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# Phytochemical analysis and bioefficacy of *ficus carica* against fall armyworm, *spodoptera frugiperda*

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**ABSTRACT**

The fall armyworm, Spodoptera frugiperda, is a very harmful pest of maize crops and can cause complete crop loss if not controlled. Farmers mainly use chemical pesticides to manage this pest, but over time the insect has developed resistance to many of these chemicals. To find safer alternatives, this study tested plant-based extracts from Ficus carica. Leaves were extracted using different solvents to identify useful chemical compounds and test their effectiveness against the pest. The results showed that the acetone extract contained alkaloids, phenolic, flavonoids, tannins and terpenoids compounds, while ethanol, methanol and water extracts shows less compounds. Among them, the methanol extract was the most effective, showing strong effects on eggs 85%, insects 80% and antifeedant 49%, followed by the ethanol (50%, 70%, 57%) , acetone (50%, 60%, 47%) and aqueous extract shows less activity. Overall, methanol and ethanol were the best solvents for extracting insect-killing compounds from this plant and they were used as an eco-friendly method to control fall armyworm.

## 1. Introduction

The fall armyworm, Spodoptera frugiperda (J.E. Smith), is a highly destructive pest that primarily affects maize, rice, and sorghum, but can also damage many other crops. The fall armyworm originally native to the tropical and subtropical regions of the Americas. It was first detected in Africa in January 2016. Since then, it has spread widely across sub-Saharan Africa, Egypt, the Canary Islands, and many parts of Asia, as well as to countries like Australia and New Zealand. This invasion threatens the food security of over 200 million people in Africa, particularly since maize is a staple crop in many of these regions. The pest causes significant crop damage, with estimated annual yield losses of USD 9.4 billion in Africa alone (Marc, 2023).

Farming methods was used to increase food production in shoddier countries. This was done by using large amounts of chemical fertilizers, synthetic pesticides, and genetically modified crops. Around 67,000 species (like pests, weeds, or diseases) can seriously affect crops, and without using these chemicals to protect the plants, over 70% of agricultural production could be badly affected (Ngegba et al., 2022). Human activities change the environment and cause harmful effects to nature in many ways, including overuse of pesticides, decreases soil nutrients, which damages the land. Soil losing its quality, becoming less fertile and productive (Kumar et al., 2021). Chemicals are used in farming to help plants grow and to protect them from pests and disease. Also those products improve crop yields but many of them are toxic because they show harmful effects on people and environment. (Goncalves et al., 2021). However, most of these chemical pesticides do not break down naturally and persist in the environment for a long time causing harmful effects living beings. Researchers are now looking for safer and more natural ways to manage pests. The natural organic sprays or biopesticides or growing crops in ways that make them more resistant to pests and diseases (Essiedu et al., 2020) are alternates to chemical pesticides. Biopesticides can help farmers grow healthy crops in a way that is better for the planet and supports long-term, sustainable farming (Samada et al., 2020). Biopesticides didn't target only specific pests and don't harm helpful insects or other living things. Today, most of the farmers are choosing biopesticides. By using biopesticides, farmers can reduce their impact on the environment and lower their carbon footprint while still protecting their crops (Mawcha et al., 2025).

## 2. Materials and Methods

### 2.1. Collection and extraction of plant material

Fresh fig leaves (*Ficus carica*) were collected from near Devchand College camps. The leaves were washed with tap water. After washing, they were left to air dry at room temperature (28°C) at the DST-FIST Science Instrumentation Facility Center, Devchand College, Arjunnagar and dried leaves were ground in to fine powder by using electric grinder. To make the plant extracts, 20 grams of the dried leaf powder were soaked in 200 mL of four different solvents such as acetone, methanol, ethanol, and distilled water. These mixtures were placed on an orbital shaker (a machine that gently shakes) at 120 rpm for 24 hours to help the extraction process. After shaking, the mixtures were filtered by using Whatman No. 1 filter paper to remove solid parts. The liquid (solvent) in the filtered extracts was then left to evaporate naturally at room temperature. The remaining crude extracts were collected in clean glass (Borosil) vials and stored in a refrigerator at 4°C (Laxmi et al., 2022).

### 2.2. Qualitative Phytochemical analysis

Qualitative phytochemical analysis is done by using standard methods of Sofowara (1993), Trease and Evans (1989) and Harborne (1973). All solvent extracts of selected plant species were diluted to mg/ml concentration and used for the analysis.

### 2.3. Insect Rearing:

*Spodoptera frugiperda* (Fall Armyworm) was used for the present study, which is belongs to the order Lepidoptera and family Noctuidae. Rearing is done by using the standard method given by Arivoli and Tennyson (2013) with modification by (Guruprasad 2024).

### 2.4. Ovicidal Activity Assay

Spraying method; intact egg masses were collected using a fine brush or forceps. Choose egg masses of similar size and developmental stage to reduce variability. Egg masses (20 eggs) were placed on filter paper in a Petri dish and uniformly spray each egg mass with 1 mL of the test solution. Allow the egg masses to dry at room temperature for 15–20 minutes. Experiments with three replicates per concentration were designed. The treated eggs were transferred to an incubator set at 25 ± 2°C and 65–75% RH, with a photoperiod of 12 hours light and 12 hours dark. Monitored the egg masses at 24-hour intervals for up to 72 hours or until most untreated eggs have hatched. The ovicidal activity (Hatchability %) was recorded by counting hatched and un-hatched eggs and analyzed statistically (Malarvannan et al., 2009).

**Hatchability (%)** = Number of eggs hatched ÷ Total number of eggs ×100.

### 2.5. Insecticidal activity

Insecticidal activity is done by using the topical method by (Pavela et al., 2005). Third instar larvae of *S. frugiperda* was used for the experiment. Place ten third instar larvae of *S. frugiperda* in each petri dish lined with moist filter paper and maize leaf as food. Use micro-pipette to apply the solution. Use 2mL different concentrations of the solution (0.5%, 1%, 2.5%, and 5%) is applied directly onto the back (dorsum) of each larva. Three replicates are used for the experiments. Monitor the larvae for 24-hours interval and record how many are dead, weak or moving poorly (moribund), or healthy. Insecticidal activity is analyzed by counting dead and live larvae.

**Mortality (%)** = Number of dead larvae ÷ Total larvae per treatment ×100

### 2.6. Antifeedant activity

Antifeedant activity of selected plant extracts was studied by using the leaf disc no-choice method, following the procedure described by Isman et al. (1990) and Arivoli and Tennyson (2013)., with slight modifications. Fresh leaf discs (2cm) of maize treated individually with different concentrations of the plant extracts (0.5%, 1%, 2.5%, and 5%). Place leaf disc in petri dish with moist filter paper to prevent the leaf discs from drying. A single third instar larva of *S. frugiperda* was introduced into each dish. Three replicates were maintained for each concentration. The amount of leaf area consumed by the larvae after 24 hours was recorded and calculated by using formula,

$$\textbf{Antifeedant activity} = \frac{C-T}{C+T} \times 100$$

 

Where, C= area of consumption in the control, T = area of consumption in the treatment

**3. Result and Discussion:**

The qualitative phytochemical analysis of *Ficus carica* plant extracts in different solvents- acetone, ethanol, methanol and water are shows the presence of different secondary metabolites such as alkaloids, phenolic, flavonoids, tannins and terpenoids. In this analysis Acetone extract shows the presence of alkaloids, phenolic, flavonoids, tannins and terpenoids, where the ethanol, methanol and aqueous extract show less compounds.

Table 1

Qualitative phytochemical analysis

| Plant species | Solvents | Alkaloids | Phenolics | Flavonoids | Tannins | Terpenoids |
|---|---|---|---|---|---|---|
| ***Ficus carica*** | Ethanol | **+** | **+** | **+** | **+** | **-** |
| | Methanol | **+** | **+** | **+** | **+** | **-** |
| | Acetone | **+** | **+** | **+** | **+** | **+** |
| | Water | **+** | **+** | **+** | **+** | **-** |

**+ = Present, -= Absent**

**Ovicidal activity**

Table 2

Ovicidal activity of F. carica extract against S. frugiperda pest

| Name of plant | Solvent | 0.5% | 1% | 2.5% | 5% |
|---|---|---|---|---|---|
| ***Ficus carica*** | Acetone | 15± 0.1 | 25±0.2 | 40±0.2 | 50±0.3 |
| | Ethanol | 20±0.2 | 35±0.1 | 45±0.1 | 50±0.2 |
| | Methanol | 25±0.1 | 45±0.1 | 65±0.2 | 85±0.1 |
| | Distilled water | 15±0.1 | 20±0.2 | 35±0.3 | 40±0.3 |
| | Control | 30±02 | 33±0.3 | 25±0.1 | 45±0.1 |

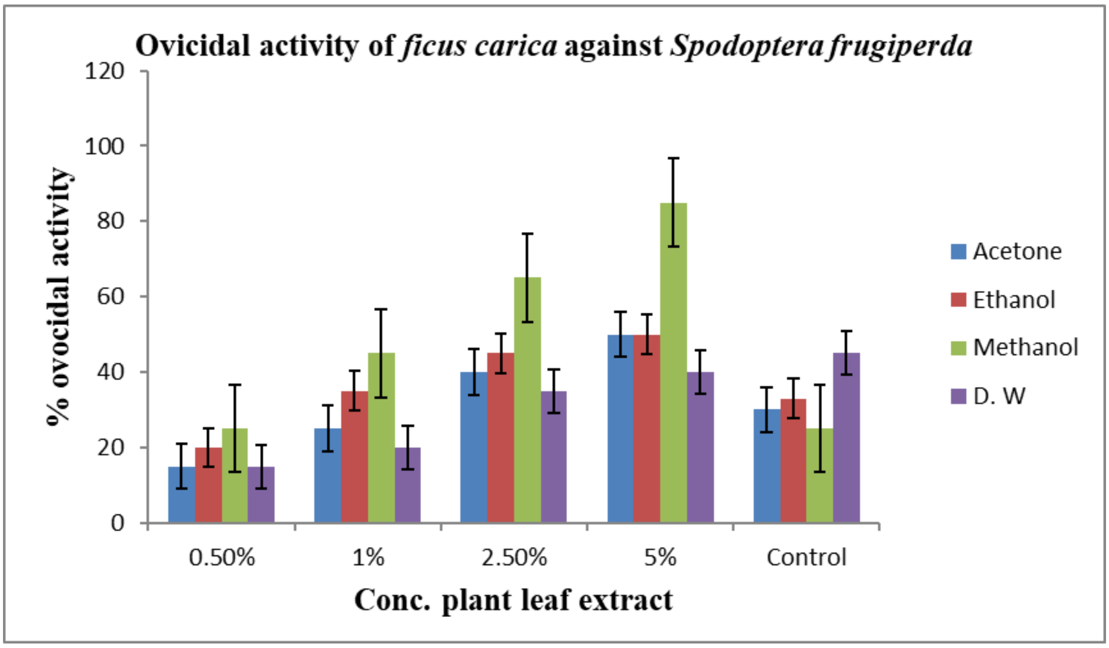


Fig 1: Ovicidal activity of *ficus carica* against *Spodoptera frugiperda*

The ovicidal activity of *Ficus carica* leaf extracts against *Spodoptera frugiperda* eggs was evaluated using four different solvents (acetone, ethanol, methanol, and distilled water) at different concentrations (0.50%, 1%, 2.50%, and 5%). The results show a clear concentration-dependent increase in ovicidal activity across all solvent types. The methanolic extract shows highest ovicidal activity 85% in 5% concentration where acetone and ethanol shows 50% ovicidal activity in 5% concentration. Aqueous extract shows lowest activity i.e. 40%.

### Insecticidal activity

Table 2
Percentage of Insecticidal activity of F. carica extract against S. frugiperda

| Name of plant | Solvent | 0.5% | 1% | 2.5% | 5% |
|---|---|---|---|---|---|
| ***Ficus carica*** | Acetone | 20±0.1 | 40±0.2 | 50±0.2 | 60±0.1 |
| | Ethanol | 30±0.1 | 50±0.1 | 60±0.1 | 70±0.1 |
| | Methanol | 40±0.2 | 60±0.1 | 70±0.1 | 80±0.1 |
| | Distilled water | 10±0.1 | 30±0.1 | 40±0.1 | 60±0.1 |
| | Control | 32±0.1 | 30±0.1 | 40±0.2 | 50±0.1 |

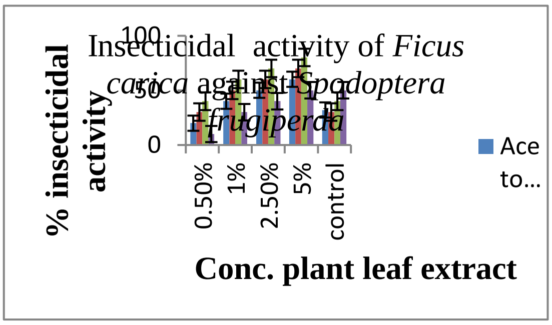


Fig 2: Insecticidal activity of *Ficus carica* against *Spodoptera frugiperda*

Methanol proved to be the most effective solvent, showing the highest larval mortality at all concentrations, reaching 80% at 5%.Ethanol followed closely, showing increasing mortality from 30% at 0.5% to 70% at 5%. Acetone extract showed moderate activity with mortality ranging from 20 ± 0.1 to 60 ± 0.1. Distilled water extract showed the least effectiveness, although still demonstrating a concentration-dependent increase in mortality, from 10± 0.1 to 60± 0.1. The higher mortality rates associated with methanolic and ethanolic extracts suggest that these solvents are more effective in extracting the bioactive compounds responsible for larvicidal action from *F carica* leaves (Nimra et al., 2024).

 

**Antifeedant activity**

Table 4.
Antifeeding activity of *F. carica* extract against *S. frugiperda* pest.

| Name of plant | Solvent | 0.5% | 1% | 2.5% | 5% |
|---|---|---|---|---|---|
| ***Ficus carica*** | Acetone | 43±0.3 | 44±0.4 | 46±0.2 | 47±0.3 |
| | Ethanol | 35±0.1 | 41±0.1 | 45±0.1 | 47±0.1 |
| | Methanol | 42±0.1 | 45±0.1 | 47±0.2 | 49±0.2 |
| | Distilled water | 29±0.3 | 29±0.2 | 38±0.5 | 42±0.6 |
| | Control | 35±0.1 | 30±0.2 | 35±0.1 | 29±0.3 |

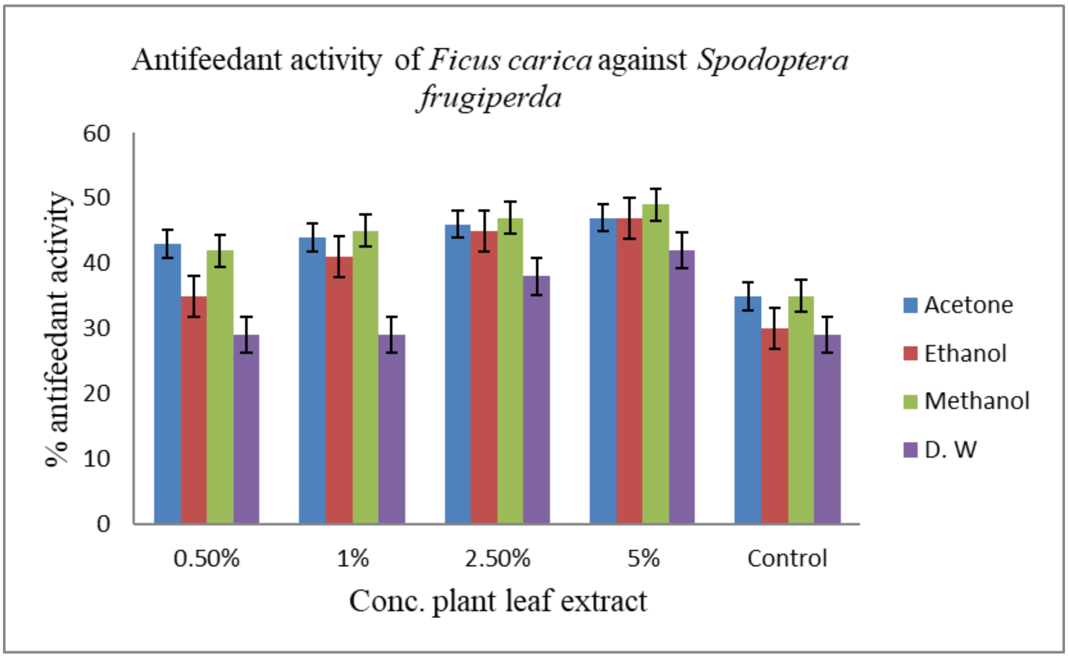


Fig 3: Antifeedant activity of *Ficus carica* against *Spodoptera frugiperda*

Table 4 indicate that the antifeeding activity of *Ficus carica* extract increased with concentration across all solvents. Methanolic extract the highest antifeeding activity at 5% concentration 49%, followed by acetone 47% and ethanol 47% Distilled water extract showed the lowest activity which confirms that water is a less effective (Mojica et al., 2010).

**Summary and Conclusion**

This research aims to expand the knowledge of plant-based natural compounds as a viable solution for pest management, specifically targeting *S. frugiperda*, a major agricultural pest. By identifying antifeedant compounds from *F. carica* this study could contribute to the development of new sustainable methods for controlling pest populations in agricultural ecosystems. Moreover, it provides insights into the broader potential of *F. carica* as a source of bioactive compounds with diverse agricultural and medicinal applications. The study shows that *F. carica* extracts exhibit significant ovicidal activity against *S. frugiperda*, with efficacy varying based on the solvent and concentration used. Among all solvents methanol extract showed the highest ovicidal potential, especially in 5% concentration. Insecticidal activity, the results shows the potential of *F. carica* as a natural insecticide against *S. frugiperda*. Methanol was the most efficient solvent for extracting insecticidal compounds which shows 80% activity. In antifeedant activity of *F.*

 

*carica* 5% Methanolic extract shows 49% result. This study shows that using wild plants is best way to control pests without causing harmful effect to the environment. F carica is rich in helpful chemicals such as tannins, phenols, alkaloids, flavonoids, terpenoids, and saponins. When plant extracts of F. carica were tested against S. frugiperda, they showed strong ability to repel the pest. These plants could be a good source of natural pesticides to protect crops from these pests.

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