean with various concentrations of ethanol extract from *L. aspera* and *X. strumarium*

Plant species	*Spodoptera*	50µg			100µg		
		24	48	72	24	48	72
L. aspera	II Instar Larva	10.70^{j}	12.27^{i}	18.70^{j}	35.87^{j}	41.53^{i}	54.53^{h}
	III Instar Larva	18.50^{i}	19.30^{h}	23.67^{i}	41.57^{h}	48.70^{g}	56.60^{g}
	IV Instar Larva	48.60^{e}	56.43^{f}	33.63^{f}	45.53^{g}	48.67^{g}	49.13^{i}
	V Instar Larva	47.73^{f}	64.03^{c}	49.57^{e}	49.67^{e}	58.53^{d}	63.57^{e}
	VI Instar Larva	56.33^{d}	57.37^{e}	52.43^{d}	37.73^{i}	49.77^{f}	57.13^{g}
X. strumarium	II Instar Larva	27.90^{h}	28.70^{g}	31.60^{h}	47.97^{f}	54.33^{e}	64.57^{d}
	III Instar Larva	31.87^{g}	29.13^{g}	32.70^{g}	58.47^{d}	45.97^{h}	59.60^{f}
	IV Instar Larva	65.53^{b}	67.50^{b}	78.50^{a}	74.53^{a}	85.77^{a}	87.60^{a}
	V Instar Larva	71.70^{a}	76.57^{a}	77.73^{b}	64.37^{b}	74.53^{b}	78.40^{b}
	VI Instar Larva	61.40^{c}	59.53^{d}	61.40^{c}	61.50^{c}	68.97^{c}	66.57^{c}
Significance		0.00	0.00	0.00	0.00	0.00	0.00
F Value		5826.843	10329.966	12570.745	3173.724	3661.939	3156.941

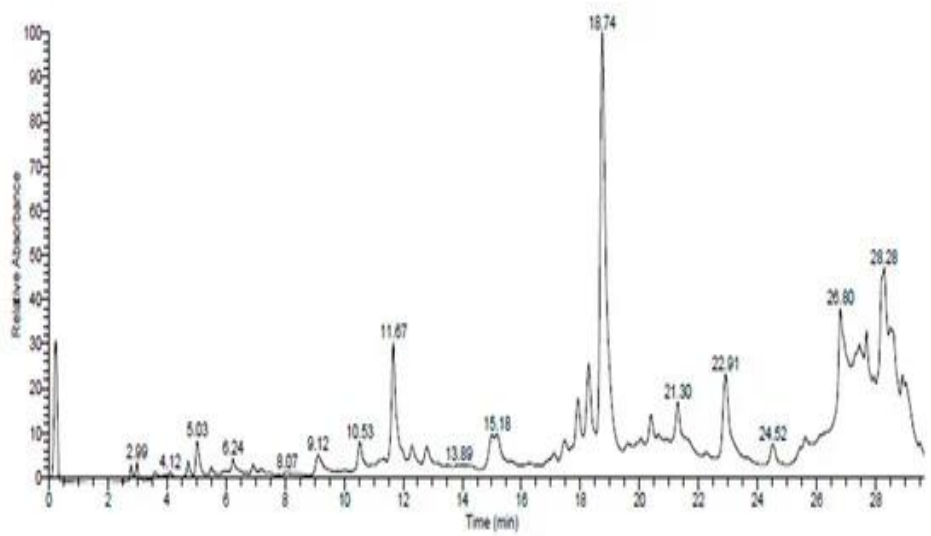

Fig. 2a: GC-MS absorption and functional group of leaves of *L. aspera*

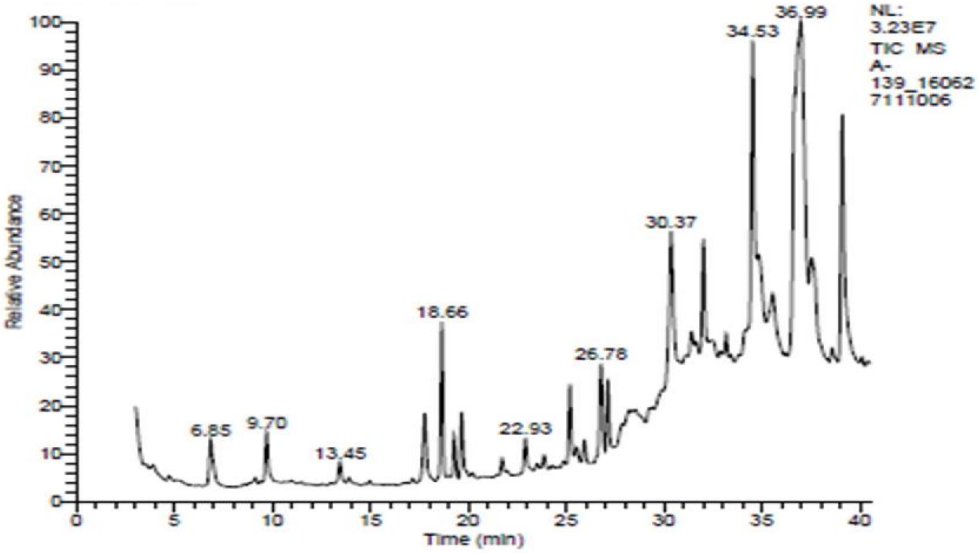

Fig. 2b: GC-MS absorption and functional group of leaves of *X. strumarium*

The plant extraction of *Hordeum vulgare* includes hexadecanoic acid, methyl ester (6.84%), n-Hexadecanoic acid (8.58%), 9,12-Octadecanoic acid (Z,Z)-, methyl ester (8.04%), 9,12-Octadecadienoic acid (Z,Z) (57.01%), Lup-20(29)-en-3-one (3.57%), γ-Sitosterol (3.31%)[6]. These peaks indicate the presence of chemical compounds which have been isolated from other medicinal plant species *L. aspera* and *X. strumarium*. These mainly comprised of secondary metabolites such as flavonoids, esters, phenolics, aldehydes, carbohydrates, amino acids, tannins, ketones and were believed to play an important role in plant defensive system.

Present experiment shows that the larvicidal effect arises because of the presence of substances (crude compounds) that are inhaled or touched. The stronger is the mixture of the compounds absorbed by the larva body, the stronger is the ability to eat and ultimately the growth decreases. The *X. strumarium* extract using petroleum ether extract has more mortality as 81.9% (IV instar), 89.7% (V instar), 81.3% (VI instar) with at 50µg concentration and at 100% concentration of extract, the mortality was 87.3% (IV instar). Present larvicidal result depended on the source plant and the concentrations used and their efficacy is dependent on the species of the source plant.

Extracts from these plants have been reported to interfere with larvicidal of the insect pests associated with paralysis and blockage of electron transportation in respiratory processes of insects, immobilization and toxicity. In the present investigation, GC-MS analysis revealed major compounds including hexadecanoic acid, phenyl derivatives and phytosterols. These metabolites are known to cause neurotoxicity and metabolic disruption in insects. *X. strumarium* extracts showed more diversity and stronger activity.

Larvicidal Activity: Present plant crude extracts were found to have different type of pest management properties in laboratory condition against pests of Tomato *Spodoptera* identifying the active principles in the plant products. Diseases and insect pests are the major limiting factors in the production of high quality agricultural products. Although conventional bio-pesticides have become an indispensable tool in controlling some pests economically, rapidly and effectively, extensive use of insecticides may lead to a number of undesirable side effects including the development of insect resistance and resurgence of primary and secondary pests outbreaks. The importance of botanical pesticides is attributed to their efficacy, biodegradability, varied modes of action, low toxicity as well as availability of source materials.

The observation presented in the highest value on larvicidal found the percent mortality of II, III, IV, V, VI instar larvae of *Spodoptera* after 24, 48, 72 hours of exposer as presented in table 2a, at 50% concentration of *L. aspera* aqueous extract, the high mortality was 54.3%, 52.7%, 49.3% (VI instar) larva with at 50µg concentration and at 100% concentration of extract, the mortality was 52.4%, 51.3%, 56.8% (II instar), 69.3%, 66.7%, 65.8% (IV instar), 57.8%, 59.8%, 57.1% (V instar) estimated. A smaller amount in mortality was observed with various *L. aspera* extracts in dose concentration such as at 50% concentration, the mortality observed was 12.3%, 14.8%, 19.6%. Gradual loss in mortality was observed with various *X. strumarium* extracts in dose concentration, such as at 50% concentration, the mortality observed was 21.5%, 23.6% and 29.8%.

The aqueous leaf extracts of *Gnidia glauca* showed more than 50% larval mortality at 0.8-1.0% and 86.1% mortality observed at 1.0% on *Toddalia asiatica* extract against the sixth-instar larvae of *H. armigera*[17]. Dirgayana et al[4] reported that pests began to be found at 14 DAP (Day after Planting) with an average of 2 individuals and the highest population was found at 70 DAP with an average of 29 individuals on tomato plants. The leaf aqueous extracts of three plants namely *A. paniculata,* C. *roseus* and *D. metal*

exhibited high rate of mortality of the insects ranging from 10.8 to 72.8. Decreasing order of *A. paniculata* > *C. roseus* > *D. metal* > *A. amara* > *C. halicacabum* > *A. indicum* > *C. tora* > *T. terrestris* > *A. aspera* > *A. lanata* against the larvae is of *H. armigera*[15].

Farooqi et al[6] found that the toxicological evaluation of *Otostegia limbata* was done against the third instar larvae of *Drosophila melanogaster* (Meigen) for 24hours of exposure extract having concentrations of 2%, 3%, 4%, 5% and 6% mixed with 1 gram of overripe banana fed caused 12%, 24.6%, 44%, 68%, 89% mortality and showed 100% death at higher concentration.

In the present investigation, the aqueous extraction of *X. strumarium* gave noticeable mortality of more than 71.4%, 72.8% (V instar), at very low concentration like 50%. The difference in the larvicidal of the two studies may be due to the difference in larva species or extract solvent used.

Two plant extracts were used to determine the larvicidal activity against the *Spodoptera* larvae. The results of this trial indicated that all two plant extracts exhibited some degree of activities deterrence when sprayed with 50, 100% w/v concentrations. From the result found during the study period, the percent mortality of II, III, IV, V, VI instar larvae of *Spodoptera* after 24, 48, 72 hours of exposure is presented in table 2b, at 50% concentration of *L. aspera* ethanol extract. The maximum mortality was 56.7% (IV instar), 64.2% (V instar), 56.3%, 57.2%, 52.9% (VI instar) larva with at 50µg concentration and at 100% concentration of extract the mortality was 56% (III instar), 58.3%, 63.7% (V instar), 57.1%, (VI instar) estimated.

A minimum amount in mortality was observed with various *L. aspera* extracts in dose concentration, such as at 50% concentration the mortality observed was 10.9%, 12.3%, 18.7%. The percent mortality of II, III, IV, V, VI instar larvae of *Spodoptera* after 24, 48, 72 hours of exposure. At 50% concentration of *X. strumarium* ethanol extract, the more mortality was 65.3%, 67.2%, 78.9% (IV instar), 71.2%, 76.3%, 77.8% (V instar), 61.4%, 59.7, 61.3% (VI instar) with at 50µg concentration and at 100% concentration of extract the mortality was 74.9%, 85.3%, 87.9% (IV instar), 64.8%, 74.6%, 78.2% (V instar), 61.5%, 69.4%, 66.7% (V instar) estimated. Gradual loss in mortality was observed with various *X. strumarium* extracts in dose concentration, such as at 50% concentration, the mortality observed was 27.6%, 28.3%.

A minimum economic injury level of one beet armyworm larva per 20 tomato plants was determined to prevent economic yield loss in tomato[9]. Panezai et al[14] showed that mean percent mortality of *Trogoderma granarium* larvae against different experimental ethanol extract had significant effect found in *Rosmarinus officinalis* extract which was 65.00%, the average mortality of 36.67% was found in *Melissa officinalis*. The effectiveness of the ethanol extract depends on the extraction method used. Larvicidal property of *L. aspera* and *X. strumarium* plant extracts brings about retardation of growth and ultimately results in control of the *Spodoptera* larva. However, compounds which do display larvicidal property, are reported to have growth regulatory activity. At high and low concentrations, they are as effect deterrents, also as growth inhibitors.

Conclusion

The study reveals that leaf extracts of *L. aspera* and *X. strumarium* can potentially be used as eco-friendly bio-pesticides to control the devastating damage caused by IV, V and VI instar larvae of *Spodoptera*. Larval attack is usually in the vegetative phase, namely the larvae eat the young leaves of tomato plants. Plant damage in the vegetative phase will disrupt the production process. The pest attacks during the development process will disrupt the process of fruit formation.

However, these compounds have considerable benefits and are precursors in sustainable tomato agriculture. Present finding of novel control and/or larvicidal from plant extracts has been recently emphasized as a potential method for the development of ecologically safe bio-pesticides.

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