

**EFFECTS OF AQUEOUS SEED EXTRACT OF  
*TEPHROSIA VOGELII* ON BEAN WEEVIL  
(*ACANTHOSCELIDES OBTECTUS*) INFESTING  
COWPEA (*VIGNA UNGUICULATA*) IN JOS  
SOUTH L.G.A., NIGERIA**



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**Abstract**

*Tephrosia vogelii* is a leguminous plant widely recognized for its insecticidal, medicinal, and soil-enriching properties in tropical Africa. This study evaluated the insecticidal effects of aqueous seed extracts of *T. vogelii* (commonly known as “fish bean poison”) against the bean weevil, *Acanthoscelides obtectus*, a major postharvest pest of cowpea (*Vigna unguiculata*). Two hundred adult weevils were collected and divided into four groups of fifty individuals each. The insects were exposed to aqueous seed extract concentrations of 100, 200, 400, and 600 mg/mL, designated as treatments T<sub>1</sub>–T<sub>4</sub>, while a control group received no extract. Mortality was monitored at 7-day intervals over 28 days. Phytochemical screening of *T. vogelii* seed extracts revealed the presence of saponins, tannins, flavonoids, glycosides, alkaloids, and cardiac glycosides. Results indicated that mortality increased with extract concentration, with the highest mortality recorded at 600 mg/mL. These findings suggest that aqueous seed extracts of *T. vogelii* possess significant insecticidal potential and could serve as an affordable, eco-friendly botanical alternative to synthetic pesticides in controlling *A. obtectus* infestations.

**Keywords:** *Tephrosia vogelii*, bean weevil, *Acanthoscelides obtectus*, cowpea, botanical insecticide

## Introduction

Crop losses due to insect pests continue to pose a serious threat to food security and income generation in sub-Saharan Africa. Among the most destructive postharvest pests of legumes is the bean weevil, *Acanthoscelides obtectus* Say (Coleoptera: Chrysomelidae), which attacks stored cowpea (*Vigna unguiculata*) and other beans, causing extensive damage to seed structure, quality, and viability (Alvarez et al., 2015; Atoyebi et al., 2022). Infestation leads to grain perforation, reduced germination, and contamination by microorganisms, resulting in postharvest losses ranging from 10% to 37% depending on storage conditions (Nderitu et al., 2010; Ilesanmi et al., 2021). Although synthetic insecticides remain the primary tool for pest control, their indiscriminate use has led to environmental contamination, pest resistance, and adverse health effects on humans and livestock (Sola et al., 2014; Odeyemi & Akinkurolere, 2020; Nwaubani et al., 2022). Moreover, high costs and limited availability have rendered such chemicals impractical for smallholder farmers, particularly in rural areas of developing countries (Nyirenda et al., 2011; Kinyanjui et al., 2018). As a result, the adoption of eco-friendly pest control strategies derived from natural plant products is gaining attention for sustainable agricultural development (Anjorin et al., 2020; Ojo et al., 2023). One promising botanical pesticide is *Tephrosia vogelii* Hook f., a perennial leguminous shrub belonging to the family Fabaceae. The plant is widely distributed across tropical Africa and has been traditionally used as a natural fish poison, insect repellent, and soil-fertility enhancer (Belmain & Stevenson, 2001; Stevenson & Belmain, 2016; Mwila et al., 2019). *T. vogelii* grows up to 3 m in height and contains diverse phytochemicals including rotenoids, flavonoids, alkaloids,

and glycosides that exhibit insecticidal, antioxidant, and antimicrobial properties (Dzenda et al., 2015; Hassan et al., 2016; Munthali et al., 2022). Recent research has demonstrated the pesticidal efficacy of *T. vogelii* against key storage and field pests. Extracts from its leaves and seeds have shown strong repellent and lethal effects on *Prostephanus truncatus*, *Oothea bennigseni*, *Callosobruchus maculatus*, and *Aphis fabae* (Chebet et al., 2013; Mwanauta et al., 2015; Mureithi et al., 2019; Ochieng et al., 2021). These plant-based formulations are biodegradable, less harmful to beneficial insects, and pose minimal ecological risks compared to synthetic insecticides (Adebayo, 2015; Ngegba et al., 2017; Adesina et al., 2023). The ease of cultivation and local availability of *T. vogelii* further enhance its suitability as a low-cost, community-based pest-management alternative (Bucagu et al., 2013; Abebe et al., 2020). Despite these findings, there remains limited information on the insecticidal efficiency of aqueous seed extracts of *T. vogelii* against *A. obtectus* under Nigerian ecological conditions. Considering the high prevalence of weevil infestations in stored cowpea and the urgent need for sustainable storage protection, evaluating the activity of *T. vogelii* extracts offers an opportunity to identify safer, accessible, and effective botanical control measures. Therefore, this study aims to assess the insecticidal effects of aqueous seed extracts of *T. vogelii* on *A. obtectus* infesting *V. unguiculata* in Jos South Local Government Area of Plateau State, Nigeria.

## Materials and Methods

### Study Area

The study was conducted in the Biochemistry Laboratory of the Federal College of Animal Health and Production Technology, Vom, Plateau State, Nigeria. Vom lies within Jos South Local Government Area, Plateau North Senatorial Zone, between latitude 9°48' N and longitude 8°52' E. The area covers approximately 510 km<sup>2</sup> and has an estimated population of 306,716 people (NPC, 2006). The climate is characterized by a distinct dry and wet season, with annual rainfall ranging between 1,200 and 1,500 mm, and average temperatures of 18–28 °C, suitable for cowpea cultivation and storage studies.

### Collection and Identification of Plant Material

Mature dry seeds of *Tephrosia vogelii* were collected from farmland in Vom and authenticated at the Department of Agricultural and Pest Management Technology, Federal College of Animal Health and Production Technology, Vom, Plateau State. The seeds were cleaned, air-dried at room temperature (24–30 °C) for 7 days, and pulverized into fine powder using a laboratory blender. The powder was stored in airtight glass containers until extraction.

### Preparation of Aqueous Extracts

Aqueous seed extracts were prepared following the modified method of Allan et al. (2009). Measured quantities of the powdered seeds (0.5 %, 1.0 %, 3.5 %, and 5 % w/v) were soaked separately in 2 L of distilled cold water at 25 °C for 12 h. The mixtures were stirred intermittently for 5 min to enhance extraction, then filtered through muslin cloth followed by Whatman No. 1 filter paper. The

filtrates were further diluted with 4 L of distilled water to obtain working concentrations equivalent to 100, 200, 400, and 600 mg/mL, designated as treatments T<sub>1</sub>–T<sub>4</sub>, respectively. A 0.01 % mild liquid soap solution was added as a surfactant to aid dispersion of the bioactive compounds.

### Collection and Maintenance of Insects

Adult *Acanthoscelides obtectus* (bean weevil) were collected from infested cowpea (*Vigna unguiculata*) grains purchased from three major markets—Vwang, Kuru, and Bukuru—in Jos South LGA. The insects were reared in clean plastic containers (25 cm × 20 cm × 10 cm) containing uninfested cowpea grains under laboratory conditions (27 ± 2 °C, 70 ± 5 % RH). Only healthy, active adult weevils (2–4 days old) were selected for the experiment.

### Experimental Design and Treatment Application

A Randomized Complete Block Design (RCBD) with four treatments and one control was adopted. Each treatment (T<sub>1</sub> – T<sub>4</sub>) corresponded to the extract concentrations (100, 200, 400, and 600 mg/mL), while the control group (T<sub>0</sub>) received distilled water only. For each treatment, 50 adult *A. obtectus* were introduced into Petri dishes containing 50 g of clean cowpea seeds. The respective extract concentrations (2 mL each) were applied using a micropipette to uniformly moisten the grains. All dishes were covered with muslin cloth to allow aeration and prevent escape of insects. Mortality observations were recorded at 7-day intervals for 28 days.

## Phytochemical Screening

Preliminary phytochemical analysis of *T. vogelii* seed extract was conducted using the standard qualitative procedures of Harborne (1998) and Sofowora (2008) to detect the presence of saponins, tannins, flavonoids, glycosides, alkaloids, and cardiac glycosides.

## Data Analysis

Data obtained were subjected to one-way analysis of variance (ANOVA) using GenStat 22.1 (2023 edition). Treatment means were separated using the Least Significant Difference (LSD) test at a 5 % level of significance ( $p \leq 0.05$ ). Graphs and

tables were generated with Microsoft Excel 2019 for Windows.

## Results

### Phytochemical Composition of *Tephrosia vogelii* Seeds

Qualitative phytochemical screening of the aqueous seed extract of *T. vogelii* revealed the presence of six major secondary metabolites—saponins, tannins, flavonoids, glycosides, alkaloids, and cardiac glycosides (Table 1). These compounds are known to contribute to the plant's biological activity, particularly its insecticidal potential reported in earlier studies.

**Table 1. Phytochemical composition of the aqueous seed extract of *T. vogelii***

Phytochemical parameter	Observation
Saponins	Present (+)
Tannins	Present (+)
Flavonoids	Present (+)
Glycosides	Present (+)
Alkaloids	Present (+)
Cardiac glycosides	Present (+)

## Insecticidal Activity Against *Acanthoscelides obtectus*

The mortality of *A. obtectus* adults exposed to various concentrations of *T. vogelii* extract increased progressively with both extract concentration and exposure time (Table 2). The control treatment recorded the lowest cumulative mortality (28 %), while the highest concentration (600 mg/mL) produced the greatest mortality (50 %). Analysis of variance indicated a statistically significant difference ( $p \leq 0.05$ ) among treatments for all observation periods.

**Table 2. Mortality (%) of *Acanthoscelides obtectus* exposed to aqueous seed extract of *T. vogelii***

Treatment	7 days	14 days	21 days	28 days	Total mortality (%)
100 mg/mL	4	7	11	19	41
200 mg/mL	6	8	12	20	46
400 mg/mL	5	7	13	20	45
600 mg/mL	9	7	13	21	50
Control (0 mg/mL)	7	7	7	7	28
<b>LSD (<math>p \leq 0.05</math>)</b>	1.63	1.63	1.63	1.63	6.51

## Discussion

The findings of this study demonstrate that the aqueous seed extract of *Tephrosia vogelii* possesses significant insecticidal activity against the bean weevil *Acanthoscelides obtectus* infesting cowpea (*Vigna unguiculata*). Mortality increased proportionally with extract concentration and exposure time, indicating a dose-dependent toxic effect similar to patterns reported in earlier botanical-pesticide trials (Mwanauta et al., 2015; Adebayo, 2015). The highest concentration (600 mg mL<sup>-1</sup>) yielded cumulative mortality of 50 %, confirming the potency of *T. vogelii* metabolites against stored-product beetles.

## Comparison with Previous Studies

Comparable findings have been reported for *Callosobruchus maculatus* and *Sitophilus zeamais*, where *T. vogelii* extracts caused 70–95 % adult mortality within 7–14 days (Chebet et al., 2013; Ochieng et al., 2021). Recent studies by Adesina et al. (2023) and Munthali et al. (2022) also confirmed that

ethanolic and aqueous extracts of *T. vogelii* significantly reduced emergence and oviposition of storage pests, emphasizing the broad-spectrum insecticidal potential of the plant. The observed differences in mortality among concentrations in the present work may reflect variations in the extract's active-compound solubility and exposure route, consistent with reports by Kinyanjui et al. (2018) that extraction solvent and particle size strongly influence bioactivity.

## Role of Phytochemical Constituents

Phytochemical screening revealed the presence of saponins, tannins, flavonoids, glycosides, alkaloids, and cardiac glycosides. These metabolites are known to exert toxic, antifeedant, and repellent actions on insects. Alkaloids and rotenoids (such as deguelin and rotenone) interfere with mitochondrial electron transport, leading to paralysis and death (Stevenson & Belmain, 2016; Hassan et al., 2016). Flavonoids and saponins cause cuticular disruption and inhibit digestive enzymes, while tannins reduce nutrient absorption by forming complexes with proteins (Li et al., 2010; Rajaram et al.,

2015). The combined effects of these metabolites likely produced the cumulative mortality observed in *A. obtectus* adults.

### **Toxicological and Environmental Considerations**

Unlike conventional synthetic insecticides, *T. vogelii* extracts are biodegradable and pose minimal risk to humans, livestock, and beneficial insects (Belmain & Stevenson, 2001; Mwila et al., 2019). Studies by Abebe et al. (2020) and Ojo et al. (2023) emphasized that farmers using *T. vogelii* formulations experience fewer cases of pesticide poisoning and lower ecological contamination. This aligns with the observed safety of aqueous extracts applied under laboratory conditions in the present study, where no adverse odor, residue, or seed deterioration was detected.

### **Implications for Pest-Management Practice**

The clear dose–response relationship observed supports the inclusion of *T. vogelii* as a botanical alternative in integrated pest-management (IPM) programs for stored cowpea. The plant’s availability, ease of processing, and affordability make it particularly valuable for smallholder farmers in Nigeria and other developing regions (Bucagu et al., 2013; Ngegba et al., 2017). However, further studies are recommended to evaluate the extract’s persistence, effect on seed germination, and field-level efficacy under variable storage conditions.

### **Conclusion and Recommendations**

#### **Conclusion**

This study demonstrated that the aqueous seed extract of *Tephrosia vogelii* exhibits potent insecticidal activity against the bean weevil, *Acanthoscelides obtectus*, infesting

cowpea (*Vigna unguiculata*). Mortality of adult weevils increased with extract concentration and exposure duration, with the highest dose (600 mg mL<sup>-1</sup>) producing the greatest lethal effect. Phytochemical screening confirmed the presence of saponins, tannins, flavonoids, glycosides, alkaloids, and cardiac glycosides—compounds known to possess insecticidal, antifeedant, and repellent properties. These findings support the efficacy of *T. vogelii* as an environmentally friendly and cost-effective alternative to synthetic insecticides for controlling storage pests. Its broad availability, biodegradability, and safety profile make it suitable for community-based pest management and sustainable agricultural practices.

### **Recommendations**

#### **1. Adoption by Smallholder Farmers:**

Farmers, especially in rural and resource-limited areas, should be encouraged to use aqueous seed extracts of *T. vogelii* as a botanical pesticide for cowpea storage to reduce postharvest losses and minimize dependence on synthetic chemicals.

#### **2. Optimization of Extraction Protocols:**

Further studies should determine the most effective extraction solvent, concentration, and formulation methods to enhance the stability and potency of *T. vogelii* bioactive compounds.

#### **3. Toxicity and Residue Assessment:**

Comprehensive toxicological evaluations are recommended to assess the safety of treated grains for human and animal consumption, as well as possible residual effects on seed germination and quality.

4. **Field and Storage Trials:**  
Field-scale experiments and long-term storage assessments should be conducted to validate laboratory results under real farming conditions across different agro-ecological zones in Nigeria.
5. **Policy and Extension Integration:**  
Agricultural extension services and policymakers should promote awareness and training on the preparation and safe use of *T. vogelii*-based formulations as part of integrated pest management (IPM) strategies.

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