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The Effects of *Baeckea frutescens* Leaves Extract on *Cucumis melo* var. *Inodorus* cv. Manis Terengganu 1 (MMT) Growth and Disease Management, and its Chemical Profiles

Nik Nurnaeimah Nik Muhammad Nasir[1], Noor Hafizoh Saidan[2], Mohammad Moneruzzaman Khandaker[1], Zakiah Mustapha[1] and Khamsah Suryati Mohd[1]*

[1]School of Agriculture Science & Biotechnology, Faculty of Bioresource and Food Industry, Universiti Sultan Zainal Abidin, Besut Campus, Besut 22200, Terengganu, Malaysia
[2]Faculty of Agro-based Industry, Universiti Malaysia Kelantan, Campus Jeli Locked Bag 100, 17600 Jeli, Kelantan, Malaysia
*Corresponding author (e-mail: khamsahsuryati@unisza.edu.my)

The study investigates the effects of *Baeckea frutescens* methanolic leaf extract on the growth and disease incidence of Melon Manis Terengganu (*Cucumis melo* var. *Inodorus* cv. Manis Terengganu 1), alongside its chemical profile through GCMS analysis. A 1 mg/mL of extract was applied under field condition using two methods: injected near the root (TI1), and foliar spray (TS1), twice a week following a Randomized, Completely Blocked Design (RCBD). The results revealed significant improvements in plant growth with increases in plant height (TI1;26.49%, TS1;14.72%), leaf number (TI1;9.79%, TS1;4.22%), ovary length (TI1;14.83%, TS1;13.58%), and fruit weight (TI1;19.91%, TS1;10.39%). Disease incidence was also notably reduced, with control plants (TS0 and TI0) exhibiting over 50% disease occurrence at 60 days, while treated plants (TS1 and TI1) showed only 10.4% and 35.4% disease incidence, respectively. GCMS analysis identified quininic acid as the most abundant compound (11.49%), followed by d-fructose (11.23%), d-mannose (10.40%), d-glucose (8.75%), sucrose (8.61%), muco-inositol (7.20%), and gallic acid (4.14%). In conclusion, the extract of *B. frutescens* has a significantly positive impact on enhancing growth performance and decreasing disease incidence compared to the control. This could be due to the chemical constituent of quininic acid, which is the most abundant.

Keywords: *Baeckea frutescens*; *Cucumis melo* var. *Inodorus* cv. Manis Terengganu 1; GCMS; Quninic acid

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Agriculture is a significant source of food, raw materials, and fuels, supporting over 70% of the world's population, with a particular emphasis on disadvantaged rural people in emerging countries [1, 2]. However, plant diseases significantly threaten agricultural productivity, causing 13-22% of global crop losses each year [3, 4]. Pathogens alone lead to annual losses in productivity valued at approximately $220 billion, with fungi contributing to 10-35% losses in major crops like rice, wheat, maize, and soybean [5]. While synthetic fungicides are widely used to control diseases, their extensive use has ecological downsides, promoting resistant pathogen strains and leaving toxic residues [6].

Recently, the use of plant extracts as a treatment application for enhancing growth and mitigating disease occurrence in crops has gained significant attention. One such plant, *Baeckea frutescens* L., has a long history of use in traditional medicine for its various therapeutic properties. *B. frutescens*, locally known as Cucur Atap in Malaysia, is a flowering plants in the Myrtaceae family. It is one species distributed from South China to Australia and has been found on mountain tops, quartz ridges and sandy coasts [7]. The plant's characteristics include needle-like leaves, which are small and narrow, only about 6–15 mm long. When crushed, the leaves give off a resinous aromatic fragrance. The tiny fruits split, releasing minute angular seeds [8]. The plant has been reported to possess various biological properties, including antibacterial, antioxidant, anti-proliferative, anti-malarial, anti-inflammatory, and prevent arteriosclerosis [9, 10]. Considering this, there is growing interest in exploring the potential of *B. frutescens* plant extract as a treatment application for enhancing growth performance and decreasing disease occurrence in crops.

Melon Manis Terengganu (*Cucumis melo* var. *Inodorus* cv. Manis Terengganu 1) is a popular fruit crop that is widely cultivated in the Terengganu state of Malaysia and belongs to the Cucurbitaceae family with smooth yellow peel and orange flesh [11]. Despite its popularity, the crop is frequently affected by various diseases, leading to a decline in yield and

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quality. One of the diseases was soil-borne, such as fusarium wilted, which usually occurs when planted in the same field without rotation [12]. This disease is caused by *Fusarium oxysporum* f. sp. melonis, which causes severe damage to melon cultivation[13]. Powdery mildew affects cucurbit crops globally and is caused by biotrophic fungi (*Erysiphales*)[14]. It downgrades fruit quality and quantity by infecting leaves, stems, flowers, and fruits [15, 16]. Downy Mildew is a major foliar disease in cucurbit crops caused by *Pseudoperonospora cubensis*. It thrives in high humidity and temperatures of 15-20°C. Its wide host range poses challenges in warmer regions with year-round melon cultivation [15]. Replacing costly and environmentally hazardous synthetic pesticides and fertilisers is essential. The growing population demands better food production with fewer approved pesticides, necessitating new strategies like biological agents and products with novel modes of action to enhance disease control, crop production, and food safety [17].

Considerable attention has been given to aromatic and medicinal plants [6]. Plants that possess biological activities are considered safe and non-toxic due to their natural origin, lack of phytotoxicity, biodegradability, low persistence, and antimicrobial characteristics. Integrating these natural plant products into alternative approaches for disease control is valuable. Many of these compounds exhibit biological activity and can be used as phenolic or essential oils to suppress pathogens. The antimicrobial substances can also be isolated from medicinal plant extracts or used directly. Previous research has highlighted that plant flavonoids, polyphenols, and tannins have antibacterial properties and can provide protection against various human microbial pathogens [8, 18]. However, little is known about the effect of *B. frutescens* extract on plant growth. Therefore, this research examines the potential of *B. frutescens* plant extract as a natural alternative to synthetic pesticides and fertilisers for treating Melon Manis Terengganu plants. The study will assess the effects of *B. frutescens* extract on Melon Manis Terengganu plants' growth and disease occurrence. In addition, the study will also evaluate the impact of *B. frutescens* extract on the yield and quality of Melon Manis Terengganu fruit.

These study findings significantly affect sustainable agriculture and natural remedies for treating plant diseases. *B. frutescens* extract offers a new solution by enhancing plant growth and reducing disease occurrences for higher fruit yield and quality.

EXPERIMENTAL

Collection of Plant Materials and Extract Preparation

The *B. frutescens* leaves were collected at Taman Rimba Ilmu Tanah BRIS (TRIBE) Universiti Sultan Zainal Abidin (UniSZA) Besut campus beach forest reservation. Dr Mohd Fahmi Abu Bakar authenticated the sample at Herbarium UniSZA, Malaysia, and a herbarium specimen with the number UNISZA/A/ 000000038 was deposited in the University Herbarium, Faculty Bioresources and Food Industry, Universiti Sultan Zainal Abidin, Terengganu. Approximately 1 kg of fresh plant leaves was collected in the morning to ensure optimal turgidity and minimal moisture. The leaves were transported in breathable bags to prevent overheating and condensation, washed with distilled water, and spread on drying trays. They were dried in an oven at 40°C for 24 hours, then ground into a fine powder, which was stored in airtight, opaque containers labelled with species and collection details to avoid contamination. For extraction, 100 g of powdered leaves were macerated in 99% methanol at a 1:10 ratio, sealed, and left to macerate for 72 hours in the dark with occasional agitation. The mixture was then filtered using Whatman filter paper no.1, and the liquid extract was concentrated with a rotary evaporator at 40-60°C. The final extracts were stored at 4°C in airtight containers for further analysis [19].

Plant Material and Experimental Site

B. frutescens extract concentration was tested at the Melon Manis Terengganu (MMT) field, Universiti Sultan Zainal Abidin Besut Campus. The research was conducted between January and April 2021 under controlled conditions (25-33°C, max PAR 500-1000 uE/m2/s, RH 70-93%) in a Rain Protection House, covering approximately 500 plants. Harvesting occurred in about 60-65 days. For this study, MMT seeds were initially planted in a nursery plate with peat moss substrate. After 7-10 days, the seedlings were transferred to planting beds, using supporting ropes for climbing. Fertigation was employed as an irrigation method, delivering consistent water and nutrients daily through a drip system. The experimental design was a Randomized, Completely Blocked Design (RCBD) with four treatment groups: TI0 (distilled water injection), TI1 (*B. frutescens* extract injection), TS0 (distilled water spray), and TS1 (*B. frutescens* extract spray). The Rain Protection House roof was divided into four blocks, each with four sections, and each section had four replications. The trials occurred from January to April 2021. Plants received a 1mg/mL dose of *B. frutescens* extract and the volume base on the plant old (2 weeks old- 50 mL, 3-4 weeks old- 100 mL, 5-6 weeks old, 150 mL, 7-8 weeks old-250 mL), applied through spraying and injection twice a week (every 3 days) from 9.00 am to 11.00 am.

Plant Physiological and Growth Parameters

This study assessed the impact of *Baeckea frutescens* extract on Melon Manis Terengganu plant disease through nine key physiological parameters, focusing on plant growth and photosynthesis [20]. The growth parameters included six measurements, while the photosynthesis parameters consisted of three

measurements. Additionally, fruit weights were recorded post-harvest.

Plant height: Measured weekly until the plants reached the Rain Shelter House panel in cm. Leaf number and area: Counted and measured weekly, with leaf area determined using a Leaf Area Meter (Model Portable Laser CI-202, CID Bio-science USA) in cm^2. Main internode circumference: Measured and recorded in cm. Ovary Length and circumference: Both measured recorded in cm. Stomatal conductance: Measured thrice daily (morning, afternoon, evening) with a Leaf Porometer (SC-1) in $mmolm^2s^{-1}$. Chlorophyll content: Assessed using a Chlorophyll Content Metre (Model CCM 200; Opti-science, USA) and reported as a chlorophyll content index (CCI). Chlorophyll fluorescence: Data collected with a Handy PEA Metre (Handsatech-Instrument, UK) and reported as Fv/Fm. Fresh and dried plant weight: Plants were weighed in their fresh state, cleaned, and dried at 60°C for 24 hours. The weight of dried plants was recorded. Fruit weight and grading: During harvest, fruit weight and grading (Premium, A, B) were determined based on group weight.

Disease Incidence

A systematic visual inspection of the plants was conducted to identify and document any signs of disease throughout the experiment. The diseases assessed included wilting and vascular diseases, viral infections, plant death, powdery mildew (*Podosphaera xanthii*), Each plant was individually examined at four key stages of growth: (1) early plant growth and development, (2) flowering and pollination, (3) fruit growth and development, and (4) fruit maturation. For each stage, disease incidence was recorded by determining the proportion of plants exhibiting symptoms of any of the aforementioned diseases. The data were recorded from January to April 2021. Incidence was calculated using the following formula:

$$\text{disease incidence (\%)} = (\text{Number of infected plants})/(\text{Total number of plants}) \times 100$$

GCMS Analysis

For derivatization, 25 mg of the methanolic crude extract was immersed with 50 µL of pyridine in 2 mL centrifuge tubes. The mixture was sonicated for 10 minutes at 30°C. After that, 100µL of methoxyamine HCI (20 mg/mL in pyridine) was added to the sample solution before vortexing. Next, 300 µL of BSTFA was added to the solution. The samples were then incubated in a ThermoMixer C (Eppendorf, Hamburg, Germany) at 60°C for 1 hour before being injected into GC-MS [21]. The prepared samples were analyzed using gas chromatography-mass spectrometry (Agilent 7890B GC System, Santa Clara, California, USA), equipped with an Agilent HP-5MS column (30 m, 250 µm, 0.25 µm). The temperature of the injector was kept at 250°C. High-purity helium gas was used as a carrier gas at a 1 mL/min flow rate. The column oven temperature was maintained at 80°C for 10 min initially and then steadily increased at a flow rate of 5°C /min to 290°C, which was maintained for 54 min till the end of the analysis. The spitless injection was used with the ionization energy of 70 eV samples. The sample peaks were identified by comparing the mass spectra available in the database of NIST libraries with the spectral data of samples with 70% acceptable limit of similarities.

Data Analysis

All study assessments were analyzed using SPSS software version 26 and visualized using Microsoft Office Excel 2021. For treatments having significant differences, the post hoc test at $p < 0.05$ probability level was used for mean comparisons among treatments.

RESULTS AND DISCUSSION

Plant Physiological and Photosynthesis Parameters

The mean heights of the plants at different growth stages revealed significant variations across treatments. At early growth (Day 19), plants treated with injection and spray exhibited the highest mean height, 7.9 cm and 7.5 cm, respectively, compared to controls. Significant differences were noted ($F = 3.467$, $p = 0.029$). From day 25 to day 39, injection to the soil (TI1) consistently showed the highest heights, with significance on day 25 ($p = 0.014$), day 32 ($p = 0.036$), and day 39 ($p = 0.10$). Leaf count showed no significant differences on days 19 and 25. However, by day 39, TI1 had significantly more leaves ($F = 4.081$, $p = 0.016$). Leaf area showed no significant differences across treatments. Main internode circumference and ovary length at early stages (day 32) showed no significant differences. However, on days 35 and 39, spray-treated plants had significantly larger ovaries ($F = 4.367$, $p = 0.016$ and $F = 3.464$, $p = 0.036$, respectively). By day 46, TI1 had the largest ovary length (mean 17.00 cm) with no significant differences in ovary circumference.

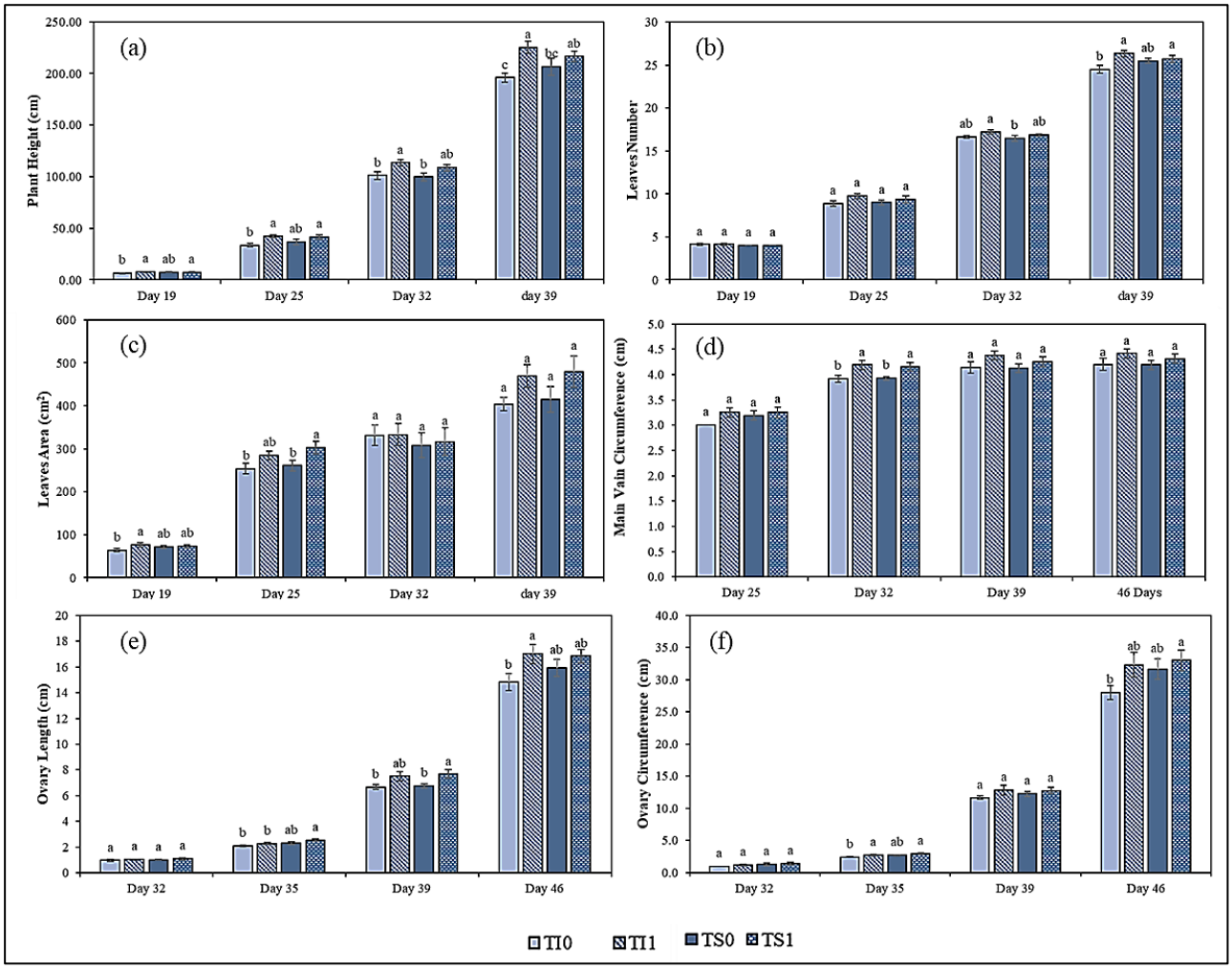

Figure 1. The effect of *B. frutescens* methanolic extract (1mg/mL) on the plant height (a), leaves number (b), leaves area (c), main vain circumference (d), ovary length (e), and circumference (vi) by two different methods application, injected to the plant soil with distilled water as control (TI0), injected to the plant soil with *B. frutescens* as treatment (TI1), spray to the plant with distilled water as control (TS0), and spray to the plant with *B. frutescens* as treatment (TS1). Significant ($P < 0.05$), differences between means obtained with each application were indicated by different letters above histogram bars according to Duncan ($p < 0.05$)

The treatments applied significantly influenced plant growth parameters. Increased plant height, leaf number, and ovary length were observed in treated groups, suggesting enhanced nutrient uptake and photosynthetic activity [22]. *B. frutescens* extract likely stimulated early root development and improved overall plant growth, contributing to higher fruit weight and better plant structure. [23]. The presence of primary metabolites such as d-fructose, d-mannose, d-glucose, sucrose, quinic acid, and gallic acid may have supported these effects by enhancing carbohydrate metabolism and lipid biosynthesis, crucial for plant development.

The study (Figure 2) revealed no significant differences in the mean values of the parameters across different treatments. However, discernible trends indicated increased parameters for the treated groups, specifically chlorophyll fluorescence. All treatments, including the controls, exhibited similar values ranging from 0.70 to 0.80, suggesting stability throughout the measured days. This implies that the *B. frutescens* extract did not negatively impact chlorophyll fluorescence, indicating consistent photosynthetic efficiency across all groups. Additionally, there was a noticeable upward trend in chlorophyll content over time for all treatments, signifying robust plant growth and effective chlorophyll production regardless of treatment. Stomatal conductance peaked at midday across all days, demonstrating normal stomatal behavior in response to environmental conditions. Moreover, stomatal conductance exhibited a slight increase in the treatment groups compared to the controls, particularly during midday measurements, hinting at a potential, albeit not statistically significant, improvement in gas exchange capacity owing to the *B. frutescens* extract. The increased photosynthetic activity in the treated plants could be attributed to the enhanced light capture and carbon dioxide assimilation resulting from the increased leaf number or area [24].

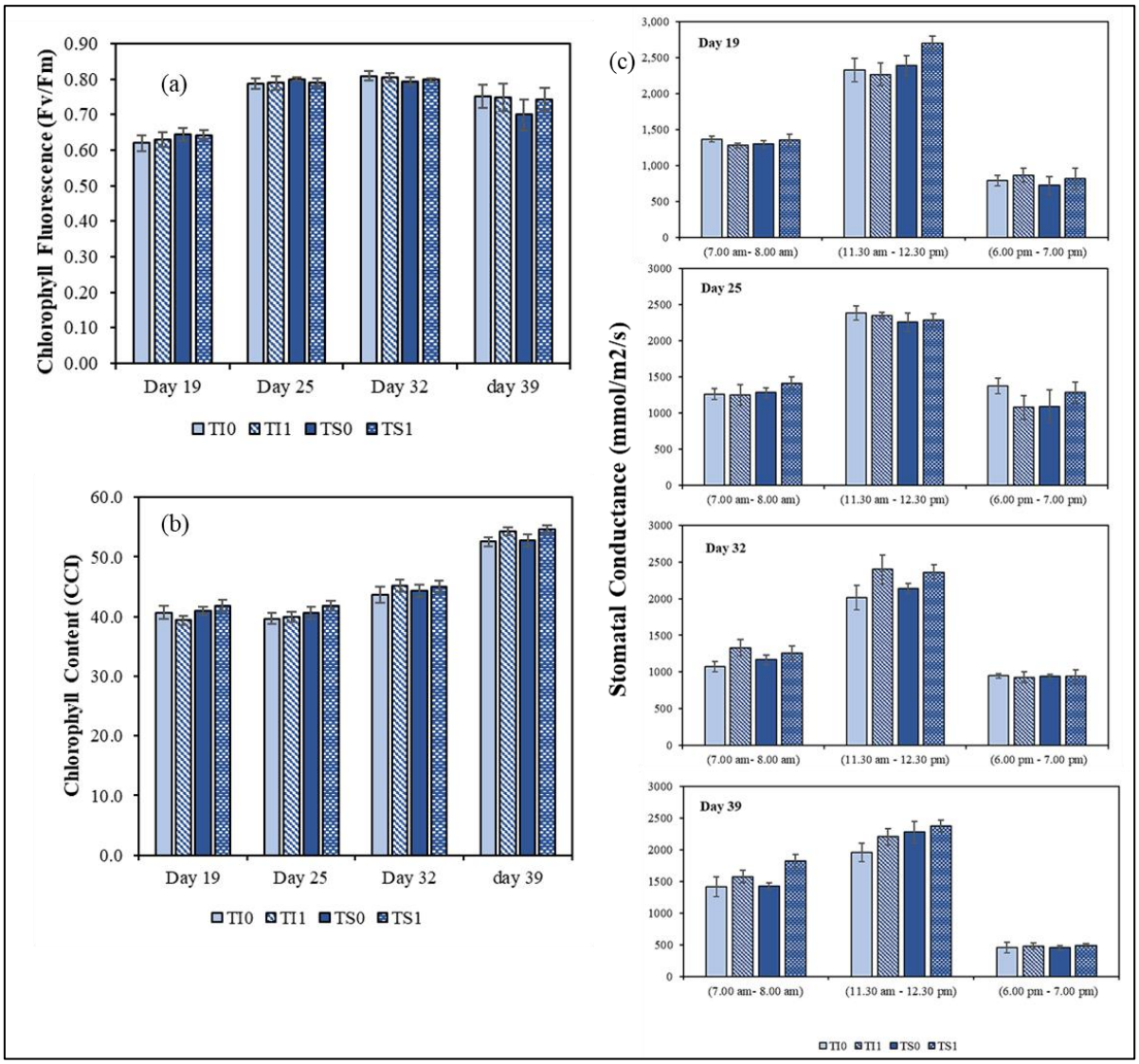

Figure 2. The effect of *B. frutescens* methanolic extract (1mg/mL) on the chlorophyll fluorescence (a), chlorophyll content (b), and stomatal conductance (c) by two different methods application, injected to the plant soil with distilled water as control (TI0), injected to the plant soil with *B. frutescens* as treatment (TI1), spray to the plant with distilled water ad control (TS0), and spray to the plant with B. frutescens as treatment (TS1). There were no differences between means obtained indicated by no letters above histogram bars, according to Duncan ($p < 0.05$).

Figure 3 shows the result of fruit weight. Control treatment by injection (T10) had the lowest mean fruit weight, with 1.276 kg. Treatment with *B. frutescens* by injection (TI1) yielded the highest mean fruit weight of 1.531 kg, followed by treatment with *B. frutescens* by spray (TS1) with 1.441 kg. The grading system used in this study by weight (Table 4.38) consisted of three categories: Grade Premium, Grade A, and Grade B. Treatment TI1 had 50% of its fruits classified as Grade Premium and 50% as Grade A. Treatment TS1 displayed Grade Premium with 25% and the remaining 75% as Grade A. While control treatment (TI0 and TS0) both have Grade B with 8.33% and 25%. Regarding fruit weight, treatment with *B. frutescens* with injection (TI1) exhibited higher fruit than the other treatments, indicating that TI1 positively impacted fruit growth and development, leading to more extensive and heavier fruits. The factors associated with TI1 treatment, such as method practices, elements in extract, or environmental conditions, may have contributed to the observed increase in fruit weight. Efforts to reduce reliance on chemical fertilizers have led to using bioactive compounds from ethnomedicinal plants as natural bio-stimulants in agriculture. Compounds such as sugars, fatty acids, amines, plant hormones, vitamins, flavonoids, phenolic compounds, sterols, etc., can enhance plant growth and development by increasing the production of beneficial secondary metabolites [25, 26]. Furthermore, the slight increase in photosynthetic activity may have contributed to the increased nutrient assimilation necessary for fruit development [27].

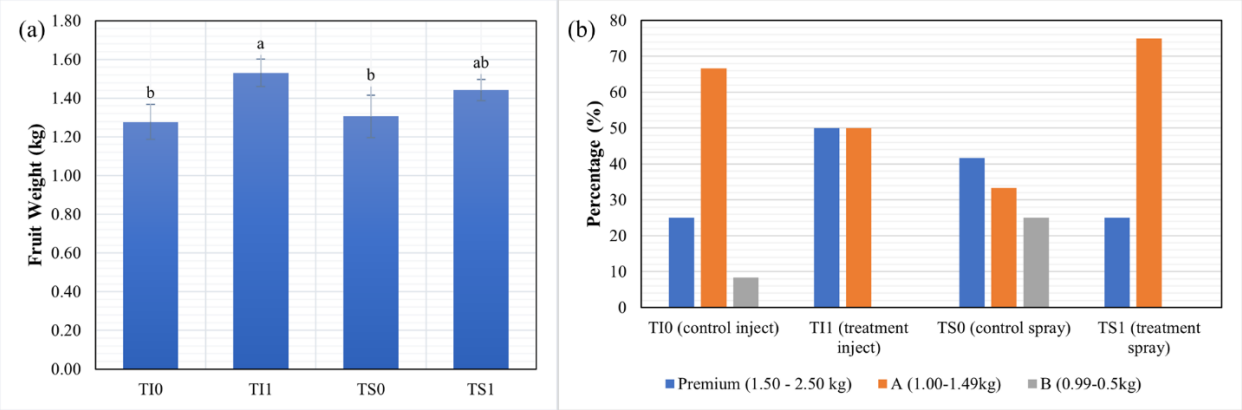

Figure 3. The effect of *B. frutescens* methanolic extract on (a) fruit weight by two different methods of application, injected into the plant soil (TI1) and sprayed to the plant (TS1) and Control (T10 and TS0), significant ($p < 0.05$) differences between means obtained with each treatment were indicated by different letters above histogram bars according to Duncan ($p < 0.05$). (b) fresh weight by the grading system.

The findings presented in Figure 4 reveal the plant's average fresh and dried weight. The study shows that treatment of *B. frutescens* extract, which involved injecting 1 mg/mL of *B. frutescens* extract into the soil near the root and spraying to the plant, resulted in a significantly higher fresh weight of the root. Interestingly, the injection treatment led to the highest weight of 2.247 g for the dried root. Notably, there were no substantial differences in the fresh and dry weights of the leaves and stems. Based on these observations, it can be concluded that the injection method is the most efficient way to boost plant growth. The observed effects can be linked to secondary metabolites such as alkaloids, phenols, flavonoids, and terpenoids, which are well-known for their crucial roles in plant growth. Rich in phenolic components, plant extracts are natural sources of these beneficial compounds [28].

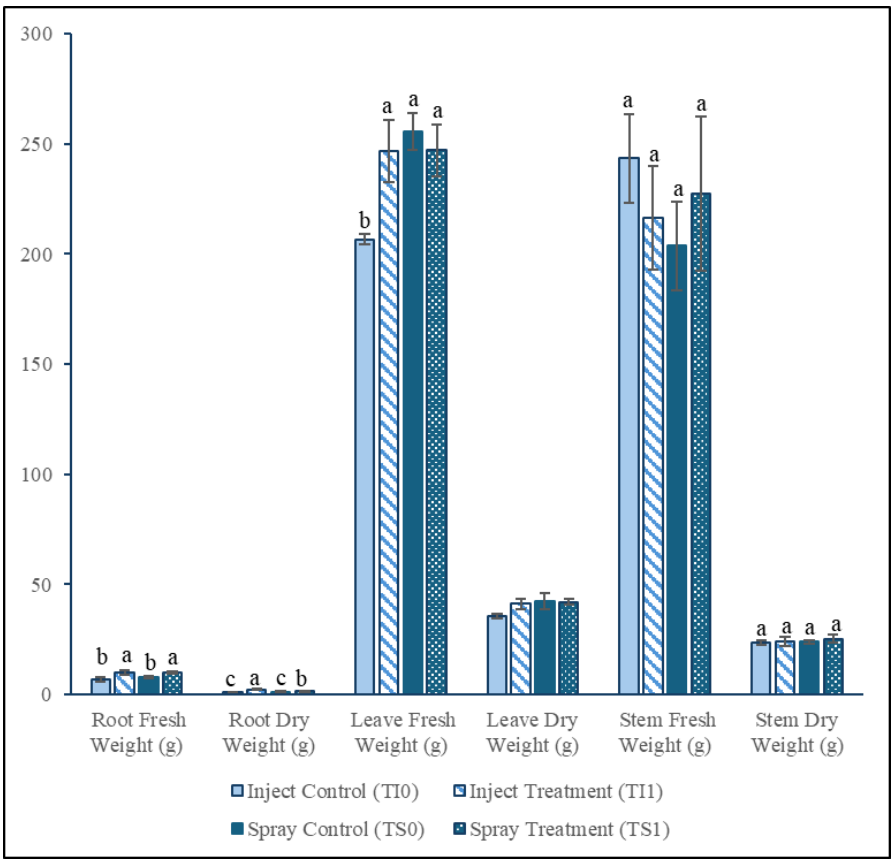

Figure 4. The fresh and dry weight plant parameter of the effect of *B. frutescens* methanolic two different methods of application, injection to the plant soil (TI1) and spray to the plant (TS1) and Control (T10 and TS0).

Disease Incidence

The findings in Table 1 and Figure 5 show varying disease incidence during different plant growth stages. Initially, no diseases were recorded. However, during flowering and pollination (Day 32), the control group showed increased incidence (TI0; 2.1%, TS0; 8.4%). During fruit development (Day 46), disease incidence remained high in controls, while spray-treated plants showed no incidence. In the final fruit maturation stage (Day 60), disease incidence rose across all groups but treated plants (TI1 and TS1) had lower rates (TI0; 58.3%, TS0; 54.2%). Vascular diseases began during flowering and worsened, leading to plant death during fruit maturation. Viruses appeared in control and injection-treated plants (2.1%) by day 46. Powdery mildew was prevalent during fruit maturation, exceeding 50% in controls, but spray-treated plants showed a significantly lower incidence of 10.4%.

Crop production faces significant threats from abiotic stress and biotic challenges, including viruses, bacteria, fungi, and pests. This study demonstrated that applied treatments notably improved disease management and overall plant health. During flowering and pollination, the spray method effectively prevented disease incidence, likely due to its broad coverage and direct contact with plant surfaces, which provided a protective barrier. While soil injection also showed promise, it was particularly effective against soil-borne diseases like Fusarium wilt [29]. The study found that *B. frutescens* extract treatments, both injection and spray, significantly reduced disease incidence during fruit maturation. The antiviral and antifungal properties of *B. frutescens* [30, 31], combined with compounds such as saponins, flavonoids, tannins, and steroids [8], contributed to enhanced plant defenses. These bioactive compounds exhibited strong antioxidant activity, reduced oxidative stress, and fortified cell walls, thereby lowering disease incidence in treated plants.

Table 1. Disease occurrence by stages of plant growth and description by disease occur (wilt and disease on vascular, viruses, and powdery mildew).

Stages	Disease Incidence	Plant Dead (%)	Wilt and Disease on Vascular (%)	Viruses (%)	Powdery Mildew (%)
Day 19 (plant sprouting and vining stages)	TI0	0	0	0	0
	TI1	0	0	0	0
	TS0	0	0	0	0
	TS1	0	0	0	0
Day 32 (flowering and pollination)	TI0	0	0	2.1	0
	TI1	0	0	0	0
	TS0	0	2.1	6.3	0
	TS1	0	0	0	0
Day 46 (fruit growth and development)	TI0	0	10.4	8.3	0
	TI1	0	4.2	2.1	0
	TS0	0	6.3	0	0
	TS1	0	0	0	0
day 60 (fruit maturation)	TI0	6.3	2.1	6.3	43.8
	TI1	6.3	0	2.1	27.1
	TS0	6.3	4.2	0	43.8
	TS1	0	0	0	10.4

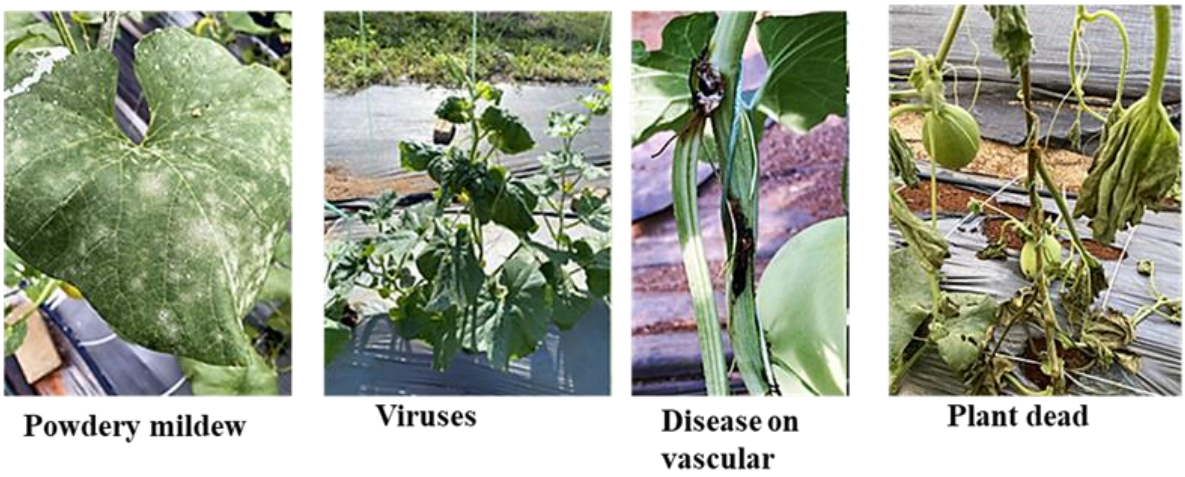

Figure 5. Image of powdery mildew, viruses, disease on vascular, and plant dead.

GCMS Analysis

The GCMS analysis (Figure 6 and Table 2) identified several compounds in the methanolic crude extract of *B. frutescens*. Quininic acid was detected as the most abundant, with a retention time of 28.22 minutes, constituting 11.49% of the total peak area and having a molecular formula of $C_{22}H_{52}O_6Si_5$ with a molecular weight of 552.3. While second and third most abundance was d-fructose, 1,3,4,5,6-pentakis-O-(trimethylsilyl)-, O-methyloxime, identified at 28.53 and 28.76 minutes, contributed 11.23% and 10.49 % to the total peak area, with a molecular formula of $C_{22}H_{55}NO_6Si_5$ and a molecular weight of 569.3. D-Mannose, with a retention time of 28.84 and 30.65 minutes, represented 8.11% and 10.40% of the peak area and had a molecular formula of $C_{21}H_{52}O_6Si_5$ with a molecular weight of 540.3. d-Glucose, 2,3,4,5,6-pentakis-O-(trimethylsilyl)-, o-methyloxyme, (1E)-, detected at 29.03 minutes, constituted 8.75% of the total peak area, exhibiting a molecular formula of $C_{22}H_{55}NO_6Si_5$ and a molecular weight of 569.3. Sucrose, identified at 42.86 minutes, contributed 8.61% to the total peak area and had a molecular formula of $C_{36}H_{86}O_{11}Si_8$ with a molecular weight of 918.4. Muco-Inositol, detected at 32.57 minutes, constituted 7.20% of the total peak area, exhibiting a molecular formula of $C_{24}H_{60}O_6Si_6$ with a molecular weight of 612.3. Lastly, gallic acid, detected at 29.88 minutes, constituted 4.14% of the total peak area, exhibiting a molecular formula of $C_{19}H_{38}O_5Si_4$ and a molecular weight of 458.2. These compounds collectively contribute in the most abundant way to the chemical composition of the methanolic crude extract of *B. frutescens*.

The result indicated that quininic acid, identified as a major component in methanolic crude extract, contributes to the bioactivity of *B. frutescens*. Quininic acid, a cyclitol derived from quinine, has drawn considerable research interest. It is biosynthesized from glucose, with quinic acid dehydrogenation and oxidation yielding gallic acid. Historically, quinine has been used as an anti-malarial and anti-parasitic drug, but its poor tolerability and compliance issues remain a concern. [27, 28]. D-Fructose, a common monosaccharide in plants, is also known as fruit sugar [34]. D-Mannose, an aldohexose, is found in various fruits and vegetables and is used for treating urinary tract infections [35]. D-Glucose, another aldohexose, is essential in metabolic pathways and energy production, serving as a primary cell energy source [36]. Sucrose, a disaccharide, functions as a plant transport sugar [37]. Muco-inositol, a cyclic polyol, may be involved in signalling pathways for plant growth and stress responses [38]. Gallic acid, a simple polyphenolic compound, is noted for its antioxidant properties and therapeutic applications [39, 40].

The economic feasibility of producing and applying *B. frutescens* extract at a commercial scale is a critical consideration. While the results show promise, the cost of large-scale extraction, formulation, and application could be a limiting factor for widespread adoption. To evaluate feasibility, future study would conduct a cost-benefit analysis, comparing the cost of producing and applying the extract to the yield gains and reductions in synthetic fungicide use. Additionally, optimizing the extraction process to maximize yield and efficacy at lower concentrations would help reduce production costs. Exploring partnerships with commercial extract producers or integrating the extract into existing pest management programs could further enhance its economic viability.

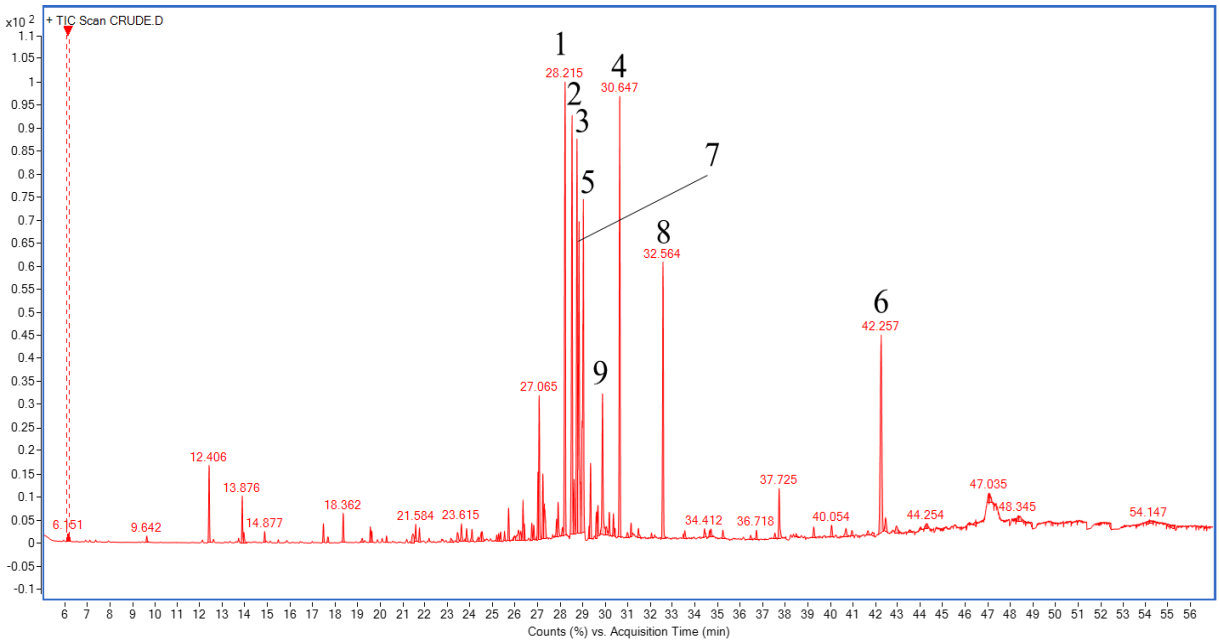

Figure 6. GCMS analysis of chemical profiles of methanolic crude extract of *B. frutescens.*

Table 2. Further GCMS analysis of chemical profiles of methanolic crude extract of *B. frutescens.*

No.	RT	Area (%)	Mol. Formula	Mol. Weight	Name of Compound
1	28.218	11.49	$C_{22}H_{52}O_6Si_5$	552.3	Quininic acid (5TMS)
2	28.528	11.23	$C_{22}H_{55}NO_6Si_5$	569.3	D-Fructose, 1,3,4,5,6-pentakis-O-(trimethylsilyl)-, O-methyloxime
3	28.745	10.49	$C_{22}H_{55}NO_6Si_5$	569.3	D-Fructose, 1,3,4,5,6-pentakis-O-(trimethylsilyl)-, O-methyloxime
4	30.645	10.40	$C_{21}H_{52}O_6Si_5$	540.3	D-Mannose, 5TMS derivative
5	29.027	8.75	$C_{22}H_{55}NO_6Si_5$	569.3	d-Glucose, 2,3,4,5,6-pentakis-O-(trimethylsilyl)-, o-methyloxyme, (1E)-
6	42.257	8.61	$C_{36}H_{86}O_{11}Si_8$	918.4	Sucrose, 8TMS derivative
7	28.837	8.11	$C_{21}H_{52}O_6Si_5$	540.3	D-Mannose, 5TMS derivative
8	32.565	7.2	$C_{24}H_{60}O_6Si_6$	612.3	Muco-Inositol, 6TMS derivative
9	29.877	4.14	$C_{19}H_{38}O_5Si_4$	458.2	Gallic acid, 4TMS derivative

CONCLUSION

In field studies, treatment by injection showed an increase in plant performance, while treatment by spraying significantly decreased disease management. These findings provide valuable insights for farmers and researchers seeking effective solutions to combat plant diseases caused by fungal pathogens. The methanol extract of *B. frutescens* was analyzed using GCMS profiling, which revealed that it contained the highest concentration of quininic acid. Additional research on the mechanism of action of *B. frutescens* is required to gain a deeper understanding of how it improves plant growth and helps reduce disease occurrence. This research can lead to valuable insights that can potentially benefit agricultural practices and crop management strategies.

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