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Nematicidal Activity of Bulb Gourd (Lagenaria Siceraria) Leaf Extract and Powder in the Control of Rootknot Nematode (Meloidogyne javanica) on Tomato in Yola, Nigeria

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Abstract
The activity of L.siceraria against Meloidogyne javanica was investigated in an experiment conducted in 2022 and 2023 at the Crop Protection Department's laboratory and Screen house, in Modibbo Adama University, Yola. Eggs and juveniles of M.javanica were exposed to leaf extract concentrations and distilled water for 96 hours (4 day). Also, tomato Roma seedlings roots were inoculated with 1000 M.javanica juveniles. Data were collected. Results showed the 95% extract greater mortality of nematode juveniles with 51% and least percentage eggs hatched with 22%. Result of the pot experiment showed the 15 g powder treatment gave taller tomato plants (122.33 and 123.63 cm), lowest final nematode population (28,722.5 and 28,903.2 nematodes) and lowest reproduction factor (28.72 and 28.90) in 2022 and 2023. Therefore, the 95% leaf extract concentration and 15 g leaf powder treatment of L.siceraria are the better treatment for managing M.javanica infestation in tomato in Yola.

Keywords: Powder, Juveniles, Eggs, Extract, M.javanica

Introduction

Tomato (*Solanum lycopersicum*) is among the most important and most cultivated vegetables in the world. In 2023, approximately 192.32 million metric tonnes of tomato was produced (Statista, 2026) [13]. Tomato is consumed fresh or processed into paste and consumed. It contains high amounts of vitamins-A and -C, minerals and antioxidants mainly lycopene and beta-carotene, together with such compounds as flavonoids, hydroxycinnamic acid derivatives (Tiwari *et al.*, 2022) [14].

The crop is the back bone of over 3 million smallholder farmers' livelihoods where it provides fresh markets, processing into paste and sauces, and export potential worth billions of naira; but being highly perishable, raises its postharvest loss to an estimated 40-60% in the tropics (Arah *et al.*, 2015) [3].

Insects and pathogens including fungi, bacteria, viruses and nematodes are known to attack tomato relentlessly. This all important is persistently threatened by soil-borne pathogens, among which root-knot nematodes (Meloidogyne spp.) are the most damaging with Meloidogyne javanica (Treub) Chitwood, alongside M. incognita, M. arenaria, and M. hapla, causing the majority of agricultural losses globally (De Paulo *et al.*, 2025). These organisms cause reduction or even complete loss in yield of tomato worldwide. Their attacks cause physiological disruptions exhibited in the above-ground symptoms (chlorosis, stunted, growth, wilting susceptibility, and reduced fruit yield and quality plus the below-ground symptoms. Plants infected with M.javanica show a significant reduction in chlorophyll content (down to 0.43 mg g^{-1}), carotenoid levels (0.06 mg g^{-1}), and nitrate reductase activity (0.21 μmol min^{-1} g^{-1}) compared to uninfected controls (Gupta *et al.*, 2025) [5].

Various methods to control the damage done by nematodes to tomato and other crops are being investigated and range from cultural, physical, cultural, biological, legislation and integrated pest management and resistance. Bacillus spp. inhibited the hatching of M.javanica eggs by 16-45% and induced the mortality of J2 by 30-46% *in vitro* whereas combining mutant isolates with chitosan caused a massive 94% reduction in the nematode reproduction factor in green house trials (Rostami *et al.*, 2024) [11]. Substrates colonized by the mushrooms Lentinula edodes or Pleurotus eryngii increased activities of defense-related enzymes—chitinase (CHI) and β-1,3-glucanase (GLU)—in tomato roots regardless of M. javanica presence, suggesting that mushroom substrates both directly antagonize nematodes and stimulate plant resistance mechanisms (Hahn *et al.*, 2025) [6]. An *in vitro* assay of latex of Carica papaya and its purified enzyme papain against M. javanica showed papaya latex achieved 100% J2 mortality at 1% concentration, while papain had 72% mortality at 3.5% with both treatments inhibiting nematode egg hatch as papaya latex reduced egg hatch by 39-61.9% and papain by 44-55% (De Paula *et al*., 2025) [4]. Root extracts of *T. diversifolia* and *B. pilosa* reduced J2 populations by 89.1% and 84.7%, respectively and caused a decline of 69.8-72.3% in Reproductive potential with root extracts of *T. minuta* and *T. diversifolia* (Alubi *et al*., 2024) [2].

Due to recorded toxicity of chemical nematicides to man and the environment, it is imperative to keep searching for materials that are environmentally safe and abundant in nature for use in bringing the population of nematodes in agricultural spaces to levels that will guarantee economic yield is obtained. This research was undertaken to achieve this objective with the use of the extract and powder of leaves of Lagenaria siceraria.

Materials and Methods

Experimental Site: This research was conducted at the laboratory and Screen house of the Department of Crop Protection, Modibbo Adama University, Yola. The laboratory of Department of Biochemistry in the University was where the test for presence of phytochemicals was carried out.

Preparation of Plant Powders and Extracts

Leaves of Lagenaria siceraria (Bulb Gourd), were sourced within and around Modibbo Adama University, Yola. The plant was identified at the Department of Forestry MAU, Yola.

The L. siceraria leaves were dried in the shade on clean polythene sheets in the laboratory for seven days and then ground to powder using mortar and pestle. Ten grams of the leaf powder was weighed with a digital weighing balance and soaked in a conical flask containing 100 ml distilled water and left to stand for 24 hours. The extract was filtered using Whatman No. 1 filter paper to obtain 100% undiluted concentration or crude extract (C). Ten millilitres (10ml) of the crude extract were serially diluted with distilled water. The four treatments were: C1 = 95% concentration, C2 = 90% concentration, C3 = 85% concentration and C4 = Control (Distilled water).

Egg Hatchability Test

Nematode egg suspension at approximately 100 eggs/ml was introduced into each of 15 petri dishes followed by the addition of the different concentration of the plant extracts and distilled water as control (Ononuju and Nzenwa, 2011) [10]. For the egg hatchability test, there were four treatments arranged in Completely randomized design and replicated three times in the laboratory. Hatched eggs were observed under the microscope at intervals of 24 hours for 96 hours and counted.

Juvenile Mortality Test

Ten ml of the leaf extract of *Cleome viscosa* was taken separately in a 10 ml syringe and diluted with 5ml, 10ml, and 15ml of distilled water and 10 ml of each was dispensed separately into each Petri dish containing approximately 100 second stage Juveniles (J_2) of *M. Javanica* in 10 ml of distilled water. The experiment comprised four treatments and replicated three times and laid out in Completely Randomized Design (CRD). Dead nematodes were touch with a needle under a binocular electric microscope to observe whether they moved or not. Immobile nematodes were considered dead. The mortality was observed at intervals of 24, 48, 72, 96 hours.

Screen House Experiment

The pot experiment was conducted at the screen house of Modibbo Adama University (MAU), Yola. Sandy loam soil collected from the landscape garden of MAU, Yola was steam sterilized at 60ºC for 45 minutes and from which 14 kg was weighed using top pan loading balance and put into each of 12 perforated 20 cm diameter plastic pots. There were four treatments replicated three times and arranged in completely randomized design (CRD). L. siceraria leaf powder was incorporated into the soil in the pots as follow: T1 = 5 g, T2 = 10 g, T3 = 15 g and T4 = Control (No powder). Water was applied to the pots. One-week old seedlings of tomato (Roma VF variety) were transplanted into the pots at the rate of two seedlings per pot and thinned down to one seedling per pot a week after transplanting.

Second stage juveniles (J_2s) of M. javanica were extracted and used to inoculate all the potted plants in the screen house with approximately 1000 J_2 of *M. javanica* contained in 20 ml suspension. The second stage juveniles J_2 suspension was applied at the base of each plant three weeks after emergence of the seedling using 20 ml disposable syringe. All other agronomic practices were applied as required.

After harvest, soils from similar treatments were pooled together and thoroughly mixed; 250cm^3 of the soil was measured in a beaker and used for final nematode extraction through the method described by Whitehead and Hemming (1965). Gall index was determined using the rating scale of Sasser (1984) as follows: 1 – no galls, 2 – less than 20 galls, 3 – 21 – 40 galls, 4 – 41 – 60 galls, 5 – more than 75 galls.

Data collection was carried out on growth, yield and nematode parameters**.** Data collected were subjected to analysis of variance (ANOVA) using SAS procedures and mean separation was done using Standard Error of the Mean (SEM).

Results

The test for phytochemicals present in the leaf powder of L. siceraria showed that tannin, alkaloid, flavonoid, terpenoid, phenol and steroid were moderately present whereas saponin and glycocides were absent.

The juvenile mortality test result showed that of the four treatments after 24 hours of exposure of juveniles of M.javanica to these treatments, the 95% concentration treatment recorded significantly (p=0.05) higher mortality of the juveniles than all other treatments with 39.69%, followed by the 90% concentration treatment (32.69%), 85% concentration treatment (25.67%) and least was control with 12.67% mortality (Fig 1). After 48 hours of exposure of juveniles to the treatments, the 95% concentration treatment had the highest juvenile mortality of 42% followed by the 90% concentration (35.33%), 85% concentration (30.00%) and least was control (13.67%) mortality. At 96 hours after the exposure of the M.javanica juveniles, the 95% concentration still recorded the highest mortality of the juveniles with 51.00%, followed by 90% concentration (47.67%), 85% concentration (40.00%) and least was control with 20.67% mortality (Fig 1).

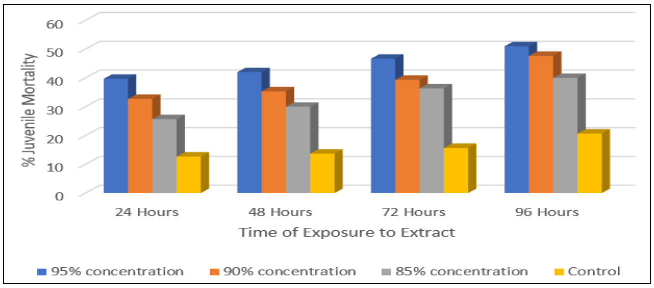

Fig 1: Effect of Leaf Extract of L. siceraria on Mortality of M. javanica Juveniles

For the egg hatch inhibition test, after 24 hours of exposure of M.javanica eggs to extract treatments of L. siceraria, the control (distilled water) recorded significantly (p=0.05) higher egg hatch than all other treatments with 64.33% eggs hatched, followed by the 85% concentration (41.33% eggs hatched), 90% concentration (23.67% eggs hatched) and least eggs hatched was 95% concentration treatment with 16.67% eggs hatched or highest egg hatch inhibition with 83.33% of the eggs hatching inhibited. After 48 hours, control still had the highest percentage of hatched eggs (69%) or least percentage egg hatch inhibition of 31%. This was followed by the 85% concentration (50% eggs hatched), 90% concentration (29.33% eggs hatched) and the 95% concentration recorded the lowest percentage eggs hatched with 17.67% or highest egg hatch inhibition with 82.31%. At 96 hours of exposure, control still recorded the highest percentage eggs hatched with 79%, followed by 85% concentration (55% eggs hatched), 90% concentration (40% eggs hatched) and least percentage eggs hatched was the 95% concentration with 22% or highest percentage hatch inhibition of 82% (Fig 1).

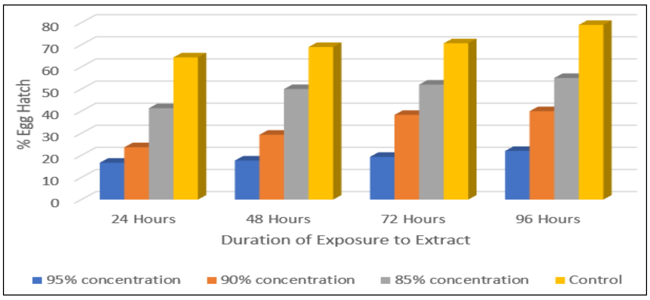

Fig 2: Effect of Leaf Extract of L. siceraria on M. javanica Egg Hatch Inhibition

The pot experiment produced results for two years, 2022 and 2023, for various parameters which are described here. For plant height, the 15g g powder treatment recorded significantly (p=0.05) taller tomato plants of all treatments with 122.33 cm and 123.63 cm in both 2022 and 2023 respectively. This is followed by the 10 g powder treatment with 104.66 cm and 105.33 cm for both years respectively, 5 g treatment recorded 88.43 cm and 87.66 cm and least was control with 62.3 cm and 62.3 cm for both years respectively (Table 1).

Tomato plants treated with the 15 g powder treatment produced significantly (p=0.05) more leaves than all other treatments with 74.3 and 73.01 leaves in both 2022 and 2023 respectively, followed by the 10 g treatment (61.3 and 61.7 leaves), 5 g powder treatment with 47.4 and 46.6 leaves and lowest was control with 33.6 and 34.3 leaves in both 2022 and 2023 respectively (Table 1). The 15 g treatment produced tomato plants that branched significantly (p=0.05) more than all the other treatment with 24.3 and 23.6 in 2022 and 2023 respectively, followed by the 10 g treatment with 20.5 and 20.4 branches, 5 g treatment (18.3 and 17.6) and least was control with 11.3 and 10.64 branches in both years respectively (Table 1). For the number of fruits produced by the treatments, the 15 g treatment recorded significantly (p=0.05) higher number of fruits than other treatments with 16.06 and 16.33 fruits for both 2022 and 2023, followed by 10 g treatment (15.33 and 15.67 fruits), 5 g treatment (14.00 and 13.88 fruits) and least was control with 10.67 and 10.33 for 2022 and 2023 respectively (Table 1).

Table 1: Effect of L.siceraria leaf powder on M.javanica on Some Parameters of Tomato

Parameters	PH (cm)		NL		NB		NF	
Treatments	**2022**	**2023**	**2022**	**2023**	**2022**	**2023**	**2022**	**2023**
5 g	88.43	87.66	47.4	46.6	18.3	17.6	14.00	13.88
10 g	104.66	105.33	61.3	61.7	20.5	20.4	15.33	15.67
15 g	122.33	123.63	74.3	73.01	24.3	23.6	16.06	16.33
Control	62.3	62.3	33.6	34.3	11.3	10.64	10.67	10.33
Mean	94.43	94.73	54.15	53.90	18.6	18.06	14.01	14.05
SEM (±)	12.75	13.06	8.77	8.48	2.73	2.76	1.19	1.34

NL – Number of leaves; NB – Number of branches; NF – Number of fruits; SEM – Standard error of the mean

The tomato plants that received 15 g powder treatment produced more fruits than all other all other treatments with 40.3 g and 42.2 g mean fruit weight for 2022 and 2023 respectively. This was followed by the 10 g treatment with 37.4 g and 36.5 g, 5 g treatment with 27.6 g and 28.2 g and least was control with 18.6 g and 18.5 g mean fruit weight in both 2022 and 2023 (Table 2). The least final nematode population was recorded by the 15 g treatment with 4,154.8 and 4,335.5 nematodes in 2022 and 2023 respectively. This was followed by the 10 g treatment with 12,319.9 and 12,500.6 nematodes in both years, 5 g treatment (20,051.6 and 20,232.2 nematodes) and the highest nematode population was recorded by control with 28,722.5 and 28,903.2 nematodes in both 2022 and 2023 respectively (Table 2). Gall index was lowest in tomato plants treated with 15 g powder treatment with 1.3 and 1.5, followed by 10 g treatment (2.3 and 2.3), 5 g treatment (4.3 and 4.3) and highest recorded gall index was control with 5 and 4.9 for both 2022 and 2023 respectively (Table 2). The least reproduction was recorded by 15 g treatment with 4.15 and 4.33 followed by 10 g treatment (12.32 and 12.50), 5 g treatment (20.05 and 20.23) and the highest reproduction factor was control with 28.72 and 28.90 in 2022 and 2023 (Table 2).

Table 2: Effect of L.siceraria leaf powder on M.javanica on Some Parameters of Tomato

Parameters	FW		FNP		GI		RF	
Treatments	**2022**	**2023**	**2022**	**2023**	**2022**	**2023**	**2022**	**2023**
5 g	27.6	28.2	20,051.6	20,232.2	4.3	4.3	20.05	20.23
10 g	37.4	36.5	12,319.9	12,500.6	2.3	2.3	12.32	12.50
15 g	40.3	42.2	4,154.8	4,335.5	1.3	1.5	4.15	4.33
Control	18.6	18.5	28,722.5	28,903.2	5	4.9	28.72	28.90
Mean	30.97	31.35	16,312.2	16,492.9	3.22	3.25	16.31	16.49
SEM (±)	4.93	5.15	5,257.8	5,257.8	0.85	0.80	5.25	5.25

FW – Fruit weight; FNP – Final nematode population; GI – Gall index; RF – Reproduction index SEM – Standard error of the mean

Discussions

The juvenile mortality and egg hatch inhibition test results showed a moderate performance similar to the moderate presence of the phytochemicals found in the leaf powder of L. siceraria. There was a progressive increase in the mortality of M.javanica juveniles with increase in concentration of L. siceraria leaf extract as higher mortality of the juveniles was recorded at the highest concentration of 95% than all other lower concentration treatments. Similarly, as the time of exposure increased, the more the percentage of juveniles that died; more juveniles died after 96 hours of exposure than at 72, 48 and 24 hours. This is similar to the works of Umar and Mamman (2014) [15], Oka *et al.* (2014) [9], Hussein *et al.* (2016) [7] and Aji *et al.* (2026) [1] who also reported mortality of nematode juveniles exposed to plant extracts. The egg hatch inhibition test followed a pattern whereby, the higher the concentration of L. siceraria leaf extract, the lower the number of M.javanica eggs hatched with the least being the 95% concentration, that is, it recorded the highest egg hath inhibition. The least egg hatch inhibition was control where the small percentage of eggs that failed to hatch could have been due to environmental factors or issues within the eggs themselves but not because of any human-induced factors since the extract was not applied to it. Also, as exposure time increased, the percentage of eggs hatched increased, although, this was highest in control and lowest in 95% concentration treatment. Papaya latex and its purified enzyme, papain, both inhibited M.javanica egg hatch with 39-61.9% reduction for papaya latex and 44-55% for papain (De Paula *et al*., 2025) [4].

The pot experiment also showed promise as tomato plants treated with the extract of L. siceriria exhibited higher growth and yield parameters and more favourable nematode parameters. For the growth parameters, all L.siceraria extract-treated plants grew taller than control plants with the 15 g powder treatment recording the highest growth, had more leaves and branches than all other treatments. For the yield parameters, more and heavier tomato fruits were produced by the 15 g powder treatment than all other treatments giving an indication that the presence of powder of L.siceraris caused the mortality of M.javanica and reduced their activity giving room for the tomato plants to flourish better. The nematode parameters showed application of the powders reduced nematodes activity with lower final nematode population, gall index and reproduction in plants treated with powder of L.siceraria particularly the 15 g powder treatment than control. Extracts of *Azadiracchta indica* (neem) *Waltheria sammfera* (ashwagandha), *Tagetes erecta* (Marigold) and *Eucallyptus citriodran* (Eucalyptus) were examined against nematode associated with papaya and the experiment recorded a reduction in nematode population and gall index (Mkandawire, 2022).

Conclusion

The extract and powder of L. siceraria proved moderately effective against the eggs and juveniles of Meloidogyne javanica in the laboratory and in pot experiments. Application of the extracts to eggs and juveniles in petri dishes inhibited egg hatch and caused the mortality of the juveniles. The leaf powder of L.siceraria produced higher plant growth, yield and reduced nematode population and galling of tomato roots. In conclusion, the 95% concentration extract treatment and 15 g powder of leaves are the treatments considered good enough to keep M.javanica at populations that will cause less damage to tomato and allow the plant produce good yield.

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