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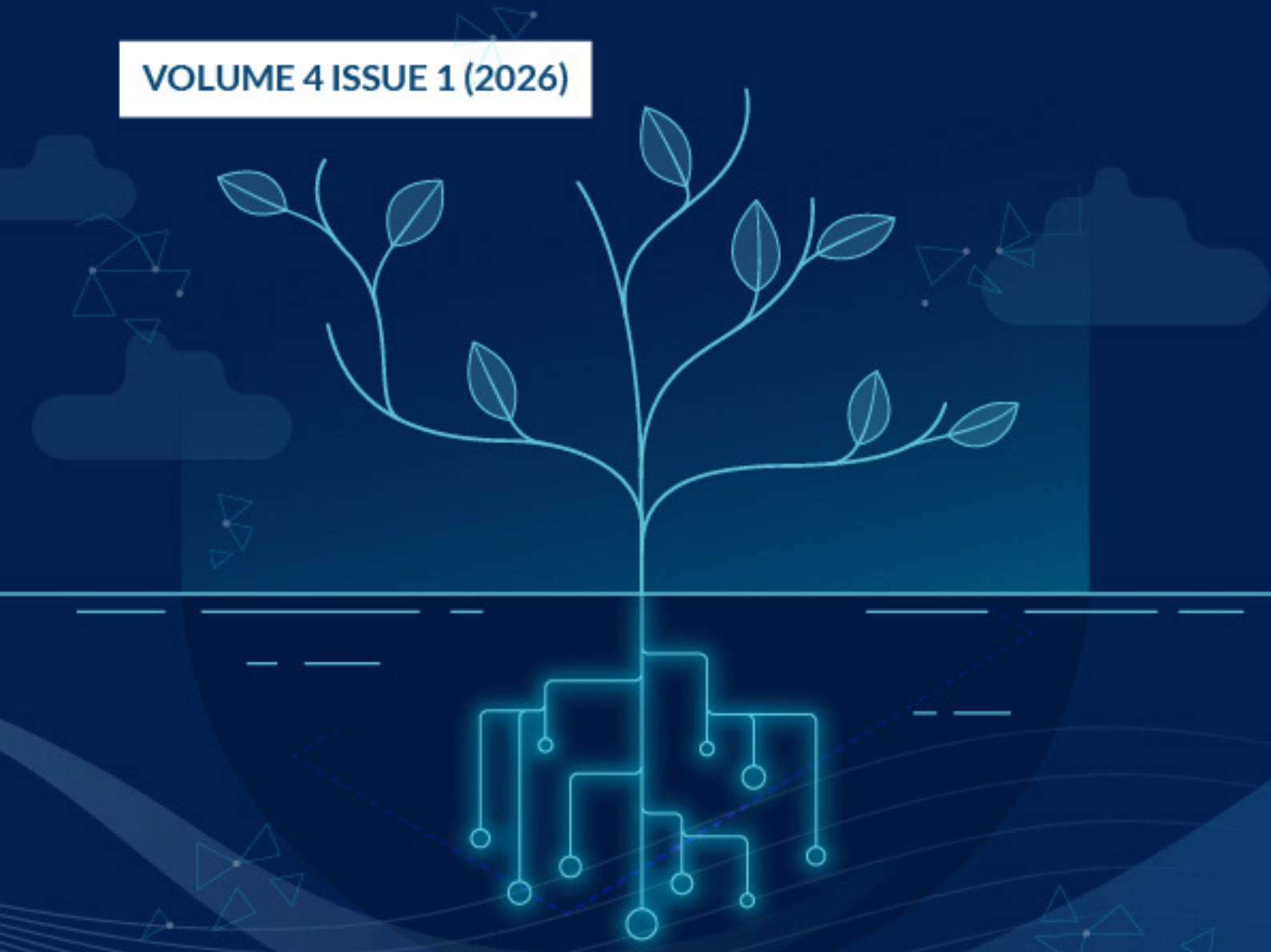

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Comparative Study on the Growth of Solanum Melongena and Capsicum Annuum Treated with Fermented Fruit Juice Fertilizer and Commercial Fertilizer

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ABSTRACT

This study examined the effectiveness of Fermented Fruit Juice (FFJ) fertilizer, commercial fertilizer, and water on the growth performance of Solanum melongena (eggplant) and Capsicum annuum (chili). Prior to treatment application, all seedlings showed similar characteristics in height, number of leaves, and leaf color, indicating that the experimental groups were uniform. Eggplant seedlings initially measured 8–10 cm with 2–4 leaves, while chili seedlings measured 10–11 cm with 6–7 leaves. After 26 days of treatment, all plants demonstrated growth improvements. Eggplants reached heights of 29–39 cm with 9–23 leaves, whereas chili plants grew to 30–39 cm with 24–68 leaves. Commercial fertilizer produced the highest growth performance, followed by FFJ fertilizer, while water-treated plants showed the least development. Despite these differences, all plants maintained healthy green leaves throughout the experiment. Analysis of Variance (ANOVA) revealed no statistically significant difference among treatments, as the computed p-value of 0.557265 exceeded the 0.05 significance level and the computed F-value was lower than the critical value. The findings indicate that FFJ fertilizer, made from banana, mango, squash, guava, tomato, and molasses, can positively support plant growth. Moreover, FFJ offers a low-cost, environmentally friendly alternative fertilizer that promotes sustainable agriculture and helps recycle biodegradable organic waste.

INTRODUCTION

The concept of fermented fruit juice (FFJ) fertilizers is rooted in organic farming principles, which emphasize the use of natural inputs to enhance soil health, improve plant resistance, and reduce reliance on synthetic chemicals. FFJ is often used alongside other organic fertilizers like compost or vermicomposting to provide a balanced nutrient supply. This organic fertilizer is particularly valued for its ability to boost microbial activity in the soil, improve water retention, and increase crop yields—all without the negative environmental impacts associated with chemical fertilizers.

As a potent organic fertilizer, fermented fruit juice enhances both plant growth and soil health while minimizing the need for synthetic chemicals. By recycling kitchen waste, gardeners and farmers can create a nutrient-rich fertilizer that aligns with sustainable gardening and agricultural practices. FFJ supplies essential vitamins and minerals, which promote healthy root and foliage development, resulting in more productive plants. Its ease of preparation makes it accessible for all gardeners and farmers, while its ability to foster beneficial microbial activity contributes to a thriving garden or farm ecosystem.

In recent years, there has been an increased demand for sustainable agricultural practices due to the harmful environmental effects of traditional chemical fertilizers. While effective at boosting crop yields, conventional fertilizers often lead to soil degradation, water pollution, and biodiversity loss. As a response, organic fertilizers have gained prominence as viable alternatives that promote healthier soils and ecosystems. This literature highlighted the effectiveness of biofertilizers in enhancing crop yield, growth, and quality while reducing reliance on chemical fertilizers. In the study "Yield and Quality of Guava Influenced by Plant Growth-Promoting Microbial Isolates" by Akshay Ingole and colleagues (2023), it was found that microbial isolates such as Pseudomonas striata, Trichoderma viride, and Bacillus megaterium significantly increased guava yield, fruit count, and quality. Notably, Pseudomonas striata combined with fertilizer resulted in a 35.93% improvement in yield, along with enhanced soluble solids, reduced acidity, and increased vitamin C content. This research supports the use of microbial inoculants as eco-friendly alternatives to chemical fertilizers, promoting sustainable agricultural practices.

One innovative approach in organic fertilizer production is the use of fermented fruit juice. This method utilizes surplus agricultural products, enhancing nutrient bioavailability and improving microbial activity and plant growth. Through the fermentation process, complex sugars are broken down, and beneficial microorganisms enrich the juice, creating a nutrient-dense fertilizer rich in nitrogen, phosphorus, potassium, vitamins, and organic acids. FFJ serves as a powerful supplement for improving soil fertility and overall plant health. Similarly, the study "Effect of Biofertilizers on Growth, Yield, and Fruit Quality of Guava (Psidium guajava L.) cv. Allahabad Safeda" by Amrinder Singh *et al.* (2020) demonstrated

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that combining a 75% recommended fertilizer dose with Azotobacter, phosphorus-solubilizing bacteria (PSB), and vesicular-arbuscular mycorrhizae (VAM) improved growth, yield, and quality of guava. This treatment resulted in increased fruit size, higher total soluble solids, and elevated sugar and ascorbic acid levels while lowering acidity. The findings illustrate that biofertilizers can effectively enhance plant growth and fruit quality, optimizing yields with reduced chemical input.

This research aims to investigate the effectiveness of fermented fruit juice as an organic fertilizer by examining its nutrient profile, its impact on soil health, and its overall effects on crop yields. Through controlled experiments and field trials, the study will assess the feasibility of integrating FFJ into existing agricultural practices, thereby contributing to the broader understanding of organic farming methods.

This research lies in its potential to offer farmers a cost-effective and eco-friendly fertilization option, ultimately supporting sustainable agriculture and food security. By harnessing the natural properties of fruits, the study seeks to promote a circular economy within agriculture, reducing waste and improving environmental outcomes. Additionally, this research will provide empirical evidence on how FFJ can benefit individuals and communities, helping them adopt more effective and sustainable farming practices. The goal of this study is to evaluate the effects of FFJ application on flowering and crop yield, thereby reducing over-reliance on chemical fertilizers and nurturing a healthier environment.

Objectives of the Study

This study aims to evaluate the effectiveness of fermented fruit juice (FFJ) as an organic fertilizer compared to commercial fertilizer in promoting plant growth. Specifically, this study aims to:

• Assess the growth level of plants treated with fermented fruit juice fertilizer in terms of plant height, number of leaves, and leaf color:

1.1 Plant height

1.2 Number of leaves

• Compare the growth of plants treated with fermented fruit juice fertilizer , commercial fertilizers , and wat

• Analyze the effectiveness of fermented fruit juice fertilizer in improving soil conditions and nutrient availability, and

• Evaluate whether fermented fruit juice fertilizer can serve as a practical and eco-friendly alternative to commercial fertilizers.

LITERATURE REVIEW

FFJ is created by fermenting fresh fruits with sugar or molasses, breaking down complex compounds into simpler, bioavailable nutrients that plants can easily absorb. This fermentation process not only boosts nutrient accessibility but also includes beneficial microorganisms like lactic acid bacteria, which preserve the nutrient quality of FFJ.

Additionally, FFJ supports environmental sustainability by utilizing waste fruits, reducing food waste, and contributing to soil health. The article draws a parallel between probiotics in fermented foods that benefit human gut health and the role of FFJ in enhancing soil microbiomes, promoting sustainable agriculture through improved nutrient cycling and plant growth.

The study by Omar *et al.* (2023), which is entitled "Effectiveness of Fermented Fruit Juice Application on Flowering and Yield of Solanum melongena," examines the effectiveness of applying fermented fruit juice (FFJ) on the flowering and yield of Solanum melongena L., commonly known as eggplant. FFJ, an organic fertilizer, is comparable to fermented plant juice (FPJ) and is simple to prepare. It has gained attention for its potential to improve plant growth while reducing dependency on chemical fertilizers in natural farming. This quantitative study employed a randomized design with four replications, using a 60cm x 60cm planting distance. Statistical analysis, conducted via one-way ANOVA and Tukey HSD tests ($p \leq 0.05$), assessed the impacts of different treatments on plant height, flowering, and fruit yield.

"Production of Fermented Fruit Juice and Value Addition by Blending Medicinal Plants" was studied by Vinayaka B Shet *et al.* (2017), which investigates the production of fermented fruit juice and the potential for value addition by blending with medicinal plants. Fermented fruit juice, one of the oldest fermented beverages, is known for its historical and global popularity. The study utilized fruits such as wild grapes, guava, sapota, fig, pomegranate, and kokum, along with blends incorporating medicinal plants like ginger, tulsi, amrutha balli, and dodda pathre. The research was conducted through quantitative methods.

Fruit musts were extracted, pasteurized, and subjected to anaerobic fermentation with yeast at a controlled pH and sugar concentration, followed by malolactic fermentation with Oenococcus oeni. The study examined the residual sugar, acidity, and ethanol content of the fermented juice. Results revealed low residual sugar levels (below 1g/L) and notable antioxidant activity, with guava showing the highest fixed acidity (5.87g/L) and pomegranate having the highest ethanol content (10%). The study concluded that blending medicinal plants with fruit juice enhances the nutritional and antioxidant properties of the juice. It recommends further quality improvements to align the fermented juice with market standards.

Fermented Fruit Juice, otherwise called FFJ, acts as natural manure for plants and gardens. This fluid expands supplements, particularly potassium levels, in the dirt to the plant's vascular tissues (Contributor, 2021).

Fermented Fruit Juice (FFJ) is a nourishing initiation protein that is incredible for natural cultivation. FFJ is a type of FPJ in which the significant ingredients are all fruits. Crops, cattle, and humans all benefit from it. It is utilized to rejuvenate harvests, animals, and people. Bananas, papaya, mango, grapes, melon, and apples can be used as the primary organic product fixings.

Fermented Fruit Juice can be used to build the fruiting systems of plants and increase the yield of some verdant green vegetables. It can be utilized as a foliar splash and as a direct application to the dirt, where t takes care of the microbiome and builds soil health (Contributor, 2021). The importance of Fermented Fruit Juicerovides nutrients such as potassium, which aids in the creation of healthy hormones, as well as increased energy and resistance to disease-causing oxidants in humans. Fermented Fruit Juice, or FFJ, is an organic fertilizer that is used on plants and gardens. This liquid raises nutrient levels in the soil, particularly potassium levels, and in the plants that grow in it (Contributor, 2021). The importance of Fermented Fruit Juice (FPJ) also includes boosting the sweetness and yield of fruiting plants while also producing healthier soil, similar to how fermented plant juice is used to improve the soil and increase the production of leafy plants in gardens. Naz *et al.* (2011) reported that fermented fruit juice is an organic fertilizer composed of banana, watermelon, papaya, apple, pineapple, or grape. Papaya, watermelon, and bananas have specific properties that can make our plants stronger and healthier. The banana, packed with potassium, encourages fruiting, and papaya and watermelon are rich ichlorophyll and chromoplasts in plants. Fermented fruit juice helps plants because of its ability to dissolve chlorophyll quickly enough to be readily absorbed by the plants due to its natural enzymes. Solanum Melongena L. or known as eggplant, brinjal, aubergine or Guinea squash is a plant of the nightshade family Solananceae. The fruit shapes and colours of Solanum melongena L. variations range from oval or egg-shaped to long club-shaped, and from white, yellow, green, to degrees of purple colouring to virtually black (Al Ali *et al.*, 2019). Moreover, eggplant is classified as a dicotyledon, and has a long tap root (Mahamad, Samah, & Khidzir, 2022). Brinjal has 4% carbohydrate content, has a high biological value of protein and amino acids, and higher vitamin content than many other vegetables, but has lower content of vitamin B2 (Rama & Narasimham, 2003). Furthermore, the flavonoids, phenolic acids, and tannins found in eggplant have been reported by numerous researchers (Hasan, 2021). The eggplant fruit is harvested when it is physiologically immature (Hasan, 2021). According to Al Ali *et al.* (2019), brinjal is an essential crop throughout Asia, Africa, and the subtropics (India and Central America), and it is also grown in some warm temperate regions of the Mediterranean and South America.

Tagotong (2015) stated that organic fertilizers like Fermented Fruit Juice (FFJ) are a good source of plant nutrients and beneficial to the physical properties of soil, which is important for the vigor, growth, and development of plants. Several studies have been conducted in the application of FFJ to investigate the effect of FFJ on plant development and yield. In the study of FFJ on growth and yield of tomato plant by Abd Rahim *et al.* (2017), the tomato plant treated FFJ have impact on higher plant height compared to control and there were significance differences in number of flowers and fruits produced by tomato plants treated by FFJ after transplant. During reproductive stages of plants, Cho's Global Natural Farming (Reddy, 2011) stated that it is suggested to apply FFJ during reproductive stage in order to supply calcium which required at reproductive stage. There are also findings by Al Ali *et al.* (2019) on the study of yield and plant vegetative growth of eggplant. They studied that there was no significant difference in number of fruit produced by Solanum melongena between organic fertilizer, developed organic fertilizer and chemical fertilizer. They explained that organic fertilizer application to the soil able to increase mineral content in soil. Furthermore, it was discovered that sixty ml of FFJ is needed to attain optimum flowering in the study of growth, flowering performance and seed yield of sunflower (Helianthus annuus) applied with FFJ and rice water (Zurbano, Merjudio, Alcantara, Remando).

MATERIALS AND METHODS

Research Method

This study, entitled "Comparative Study on the Growth of Solanum melongena and Capsicum annuum Treated with Fermented Fruit Juice Fertilizer and Commercial Fertilizer," utilized an experimental research design. It followed a systematic and carefully structured procedure to determine and compare the effectiveness of two types of fertilizers on plant growth. Experimental research involves the planning and execution of controlled tests in order to validate a hypothesis while minimizing external influences that could affect the results. In this study, the independent variables were the types of fertilizers used Fermented Fruit Juice (FFJ) fertilizer and commercial fertilizer while the dependent variable was the growth performance of the plants. The researchers closely observed how each fertilizer influenced the development of Eggplant and Chili plants under controlled conditions. Key growth parameters such as plant height, stem and diameter, were measured and analyzed to ensure accurate comparison. Furthermore, the study emphasized the cause and effect relationship between the type of fertilizer applied and the resulting plant growth. By maintaining consistent environmental conditions and carefully monitoring each treatment, the researchers were able to determine which fertilizer was more effective. Ultimately, this research aimed to provide a clearer understanding of how organic alternatives like FFJ compare to commercial fertilizers in promoting the healthy growth of selected crops.

This chapter of the study indicates and discusses the step-by-step procedure of fermented fruit juice

1. **Washing of materials** - Wash the materials thoroughly to remove dirt, dust, and other impurities that may affect the fermentation process. This also helps keep the mixture clean and safe.
2. **Cutting materials** - Cut or chop the materials into small pieces so they can be mixed easily and to help release

nutrients and natural juices faster during fermentation.

3. **Add molasses and mix** - Add molasses to the chopped materials and mix well. Molasses serves as food for the microorganisms that help in the fermentation process and speed up the decomposition of organic materials.

4. **After mixing, put it in the container** - Place the mixed materials into a clean and dry container. Make sure the container is properly sealed to prevent air or contaminants from entering and damaging the fermentation process.

5. **Ferment the mixture for 7 days and store it in dark areas away from sunlight**. Leave the mixture stored in a dark and cool place for seven days. Avoiding direct sunlight is important to maintain the proper temperature and ensure a successful fermentation process.

Application of the Fermented Fruit Juice , Commercial Fertilizer, and Water

• Before application, mix 100 mL of fermented fruit juice with 5 liters of water.

• Prepare the commercial fertilizer as is; it does not require mixing with water.

• To apply, pour the mixture of fermented fruit juice directly onto the plants.

• For the commercial fertilizer, apply it directly onto the soil.

• The application is performed every 3 days.

Preparation of Fermented Fruit Juice

1. We thoroughly washed the materials we would use such as (Tomato, Squash, Mango, Banana and Guava).

2. After washing, we cut it into small pieces to make it easier to absorb the nutrients.

3. We put the materials in the container.

4. And after we put it in the container, we mixed it with molasses to ferment it.

5. We covered it and waited for 7 days for it to ferment.

6. After 7 days we opened it and checked if it was fermented and it was successful.

7. We strained it into another container so we could squeeze the materials we used and extract its nutrients.

Fermentation Process

At the core of FFJ development is the fermentation process, which involves specific microorganisms like yeasts (Saccharomyces Cerevisiae) and Lactic Acid Bacteria (Lactobacillus spp.). These microbes play a critical role in transforming the fruit's sugars into alcohols and organic acids, enhancing the flavor and nutritional profile of the juice (Zhao *et al.*, 2018; Cai *et al.*, 2021). Optimal conditions such as temperature and pH—are crucial for maximizing microbial activity and ensuring high-quality fermentation (Jiang *et al.*, 2019).

Statistical Analysis

The gathered data on the growth parameters of Eggplant (Solanum melongena) and Chili (Capsicum annuum) were processed and analyzed using Microsoft Excel to obtain the mean values and other statistical computations. Analysis of Variance (ANOVA) was utilized to determine if there was a significant difference in the growth performance among the plants treated with Fermented Fruit Juice (FFJ), Commercial Fertilizer, and water only. ANOVA is a statistical tool used to determine the significant differences between the means of three or more groups (Kenton, 2024). This test was applied to evaluate the effect of different fertilizer treatments on the plant height, number of leaves, and overall development of the crops. The results obtained from this analysis served as the basis to conclude whether the type of fertilizer applied had a significant effect on the growth of the plants.

RESULTS AND DISCUSSION

This chapter of the study analyzes and presents the data obtained about the growth parameters of Eggplant and Chili plant involved in this study.

Before the treatment of Fermented Fruit Juice Fertilizer

Table 1. Shows the data about growth parameters of Eggplant (Solanum melongena) and Chili (Capsicum annuum) plants before applying the treatment. Plant height, number of leaves, and leaf color were measured and

Table 1: Data of growth parameters of Eggplant and Chili plant before treatment of FFJ

FERTILIZER	PLANT TYPE	HEIGHT (CM)	NUMBER OF LEAVES
FFJ	Eggplant 1	9 cm	2
	Eggplant 2	8 cm	3
	Chili 1	11 cm	7
	Chili 2	10 cm	6
Commercial Fertilizer	Eggplant 1	9 cm	3
	Eggplant 2	8 cm	2
	Chili 1	11 cm	6
Water	Eggplant 1	10 cm	4
	Eggplant 2	9 cm	3
	Chili 1	11 cm	7

listed for all groups. The height of the Eggplant seedlings ranges from 8 cm to 10 cm, while the Chili seedlings are between 10 cm to 11 cm. In terms of the number of leaves, the Eggplants have 2 to 4 leaves, and the Chilies have 6 to 7 leaves. All plants have green leaves, indicating that they are healthy and uniform in appearance. In this table, it clearly shows that the measurements of each group are close with each other. This suggests that the condition, size, and development of the seedlings were similar from each other before they were transplanted and before they received the Fermented Fruit Juice (FFJ) and Commercial Fertilizer treatments.

Data after a 26 days of treatment

Table 2. Shows the data about growth parameters of Eggplant (Solanum melongena) and Chili (Capsicum Annuum) plants after 26 days of applying the treatment. Plant height, number of leaves, and leaf color were measured and listed for all groups. The height of the Eggplant plants ranges from 29 cm to 39 cm, while the Chili plants are between 30 cm to 39 cm. In terms of the number of leaves, the Eggplants have 9 to 23 leaves, and the Chilies have 24 to 68 leaves. All plants maintained their green color, indicating that they remained healthy throughout the observation period. In this table, it clearly shows that there is a significant difference in the measurements of each group. The plants treated with Commercial Fertilizer obtained the highest height, followed by those treated with Fermented Fruit Juice (FFJ), while the plants watered only had the lowest growth. This suggests that the application of fertilizer greatly affected the development and growth performance of the plants after 26 days.

Table 2: Data after a 26 days of treatment

FERTILIZER	PLANT TYPE	HEIGHT (CM)	NUMBER OF LEAVES	LEAF COLOR
FFJ	Eggplant 1	34 cm	10	Slightly Yellow Green
	Eggplant 2	39 cm	12	Slightly Yellow Green
	Chili 1	34 cm	59	Green
	Chili 2	39 cm	68	Green
Commercial Fertilizer	Eggplant 1	31 cm	10	Slightly Yellow Green
	Eggplant 2	32 cm	9	Slightly Yellow Green
	Chili 1	33cm	57	Green
Water	Eggplant 1	30 cm	7	Yellow Green
	Eggplant 2	29 cm	23	Yellow Green
	Chili 1	30 cm	24	Yellow Green

Results of ANOVA

To determine if there is a significant difference in the means of the treatments applied, Analysis of Variance (ANOVA) was performed. The results revealed that there is no significant difference between the groups. The computed P-value is 0.557265, which is greater than the standard significance level of 0.05. Additionally, the computed F-value of 0.359344 is less than the critical P-value of 0.557265.These results suggest that the type of fertilizer used did not have a significant effect on the growth performance of both Eggplant (Solanum melongena) and Chili (Capsicum annuum). This means that the differences in growth observed between the plants treated with Fermented Fruit Juice (FFJ), commercial fertilizer, and water only may be due to chance and are not statistically significant.

Table 3: Results of ANOVA

Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	117.5556	1	117.5556	0.359344	0.557265	4.493998
Within Groups	5234.222	16	327.1389			
Total	5351.778	17				

CONCLUSION

This study aimed to compare the effectiveness of Fermented Fruit Juice (FFJ), commercial fertilizer and water for the growth of Solanum melongena (Eggplant) and Capsicum annuum (Chili). For our Fermented Fruit Juice fertilizer (FFJ) we used Banana, Mango, Squash, Guava, Tomato, and Molasses as we fermented it to do the Fermented Fruit Juice (FFJ) and was applied with water to the plant. As for the commercial fertilizer we applied it directly to the soil and lastly water. The application happened every 3 days for 26 days that resulted to 9 total days of applications. Based on the result, fermented fruit juice (FFJ) was effective when it comes to the strength and growth of the plant ,but still the commercial fertilizer have shown better growth than fermented fruit juice

and water. This study shows the effectiveness of both fermented fruit juice (FFJ) and commercial fertilizer with a better result than water. Moreover, we are doing this to help farmers find another method to grow their plants using rotten fruits and vegetables or their peels. It helps not just the farmers but also the society to reduce pollution, recycle materials and reuse it for a better product for free or with just minimal cost.

Recommendations

It is recommended that farmers and gardeners use Fermented Fruit Juice (FFJ) as an alternative organic fertilizer to reduce dependence on chemical fertilizers and promote sustainable agriculture. Future researchers may further explore the long-term effects of FFJ on different crops and soil types to strengthen its effectiveness and applicability. Agricultural communities are also encouraged to utilize fruit waste in producing FFJ to minimize environmental waste while improving soil fertility and crop productivity. Regular application of FFJ, together with proper farming practices, may help achieve healthier plants, better yields, and a safer environment.

• If it rains after planting, FFJ can still be effective because some nutrients may already be absorbed by the soil and roots before the rain starts.

• It is better to apply FFJ during light weather or when no heavy rain is expected for a few hours to avoid the fertilizer being washed away.

• During the rainy season, reduce the amount of water mixed with FFJ to prevent overwatering the plants.

• Apply FFJ early in the morning or late in the afternoon so the soil can absorb nutrients properly.

• Make sure the plants have proper drainage because too much rainwater may weaken the effect of FFJ and damage the roots.

• Reapply FFJ after heavy rain if necessary, especially when the soil nutrients may have been washed out.

• Continue regular observation of plant height, leaf color, and overall health to determine if the FFJ application remains effective during rainy conditions.

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