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Effects of Natural and Home-Made Bio-Inoculants on Containerized Okra Plants (*Abelmoschus Esculentus*)

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Abstract

The study focused on growing okra plants (*Abelmoschus esculentus*), one of the most popular vegetables that can be grown in containers, with composted chicken manure, vermi compost, and home-made liquid bio-inoculants such as fish amino acid (FAA), fermented fruit juice (FFJ), and calcium phosphate (CALPHOS). The scope was to determine which of these natural amendments could improve the growth performance of containerized okra plants during the vegetative stage, as well as to reveal the significant difference in the mean height of the containerized okra plants at two-time points, Week 1 and Week 8, as well as the significant difference in the mean growth rate among the three treatments. Composted chicken manure and vermicompost were applied directly to the soil, whereas bio-inoculants were used as a foliar or direct fertilizer application to the leaves. To compare the mean difference between groups, the Paired Samples t-test, and One-way Variance Analysis were used concurrently to compare height differences and weekly growth rates. The experiment revealed that okra plants fertilized with liquid bio-inoculant outperform significantly those fertilized with composted chicken manure and vermicompost. Furthermore, the disparity in mean growth rates in containerized okra plants is most likely the result of experimental manipulation rather than random occurrence. The efficacy of vermicompost is related to the nutrient content of substrates, which in this study had a low growth effect on the specific okra plants. Bio-inoculants, on the other hand, have a greater impact on containerized okra plants as a foliar fertilizer.

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Calcium Phosphate;
Container Gardening;
Fermented Fruit Juice;
Fish Amino Acid;
Foliar Fertilizer.

Introduction

Gardening is a wonderful hobby that provides physiological and psychological benefits to most people. It also encourages greater environmental awareness and connection to nature.[1] Container gardening may be an option in urban areas where gardening is difficult due to a lack of space. Container gardening can be combined with the cultivation of

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flowering ornamental plants to attract pollinators that are beneficial to fruiting vegetables.[2] Gardening promotes the recycling of food waste and kitchen scraps for composting, as well as the use of discarded plastic containers for plants, rather than creating environmental issues.[3] Container gardening also reduces household food costs by ensuring that vegetables are always available to the family rather than purchasing them from the market. According to the Philippine Association of Nutrition (PAN),[4] the average Filipino household spends 40 percent of its income on food, while the poorest families spend 60 percent of their income on food. Container gardening is popular among urban gardeners and plant hobbyists. The most important goal, perhaps, is to have an immediate supply of clean, chemical-free, and fresh vegetables.

Okra is a well-known and simple-to-grow vegetable. Its fruits mature faster after flowering. The best time to harvest edible green pods or fruits is when they are young and the tip can be snapped or split quickly.[5] Okra is a low-calorie vegetable that can be stir-fried, steamed, boiled, or grilled. According to the Nutrition Journal, it is a good source of healthy dietary fiber, vitamins like Vitamin C, A, and B complex, and minerals like calcium, potassium, iron, zinc, copper, and manganese.[6] It has a higher concentration of antioxidant compounds than other vegetables and berries.[7] Antioxidants are in charge of protecting DNA and cellular tissue from free radical damage. Because okra has a low glycemic index, it has no effect on blood sugar levels after consumption.[8] The study looks at the efficacy of vermicompost, composted chicken manure, and bio-inoculants as organic fertilizers during the vegetative stage of containerized okra plants.

Statements of the Null Hypothesis

The following were assumptions of the study tested at a level of 0.05 significance.

Ho^1

There is no significant difference in the height of the containerized okra plants at Week 1 and Week 8.

Ho^2

There is no significant difference in the mean growth rate of containerized okra plants using the three natural fertilizers at Week 1 and Week 8.

Materials And Methods

The seeds were obtained from the smooth green variety. Okra seeds were first soaked in water overnight to aid in moisture absorption and germination. The following day, seeds were sown about 1.0 cm deep in the potting mixture. Seedlings were grown in recycled plastic cups until they were ready to be transplanted into permanent containers. Planted cups were then labeled Groups A, B, and C before being placed in direct sunlight. Okra seeds were sown in a potting mix made up of 50 percent garden soil, 25 percent carbonized rice hull, and 25 percent commercialized coco peat. Coco peat is a natural anti-fungal product made from the pith of the coconut husk. It was solarized, or exposed to direct sunlight for one to two weeks to kill fungi, bacteria, and other harmful microorganisms that could inhibit seed germination. Seedlings were transplanted to permanent containers when 2-4 true leaves were observed.

Table 1: Amount and Application of Composted Chicken Manure/ Vermicompost[19]

Fertilizer Quantity	Frequency
16 tbsps./1 cup	Every 7 days

In this experimental study, natural fertilizers such as composted chicken manure, vermicompost, and liquid bio-inoculants such as FAA (Fish Amino Acid), FFJ (Fermented Fruit Juice), and CALPHOS (Calcium Phosphate) were used to supplement macro and micronutrient requirements of containerized okra plants

The chicken manure was sun-dried and composted, as it is a good source of nitrogen for plant growth. The manure was collected from native chickens that were fed with pellets, manzanitas fruit, a variety of edible seeds, corn, and food scraps (overripe banana, fruit peelings, cooked rice). As an agricultural input, chicken manure improves soil fertility. Fertile soil results in healthier plants, which results in higher yields.[9]

Furthermore, one week before its use in the experiment, vermicompost was collected. The researcher currently maintains a make shift composting and vermiculture facility to manage organic household and garden waste. Vermicompost, which is composed of worm castings and composted organic materials, contains a high concentration of beneficial microbes that contribute to a thriving soil environment for microbes that aid plant growth.[10] Vermicompost enhances soil quality and structure, promoting plant growth and development.[11] Table 1 shows the specific amount and time of application of composted chicken manure and vermicompost to the soil.

Table 2: Amount and Application of Water and Home-made Bio-inoculants[20]

Quantity of water	Quantity of bio-inoculant	Quantity in milliliter (ml)	Frequency
¼ liter	3 tsps.	7.5 ml	Every 7 days
½ liter	1 tbsp.	15 ml	
1 liter	2 tbsps.	30 ml	
3 liters	6 tbsps.	90 ml	
5 liters	10 tbsps.	150 ml	

*Applicable to FFA, FFJ, and CALPHOS

Furthermore, homemade liquid bio-inoculants such as fish amino acid, fermented fruit juice, and calcium phosphate were used as foliar fertilizers in the study. Table 2 shows the application period and the exact amount of liquid bio-inoculants (FFA, FFJ, CALPHOS) to be diluted in water, preferably unchlorinated, for foliar feeding with a sprayer because plants absorb nutrients through the stomata on their leaves.

Fish amino acid (FFA) is a nitrogen-rich liquid fertilizer made by fermenting fish heads, gills, and entrails, which are typically discarded as kitchen waste. It is made by combining raw fish leftovers with molasses in a 1:1 ratio. In a container, the mixture is kept and fermented anaerobically. After twenty (20) to thirty (30) days, the extract can be applied to plants. Molasses as a dark-colored, sweet, and syrupy byproduct of sugarcane and sugar beet sugar extraction that contains concentrated levels of vitamins and minerals. It is an important source of carbon for microbial growth.[12] As a primary source of nitrogen and other trace minerals, fish amino acid is an organic liquid bio-inoculant fertilizer that boosts plant foliage and growth during the vegetative stage.[13] The Department of Science and Technology claims that FAA contains 90.0 percent nitrogen and 2.5 percent phosphorous.[21]

Dr. Han Kyu Cho of South Korea was the first to develop fermented fruit juice (FFJ), which is made by fermenting ripe fruits with molasses. Because banana and mango peels were readily available, the researchers used them as raw materials for fermentation. In a 1:1 ratio, a kilo of peelings is combined with a kilo of molasses. After seven (7) to ten (10) days of fermentation, the liquid portion of the mixture is ready for use. Fermented fruit juice provides potassium and trace minerals to plants, allowing them to flower and fruit more efficiently. It also raises the nutrient level of the soil and activates enzymes.

According to Department of Agriculture, FFJ has the following nutrients beneficial to plants such as nitrogen, phosphorus, calcium, magnesium, sodium, iron, copper, manganese.

Calcium phosphate (CALPHOS) is a widely used liquid fertilizer made from vinegar-fermented eggshells, seashells, and animal bones. Powdered eggshells were used as the primary calcium source for plants damaged by blossom end rot disease in tomatoes and other berries.[14] Despite the fact that nitrogen, phosphorus, and potassium (NPK) are the most important nutrients for plant growth. Egg shells also contain other trace minerals that are beneficial to plants.[15] Eggshells, seashells, and animal bones, on the other hand, would take longer to decompose in the soil, allowing plants to absorb the much-needed calcium and phosphorus. One (1) part of crushed eggshells, seashells, and animal bones is lightly roasted over low heat before being soaked in five (5) parts of vinegar.

The mixture would cause a massive chemical reaction, releasing calcium, phosphorus, and other trace minerals. After 21-30 days, the liquid is ready to supplement nutrient requirements of plants.

During weekly application, the researchers mixed all three bio-inoculants with the appropriate amount of water.

Okra plants with 2 to 4 leaves were transplanted in 5-gallon containers. The perusal of the data collected revealed that the average plant height ranged from 7.2 cm to 7.6 cm. Every week, the growth height is measured manually with a metric calibrated measuring tool. Each plant was evaluated from the plant's base stem up to its growing point. There was 10 days gap after transplantation before growth was monitored and recorded, as well as when different fertilizers were introduced to each of the subjects. The okra plants in Group A were fertilized with composted chicken manure, while those in Group B, vermicompost, and Group C, bio-inoculants (Table 3). For eight (8) weeks, the identified natural fertilizers were applied weekly or every seven (7) days to plant subjects.

Table 3: Growing Medium for Containerized Okra plants

Specific Composition of Growing Medium	
Group A	The containers have a growing medium mixture of 50 percent solarized garden soil and 50 percent poultry manure.
Group B	The containers have a growing medium mixture of 50 percent solarized garden soil and 50 percent vermicompost.
Group C	The containers have a growing medium of 100 percent solarized garden soil. However, the soil has been drenched with liquid bio-inoculant

The researchers employed the Paired Samples t-test to determine the difference in containerized okra's height at the two-point time, Week 1 and Week 8. One-Way Analysis of Variance (ANOVA) was also utilized to test and compare whether there is a statistically significant difference in Okra plants mean growth rate.

Results and Discussion

Table 4 shows that application of composted chicken manure fertilization resulted in significantly higher growth rates in Group A, which included S1- 7.4 cm to 34.0 cm, S2- 7.2 cm to 33.5 cm, S3- 7.3 cm to 32.9 cm, S4- 7.6 cm to 34.3 cm, and S5- 7.5 cm to 33.8 cm. Average growth rate from Week 1 to Week 8 is 33.7cm in plants of Group A weekly growth data. Each Okra plants in Group A's calculated weekly growth average could be summarized as follows. S1 is 3.80 cm, S2 is 3.76 cm, S3 is 3.66 cm, S4 is 3.81 cm, and S5 is 3.76 cm.

Group A Okra plants were observed to have a lush green foliage system with distinct sturdy stems. The okra sprouted small flower buds, indicated that the fruiting stage is near. There were no leaf deformities, discoloration, or drying, and no physical evidence of pest infestation. Composted chicken manure fertilization significantly increased the growth of Okra plants in Group A. Every 7 days, sixteen (16) tablespoons of fertilizer, or one cup, was applied to each plant.

The okra plants in Group B were fertilized weekly with vermicompost. Fertilization resulted in significantly lower growth rates of S1- 7.4 cm to 15.1 cm, S2-7.5 cm to 14.5 cm, S3- 7.3 cm to 14.2 cm, S4- 7.4 cm to 15.5 cm, and S5- 7.5 cm to 15.0 cm. Group B okra plants have the average growth rate of 14.9 cm from Week 1 to Week 8 based on data collected weekly. The calculated weekly growth rate of okra plants in Group B is shown below. S1 measures 1.10 cm, S2 measures 1.00 cm, S3 measures 0.99 cm, S4 measures 1.16 cm, and S5 measures 1.07 cm. respectively.

The growth of the okra plants in Group B has been stunted. The foliage system and stems were underdeveloped. Although there was no pest infestation, a few leaves had minor deformities and discoloration (yellowish). On Group B, vermicompost fertilization had little effect on growth. Every 7 days, sixteen (16) tablespoons of fertilizer, or one cup, was applied to each plant.

Table 4. Growth effect of Natural and Home-made Bio-inoculants

Composted Chicken Manure Fertilization									
Group A	**W1**	**W2**	**W3**	**W4**	**W5**	**W6**	**W7**	**W8**	**Weekly Growth Rate (cm)**
S1	7.4	11.3	14.9	17.8	20.5	23.9	29.3	34.0	**3.80**
S2	7.2	11.9	14.7	17.0	20.8	24.1	28.9	33.5	**3.76**
S3	7.3	11.2	14.9	17.2	20.7	23.6	28.9	32.9	**3.66**
S4	7.6	11.6	14.8	17.4	21.0	23.8	29.5	34.3	**3.81**
S5	7.5	11.0	14.5	17.4	21.0	23.6	29.0	33.8	**3.76**
Vermicompost Fertilization									
Group B	**W1**	**W2**	**W3**	**W4**	**W5**	**W6**	**W7**	**W8**	**Weekly Growth Rate (cm)**
S1	7.4	8.6	9.3	11.0	11.9	12.0	14.2	15.1	**1.10**
S2	7.5	8.9	9.4	10.8	11.5	11.9	14.0	14.5	**1.00**
S3	7.3	8.5	9.5	9.5	10.0	10.9	13.8	14.2	**0.99**
S4	7.4	8.5	9.5	10.0	10.5	11.0	13.5	15.5	**1.16**
S5	7.5	8.6	9.5	9.9	10.5	11.1	14.0	15.0	**1.07**
Home-made Bio-inoculants Foliar Fertilization									
Group C	**W1**	**W2**	**W3**	**W4**	**W5**	**W6**	**W7**	**W8**	**Weekly Growth Rate (cm)**
S1	7.3	13.5	17.5	21.5	25.7	28.9	33.0	37.2	**4.27**
S2	7.5	13.6	17.9	22.0	26.0	29.1	32.5	36.7	**4.17**
S3	7.6	13.9	17.9	21.9	26.5	28.7	33.2	37.0	**4.20**
S4	7.3	13.9	17.9	21.8	25.9	29.9	32.9	36.9	**4.23**
S5	7.4	14.0	17.5	21.9	25.5	29.9	33.5	37.5	**4.30**

In addition, Group C okra plants with accelerated growth could be depicted as follows. The apparent effect of weekly application of liquid bio-inoculant fertilizers, namely FFA, FFJ, and CalPhos on plant height was S1-7.3 cm to 37.2 cm, S2-7.5 cm to 36.7 cm, S3- 7.6 cm to 37.0 cm, S4-7.3 cm to 36.9 cm, and S5- 7.4 cm to 37.5 cm. Based on the data collected from Week 1 to Week 8, the okras had the significantly highest growth rate of 37.1cm. The weekly growth rate of Group C okra plants can be simplified to the following: S1–4.27 cm, S2–4. 17 cm, S3–4.20 cm, S4–4.23 cm, and S5–4.30 cm.

As previously stated, the foliage system and stems were discovered to be in optimal development. The leaves were larger and free of deformity and discoloration, and several flower buds began to form as the fruiting stage approached. There was no evidence of pest infestation. Liquid bio-inoculants foliar fertilization resulted in the best growth of Group C okra plants. Every 7 days, each plant received two tablespoons of FAA, FFJ, and CALPHOS diluted in one (1) liter of water and sprayed all over.

Table 5 shows Group A descriptive statistics that the paired samples were normally distributed using Shapiro-Wilk's test for normality, W = 0.827 with p = 0.277. Group A containerized okra plants on composted chicken manure had a mean height of 7.40 cm with a standard deviation of 0.158 cm in week 1.

The mean height of okra plants increased to 33.70 cm (SD = 0.534) at the end of week 8. Table 5 shows that for pair 1, at 5 percent level of significance, t (5) = 136.727; $p < 0.05$. Hence, there is sufficient evidence to support that there is a statistically significant difference between the two mean heights of containerized okra plants in Group A from week 1 to week 8.

Table 5: Paired Samples t-test on Height of Containerized Okra plants Fertilized with Composted Chicken Manure at Week 1 and Week 8

Height of Okra (in cm)	N	M	SD	Shapiro-Wilk's test for normality	t-value (p-value)
Week 1	5	7.40	0.158	W = .827	t =136.727
Week 8	5	33.70	0.534	(p = .277)	(p = .000)

Table 6: Paired Samples t-test on Height of Containerized Okra plants Fertilized with Vermicompost at Week 1 and Week 8

Height of Okra (in cm)	N	M	SD	Shapiro-Wilk's test for normality	t-value (p-value)
Week 1	5	7.42	0.084	W = .942	t = 33.407
Week 8	5	14.86	0.513	(p = .678)	(p = .000)

Table 6 shows Group B descriptive statistics that the paired samples were normally distributed using Shapiro-Wilk's test for normality, W = 0.942 with p = 0.678. Group B containerized okras on vermicompost had a mean height of 7.42 cm (SD = 0.084) in week 1, and the mean height of okra plants increased to 14.86 cm (SD = 0.513) at the end of week 8. Table 6 shows that for pair 2, at 5 percent level of significance, t (5) = 33.407; $p < 0.05$. Hence, there is sufficient evidence to support that there is a statistically significant difference between the two mean heights of containerized okra plants in Group B from Week 1 to Week.[8]

Table 7: Paired Samples t-test on Height of Containerized Okra plants Fertilized with FFA, FFJ (*Banana and Mango Fruit Peelings*) & CalPhos at Week 1 and Week 8

Height of Okra (in cm)	N	M	SD	Shapiro-Wilk's test for normality	t-value p-value)
Week 1	5	7.42	0.130	W = .971	t = 181.735
Week 8	5	37.06	0.305	(p = .884)	(p = .000)

Group C descriptive statistics that the paired samples were normally distributed using the Shapiro-Wilk's test for normality, W = 0.971 with p = 0.884. Group C containerized okra plants on liquid bio-inoculant had a mean height of 7.42 cm (SD = 0.130) in week 1, and the mean height increased to 37.06 cm (SD = 0.305) at the end of week 8. Table 7 shows that for pair 3, at 5 percent level of significance, t (5) = 181.735; $p < 0.05$. Hence, there is sufficient evidence to support a statistically significant difference between the two mean heights of containerized okra plants at Week 1 and Week 8. There is a significant increase in the mean height of the containerized Okra plants in Group C.

Table 8: Descriptive Statistics on the Mean Growth Rate of Containerized Okra plants

Type of Fertilizer	N	M	SD	Levene's statistic	P - value
Group A Composted Chicken Manure Fertilization	5	3.758	0.059		
Group B Vermicompost Fertilization	5	1.064	0.071	F(2,12) = 0.336	.721
Group C Home-made Bio-inoculants Foliar Fertilization	5	4.234	0.052		

Table 9: ANOVA Summary Table of Mean Growth Rate of Containerized Okra plants

Sources of Variation	Sum of Squares	df	Mean Square	F - value	P-value
Growth Rate of Okra	29.222	2	14.611		
Within Groups	.045	12	.004	3885.885	.000
Total	29.267	14			

The descriptive statistics associated with the containerized okra plants' mean growth rate given different types of natural fertilizer are shown in Table 8. The growth rate of the containerized okra plants treated with liquid bio-inoculants (M = 4.234, SD = 0.052) was numerically higher than the okra plants fertilized with composted chicken manure (M = 3.758, SD = 0.059) and those employed with vermicompost (M = 1.064, SD = 0.071). The containerized okra plants treated with vermicompost had the lowest growth rate.

The assumption of homogeneity of variances was tested based on Levene's F-test, $F(2,12) = 0.336$, $p = .721$. The p-value = 0.721 > 0.05 implies no violation in the assumption for a variance to be statistically equal among subjects. A One-way ANOVA is performed to test whether there is a statistically significant difference in mean growth rate of okra plants.

The one-way analysis of variance (ANOVA) was used to analyze the mean growth rate of containerized okra plants. Based on Table 9, there was a significant main effect for treatment, $F(2, 12) = 3885.885$, $p < 0.05$. The p-value < 0.05 means that at a 5 percent level of significance, it rejects the null hypothesis and concludes that there is a statistically significant difference between the means growth rate of containerized okra plants given different types of natural fertilizers. Hence, there is sufficient evidence to support that the mean growth rate differences of okra plants are not likely due to chance but probably due to experimental manipulation.

Table 10. Post Hoc Analysis between the Three Types of Fertilization

Method	(I) Type of Fertilization	(J) Type of Fertilization	Mean Difference (I-J)	Std. Error	p-value
Tukey HSD	Group A (Chicken manure	Group B (Vermicompost	2.694*	0.03878	.000
		Group C (Bio-inoculants)	-0.476*	0.03878	
	Group B (Chicken manure)	Group C (Bio-inoculants)	-3.170*	0.03878	.000

*. The mean difference is significant at the 0.05 level.

Table 10 presents the positive mean difference (*M* = 2.69 cm) for Group A and Group B indicating that the containerized okra plants fertilized with composted chicken manure have a significantly higher growth rate than those employed with vermicompost. Meanwhile, the negative mean difference (M = -0.476 cm) between Group A and Group C indicates that the containerized okra plants fertilized with composted chicken manure have a significantly lower growth rate than those treated with liquid bio-inoculants. Also, the negative mean difference (M = -3.170 cm) between Group B and Group C indicates that the containerized Okra plants employed with vermicompost have a significantly lower growth rate than those okras treated with liquid bio-inoculants. Hence, at a 5 percent level of significance, has shown sufficient evidence to conclude that the containerized okra plants which were treated with liquid bio-inoculants (Group C) have a significantly highest growth rate than those fertilized with composted chicken manure (Group A) and those employed with vermicompost (Group B). The Post Hoc Analysis table shows that there is a statistically significant difference in the mean growth rate between the containerized Okra plants belonging to Group A and Group B ($p < 0.05$), as well as between Group A and Group C ($p < 0.05$) and Group B and Group C ($p < 0.05$). Therefore, the null hypotheses are still rejected.

Table 11: Homogeneous Subsets

Growth of Containerized Okra Plants				
		Subset for alpha = 0.05		
Treatment	**N**	**1**	**2**	**3**
Group B Vermicompost Fertilization	5	1.0640		
Group A Composted Chicken Manure Fertilization	5		3.7580	
Group C Home-made Bio-inoculants Foliar Fertilization	5			4.2340
Sig.		1.000	1.000	1.000
Means for subjects in homogeneous subsets are displayed.				
a. Uses Harmonic Mean Sample Size = 5.000.				

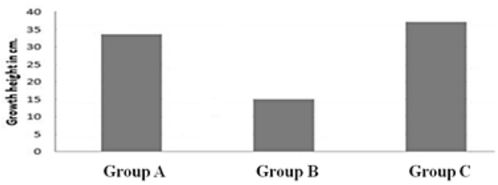

Fig. 1: Average Height of Containerized Okra Plants from Week 1 To Week 8

The post hoc test is also provided with homogenous subset results wherein the groups are listed in ascending means. The means listed under each subset comprise a set of means that are not significantly different from each other. Table 11 shows that each treatment applied to the containerized okra plants belongs to three different subsets with an ascending order of the means Group B (M = 1.06), Group A (M = 3.76), and Group C (M = 4.23). This supports Group C's result, having a significantly higher growth rate compared to Groups A and B.

The effect of composted chicken manure on Group A validated the findings of[16] superior performance on Okra plants grown directly in soil compared to other organic manures. Chicken manure as a natural fertilizer could improve soil productivity and crop production.[9] Over the course of eight (8) weeks, dried and composted chicken manure used as fertilizer for Group A containerized okra plants demonstrated a significantly high growth rate. The potency of vermicompost, on the other hand, is most likely determined by the type of substrate fed to earthworms known as African night crawlers. The substrate must be made of organic matter that contains the necessary micro and macronutrients for the plants. A specific ratio of nitrogen and carbonrich substrates is also required to produce high-quality vermicast or vermicompost, also known as "black gold" because it promotes plant health and growth when mixed into the soil. Because pure, high-quality vermicast or vermicompost is expensive on the market, home gardeners raise African nightcrawlers. Furthermore, raising earthworms is a way to reduce organic household waste without negatively impacting the environment.

Vermicast is pure worm casting, whereas vermicompost is a combination of worm casting and compost. In the study of[10] African nightcrawlers were fed with cow manure substrate and the potent casting produced had a significant effect on Capsicum plant growth and fruiting, demonstrating that cow manure is an excellent substrate for vermicomposting. African nightcrawlers eat substrates, which they convert into a humus-like matter. The vermicompost used in this study was produced by earthworms, whose substrate consumption was limited to dry leaves, used paper, and kitchen scraps instead of cow manure, banana stalk, and other nutrient-rich organic matter. The micro and macronutrient requirements for the expected growth rate of plant subjects were not desirable; thus, the result of vermicompost fertilization of containerized okra plants in Group B was significantly lower. Other factors could include the chemical reaction of vermicompost to soil and the pH level, which was not determined in this experimental study.

Moreover, the liquid bio-inoculant effect was superior and significantly highest in Group C okra plants growth and development. The FFA or Fish Amino Acid, FFJ, or Fermented Fruit Juice (*banana and mango fruit peelings)*, and CALPHOS or Calcium Phosphate were the three (3) home-made liquid bio-inoculants used to supplement the weekly macro and micronutrient needs of Group C as affirmed by the studies of[13,14,15] and Dr. Han Kyu Cho of South Korea. The high efficacy of liquid bio-inoculants to plants' growth and fruiting due to beneficial microorganisms would improve soil quality and fertility. Foliar fertilization employed in Group C resulted in optimum growth performance. Liquid fertilizers can provide important bio resources for agriculture because their beneficial microbes can improve plant growth and nutrient uptake through P, K, and Zn solubilization as well as N fixation. As a result, the activities of these beneficial microbes may be able to increase crop yield, remove contaminants, inhibit pathogen activity, and produce fixed N or other plant growth and development substances.[17]

As a point of inference, the combination of the three identified natural fertilizers on container gardening might as well show a more interesting outcome, which may lead to further studies.

Conclusion

Home gardeners have a wide preference of growing media, soil amendments, fertilizers for optimum plant growth and development, for whatever they want to propagate. Almost all vegetables that can grow directly in soil can also be grown in suitable containers.[18] Home container gardening solves the problem of space scarcity for growing and nurturing healthy, chemical-free, and fresh vegetables to meet nutritional needs of the family and food sufficiency. Okra is a popular and nutrient-dense vegetable that can be grown in containers. Future research may be undertaken to identify a different outcome of organic fertilizers such as foliar fertilizer, specifically from that of the composted chicken manure. Whether it can be fermented using similar raw material used in making bio-inoculants like FFA, FFJ, and CALPHOS. Research findings on the liquid concoction known as "*vermitea*" may be a sufficient foliar input in gardening; however, vermicompost potency depends mainly on the substrate's quality or organic materials fed to African night-crawlers. The nutrient content of substrates correlates with the efficacy of the vermicompost to plants. The superior effect and impact of bio-inoculants on containerized okra plants as foliar fertilizers have been proven in the study.

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Conflict of Interests

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