A Comparative Study of Used Coffee Grounds Fertilizer, Chemical Fertilizer, and Organic Fertilizer on Yield and Growth of *Ipomea Aquatica* in Home Gardening with the Use of One-Way Anova and Kruskal-Wallis Test

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Abstract

Inflation has been one of the main issues that the Philippines has been dealing with, especially in navigating life with COVID-19 in the new normal. This study aimed to address the food security problems in the Philippines by comparing various fertilizer alternatives namely, organic fertilizer, chemical fertilizer, and used coffee grounds fertilizer. A field experiment was conducted to see the effect of organic fertilizer, chemical fertilizer, and used coffee grounds fertilizer on the yield and growth of Ipomea Aquatica (kangkong) in home gardening. An interview was also conducted with sixteen (16) respondents with regards to human preference on the physical characteristics and taste of the kangkong crop. The data between the relationships between the independent variables and fertilizers regarding physical characteristics was analyzed through One-Way ANOVA and the data for human preference was analyzed through the use of Kruskal-Wallis Test through SPSS. The results on the data for human preference showed that the kangkong 3 (chemical fertilizer) stood up compared to the other two kangkongs, which was indicated by 62.5% overall appearance and 37.5% on overall taste among the kangkong. The proponents recommend using the coffee ground as a fertilizer as based on the computed data, the percentage of each fertilizer doesn't have a huge gap, especially on the taste, which is the criterion that is the most important for people who source their vegetables on planting. This study will help future researchers to consider a fertilizer with a high acidity level. Additionally, it will contribute to the community that promotes home gardening to have a much healthier and breathable air.

Keywords
Coffee ground fertilizer, Ipomea Aquatica, One-way ANOVA, Kruskal-Wallis Test.

1. Introduction

Fertilizer, a compound containing nutrients that improve plant growth and yield, has been used since the 19th century. The industry has evolved due to slow production caused by nutrient deficiency in organic fertilizers. Chemical or synthetic fertilizers have become more popular due to the COVID-19 pandemic, which has caused fertilizer shortages worldwide, higher input costs, and fuel prices.The researchers aim to emphasize the use of organic fertilizer using coffee grounds, which can be easily found in households. This research is relevant to the daily livelihood of people in the Philippines, where the economic crisis has led to increased interest in backyard gardening. However, many Filipinos have lost jobs, leading to rising prices and food shortages. The country is a net importer of agricultural and food products due to limited land resources and the deliberate destruction of natural resources.The fluctuating inflation rate is a major issue, with many struggling to make ends meet as the cost of everything continues to rise. The Russia-Ukraine conflict has also contributed to the increase in global agricultural and food commodity prices. The economic blockade imposed by Western countries on Russia has resulted in price increases for oil and its byproducts, such as fertilizer. The ongoing rise in unemployment rates is another issue to tackle. Many Filipinos have lost their jobs due to the COVID-19 lockdown, and opportunities have been limited, making it difficult for families to put food on the

Table 1 and Table 2. Climate change affects the seasons, disrupting the cultivation of agriproducts that should be harvested during their appropriate season.

The study aims to compare various fertilizer alternatives, including organic, chemical, and coffee grounds fertilizer, for home gardening to address the food security challenges faced by Filipinos during the COVID-19 pandemic. A field experiment will be conducted using a randomized complete block design (RCBD) with four replications, 48 samples, and four treatments: chemical fertilizer, organic fertilizer, and coffee grounds fertilizer. The data will be analyzed using Analysis of Variance (ANOVA) to determine the significance of differences between means of treatments.

1.1 Objectives

General Objective

The primary objective of this study is to compare various fertilizer alternatives, namely, organic fertilizer, chemical fertilizer, and used coffee grounds fertilizer that will be utilized mainly in home gardening. With this, the researchers would like to determine if a cheaper alternative is better than the much more expensive existing commercial fertilizers in the market for Kangkong growth.

Specific Objectives

With the primary objective in mind, the researchers' secondary objectives are as follows:

1. Create a fertilizer out of used coffee grounds.
2. Conduct an experiment to test the effectiveness on the growth and yield of kangkong using three different types of fertilizers: used coffee ground fertilizer, chemical fertilizer, and organic fertilizer.
3. Conduct a taste test for kangkong crops.
4. Compare the results of used coffee grounds fertilizer to chemical fertilizer and organic fertilizer for kangkong growth and yield in terms of physical criteria and human preference.
5. Compare the results of physical criteria using several statistical analysis, specifically One-Way ANOVA and Kruskal-Wallis Test.
6. Compare the results of human preference using a statistical analysis, specifically a Non-parametric test.
7. Provide reliable conclusions and recommendations on improving the used coffee grounds fertilizer.

2. Literature Review

Various claims that the COVID-19 pandemic has affected the livelihood of many people, including the economy, income, source of food, inflation rate, small and large businesses, etc. However, what made people struggle during the pandemic was the loss of most of the people's jobs, making it difficult for them to buy food for themselves and their families. Based on a study, the surge of the COVID-19 pandemic, people have now adjusted to the new normal setup. The government removed the restrictions and lockdown despite the number of new cases affected by the Covid 19. The tremendous impact of the COVID pandemic on the economy. Starting from the unemployment rate down to the inflation rate. The proponents took the opportunity to look for an alternative food source and used it as the core subject of this research. Given the current situation of the high inflation rate and unemployment rate, backyard gardening 20 is part of the solution using the coffee ground as an alternative for organic fertilizer, which can easily be found inside the house and in coffee shops without costing too much. The study will focus on the experiment results that the proponents will conduct based on the given criterion that would prove that the coffee ground would be better and more effective. The trends presented in the literature review have shown the influence of backyard gardening and the trends of fertilizers during the pandemic. On the other hand, trends in fertilizers have shown that consumers of fertilizers are becoming more conscious of the effects on the Environment of chemical fertilizers than organic fertilizers. The prices of fertilizer fell due to the tightening of the lockdown restriction. The raw materials became limited due to the lockdown effect that caused delays in transporting the raw materials. The proponents address the research gap by using used Arabica coffee grounds as a fertilizer. The said coffee contains high acidity that can increase the growth and yield depending on the plant. The amount at which Kangkong plants may extract nutrients from the soil depends on the pH level (Kartzman, 2022).

3. Methods

The type of research design that the proponents used in this study was comparison research. It explained how the dependent variable—kangkong yield and growth—and the independent variable—the physical requirements and human preference for taste testing—were significantly correlated. The researchers utilized One-Way ANOVA, a statistical technique that revealed an important correlation between the variables for the physical criterion, to acquire a deeper understanding. For human preference, the Kruskal-Wallis test was also employed. Furthermore, the researchers also conducted a reliability test to ensure the reliability of the data collected using Cronbach's alpha.

- Respondents: Individuals aged 18 and above who can cook, categorized by gender (male or female)
- Study Area: Filipino Citizens in Bulacan
- Instruments: Taste Test and Interview
- Data Analysis: SPSS Basic for One-Way ANOVA and Kruskal-Wallis test

4. Data Collection

In this study, the researchers utilized the following method for data gathering:

1. **Interview –** In-depth information about a small group of people's characteristics, behaviors, preferences, feelings, attitudes, opinions, and knowledge is gathered through interviews. The researchers interviewed males and females aged 18 and above currently residing in San Jose del Monte, Bulacan, Philippines, specifically those who engage in household cooking or cooking in general. The interview was conducted after having the interviewees taste the kangkong planted and harvested by the researchers.
2. **Field Experiment -** A field experiment was conducted to see the effect of organic fertilizer, chemical fertilizer, and used coffee grounds fertilizer on the yield and growth of *Ipomoea Aquatica* in home gardening. The researchers acquired three recycled sytro-foam boxes to serve as the soil bed, 48 Kangkong seeds, and three fertilizers to complete the experiment. Each styro-foam box was at least 14 inches (35.5 cm) deep, 15 inches (38 cm) length, and 15 inches (38 cm) width.

5. Results and Discussion

5.1 Numerical Results

One-Way ANOVA

Leaf Width

Table 1. One-Way ANOVA Results for Leaf Width

SUMMARY				
Groups	*Count*	*Sum*	*Average*	*Variance*
Kangkong 1	14	12.11	0.865	0.06528846
Kangkong 2	24	14.93	0.62208333	0.04833025
Kangkong 3	15	47.11	3.14066667	1.48543524

Table 2. One-Way ANOVA Assumption for Leaf Width

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	63.9796137	2	31.9898068	70.2873736	2.969E-15	3.18260985
Within Groups	22.7564392	50	0.45512878			
Total	86.7360528	52				

In accordance to leaf width, Table 1 shows that there are significant differences between the means of the three groups ("Kangkong 1," "Kangkong 2," and "Kangkong 3"). The very low p-value (2.96904E-15) in Table 2 indicates that the observed mean differences are highly unlikely to have occurred by chance alone. Therefore, we can conclude that there are statistically significant variations in the "Kangkong" groups' means concerning the variable being analyzed. The F-statistic (70.2873736) in Table 2 further supports this conclusion. Overall, the ANOVA analysis confirmed that the means of the three "Kangkong" groups are unequal and meaningful differences exist in the variable "Kangkong" among the groups. The given P-value for the leaf width is 2.96, which is greater than the value Alpha of 0.05. Therefore, the null hypothesis will not be rejected, and the variances are not the same across the three groups assume that the variances are not different.

Leaf Length

Table 3. One-Way ANOVA Results for Leaf Length

SUMMARY				
Groups	*Count*	*Sum*	*Average*	*Variance*
Kangkong 1	14	44.96	3.21142857	0.91172088
Kangkong 2	24	65.17	2.71541667	0.48441721
Kangkong 3	15	47.11	3.14066667	1.48543524

Table 4. One-Way ANOVA Assumption for Leaf Length

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	2.80789412	2	1.40394706	1.60304307	0.21145467	3.18260985
Within Groups	43.7900606	50	0.87580121			
Total	46.5979547	52				

The one-way ANOVA results in Table 3 indicates that there are no significant differences between the means of the three groups ("Kangkong 1," "Kangkong 2," and "Kangkong 3") in accordance to leaf length. The p-value (0.211454669) shown in Table 4 is greater than the chosen significance level (0.05), suggesting that any observed variations in the means are likely due to random chance and not meaningful distinctions among the groups. This indicates that the null hypothesis will not be rejected and that variances are not the same across the Kangkong groups and assume that the variances are not different. Therefore, the researchers concluded that there are no statistically significant differences in the means of the "Kangkong" groups with respect to the variable being analyzed.

Root Length

Table 5. One-Way ANOVA Results for Root Length

SUMMARY				
Groups	*Count*	*Sum*	*Average*	*Variance*
Kangkong 1	14	50.28	3.59142857	2.50736703

Kangkong 2	24	52.27	2.17791667	0.45005199
Kangkong 3	15	39.5	2.63333333	0.69008095

Table 6. One-Way ANOVA Assumption for Root Length

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	17.7125975	2	8.85629876	8.41723866	0.0007067	3.18260985
Within Groups	52.6081006	50	1.05216201			
Total	70.3206981	52				

The one-way ANOVA results in Table 5 indicate that there are significant differences between the means of the three groups ("Kangkong 1," "Kangkong 2," and "Kangkong 3") in accordance to root length. The p-value (0.000706702) shown in Table 6 is less than the chosen significance level (0.05), suggesting that the observed variations in the means are unlikely to have occurred by random chance. Therefore, the researchers concluded that there are statistically significant differences in the means of the "Kangkong" groups with respect to the variable being analyzed. The F-statistic (8.417238656) in Table 7 further supports this conclusion. In other words, the "Kangkong" groups differ significantly in their mean values for the measured variable. The given P-value for the root length is 0.0007, which is less than the value Alpha of 0.05. Therefore, the null hypothesis is rejected, and the variances are the same across the Kangkong groups and assume that the variances are different.

Number of Leaves

Table 7. One-Way ANOVA Results for Number of Leaves

SUMMARY				
Groups	*Count*	*Sum*	*Average*	*Variance*
Kangkong 1	14	175	12.5	43.5
Kangkong 2	24	176	7.33333333	8.4057971
Kangkong 3	15	177	11.8	24.3142857

Table 8. One-Way ANOVA Assumption for Ñumber of Leaves

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	306.691195	2	153.345597	6.97511588	0.0021291	3.18260985
Within Groups	1099.23333	50	21.9846667			
Total	1405.92453	52				

The one-way ANOVA results in Table 7 indicates that there are significant differences between the means of the three groups ("Kangkong 1," "Kangkong 2," and "Kangkong 3") in accordance to the number of leaves. The p-value (0.002129105) shown in Table 8 is less than the chosen significance level (0.05), suggesting that the observed variations in the means are unlikely to have occurred by random chance. Therefore, the researchers concluded that there are statistically significant differences in the means of the "Kangkong" groups with respect to the variable being analyzed. The F-statistic (6.975115876) in Table 8 further supports this conclusion. In other words, the "Kangkong" groups differ significantly in their mean values for the measured variable. The Number of leaves calculated has a P-value of 0.002, which is less than the value of Alpha. As a result, it is assumed that the variances are different and that the variances are different across the Kangkong groups as compared to the null hypothesis, which is rejected.

Stem Length

Table 9. One-Way ANOVA Results for Stem Length

SUMMARY				
Groups	*Count*	*Sum*	*Average*	*Variance*
Kangkong 1	14	145.36	10.3828571	14.3366681
Kangkong 2	24	428.2	17.8416667	21.0651449
Kangkong 3	15	305.2	20.3466667	52.6898095

Table 10. One-Way ANOVA Assumption for Stem Length

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	788.68404	2	394.34202	13.9983302	1.4871E-05	3.18260985
Within Groups	1408.53235	50	28.170647			
Total	2197.21639	52				

The one-way ANOVA results shown in Table 9 indicates that there are significant differences between the means of the three groups ("Kangkong 1," "Kangkong 2," and "Kangkong 3") in accordance to stem length. The p-value (1.48713E-05) in Table 10 is much less than the chosen significance level (0.05), indicating that the observed variations in the means are highly unlikely to have occurred by random chance. Therefore, the researcher concluded that there are statistically significant differences in the means of the "Kangkong" groups with respect to the variable being analyzed. The F-statistic (13.99833023) in Table 10 further supports this conclusion. In other words, the "Kangkong" groups differ significantly in their mean values for the measured variable. The computed data for stem length shows that the given P-value for the Stem Length is 1.48, which is greater than the value Alpha of 0.05. Therefore, the null hypothesis will not be rejected, and that variances are not the same across the Kangkong groups, and assume that the variances are not different.

Crop Weight

Table 11. One-Way ANOVA Results for Crop Weight

SUMMARY				
Groups	*Count*	*Sum*	*Average*	*Variance*

Kangkong 1	14	28.81	2.05785714	0.23621813
Kangkong 2	24	26.09	1.08708333	0.35231721
Kangkong 3	15	28.06	1.87066667	0.30610667

Table 12. One-Way ANOVA Assumption for Crop Weight

ANOVA					
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*
Between Groups	10.2838959	2	5.14194794	16.6302481	2.9059E-06
Within Groups	15.4596249	50	0.3091925		
Total	25.7435208	52			

The one-way ANOVA results shown in Table 11 indicates that there are significant differences between the means of the three groups ("Kangkong 1," "Kangkong 2," and "Kangkong 3"). The p-value (2.90586E-06) in Table 12 is much less than the chosen significance level (0.05), indicating that the observed variations in the means are highly unlikely to have occurred by random chance. Therefore, the researchers conclude that there are statistically significant differences in the means of the "Kangkong" groups with respect to the variable being analyzed. The F-statistic (16.63024807) in Table 12 further supports this conclusion. In other words, the "Kangkong" groups differ significantly in their mean values for the measured variable.According to the computed data for the crop weight of the Kangkong group, the given P-value is 16.63, which is higher than the value of alpha, which is 0.05. Assume that the variances are not different across the Kangkong groups and the null hypothesis that the variances are not the same and will not be rejected.

Texture Results

The data distributions of three groups were compared using the Kruskal-Wallis test: "Soft," "Smooth," and "Rough." The test produced the following H values for each group: 1.144 for "Soft," 2.567 for "Smooth," and 5.624 for "Rough." In simpler terms, the data patterns for these two groups are quite similar. However, for the "Rough" group, the p-value was 0.060. This value is lower than the significance level, indicating that there is significant evidence to suggest differences between the "Rough" group and the other two groups ("Soft" and "Smooth"). In other words, the data distribution for the "Rough" group is distinct and likely different from the other groups. In summary, the Kruskal-Wallis test results show that there is no significant difference between the "Soft" and "Smooth" groups, but the "Rough" group appears to be distinct from the other two groups.

Kruskal-Wallis Test for Human Preference

Acidity

In conclusion, the null hypothesis is retained, stating that acidity distribution is the same across "Kangkong" categories. Furthermore, there is no significant evidence to conclude differences in the distributions of the independent groups being compared. The p-value (0.916) indicates that any observed variations in the data are likely due to chance and not meaningful distinctions among the groups. The test statistic (0.176) further supports this interpretation and emphasizes that the differences between the groups are not statistically significant. Therefore, the null hypothesis of no differences in the groups' distributions is not rejected.

The assumption for the Kruskal-Wallis test, given data, is the acidity mean ranks of an individual Kangkong. The Kangkong 3 has the highest mean rank value of 25.25, followed by Kangkong 2, which has a value of 24.72, and Kangkong 1, which has a mean rank value of 23.53. On the other hand, the test statistics given have a statistical significance of 0.916. Therefore, the null hypothesis will not be rejected, and the difference between the groups.

Bitterness

In conclusion, the null hypothesis, stating that the distribution of bitterness is the same across "Kangkong" categories, is retained. In line with this, no significant evidence exists to conclude differences in the distributions of the independent groups being compared. The p-value (0.991) indicates that any observed variations in the data are likely due to chance and not meaningful distinctions among the groups. The test statistic (0.017) further supports this interpretation and emphasizes that the differences between the groups are not statistically significant. Therefore, the null hypothesis of no differences in the groups' distributions is not rejected.

The assumption for the Kruskal-Wallis test, given data, Kangkong 3 has the highest mean rank value of 24.81, followed by Kangkong 2, which has a value of 24.41, and lastly, Kangkong 1, which has a mean rank value of 24.28. While for the test statistics, the given statistical significance of the group is .991. Therefore, the null hypothesis will not be rejected and has the same difference between the groups

Sweetness

In conclusion, the null hypothesis, stating that the distribution of sweetness is the same across "Kangkong" categories, is retained. Additionally, no significant evidence exists to conclude differences in the distributions of the independent groups being compared. The p-value (0.571) indicates that any observed variations in the data are likely due to chance and not meaningful distinctions among the groups. The test statistic (1.119), adjusted for tied ranks, further supports this interpretation and reinforces that the differences between the groups are not statistically significant. Therefore, the null hypothesis of no differences in the groups' distributions is not rejected.

The assumption for the Kruskal-Wallis test, given data, the sweetness of Kangkong 2 has the highest mean rank value of 26.75, followed by Kangkong 1, which has the value of 24.50, and lastly, Kangkong 3 which has a mean rank value of 22.25. On the other hand, for the test statistics, the given statistical significance of the group is .551, which would still result in not rejecting the null hypothesis and the difference between the groups.

5.2 Proposed Improvements

The researchers recommend using coffee grounds as a fertilizer for kangkong crops based on the overall performance, the insignificant difference in physical criteria, and the lack of significant effects on taste preferences. Considering the overall results identified in the study, the following are recommended for future research:

1. The use of recycled water gallon bottles could be used for future studies as an alternative to soil beds to decrease waste and promote recycling. Additionally, the kangkong could be planted in water instead of soil to determine the most efficient way to plant it.
2. The proponents could reach out to companies with the necessary instrument to accurately measure the other factors of physical characteristics of kangkong, such as its stem color and leaf color, to provide a more in-depth finding regarding its differences and similarities.
3. For future studies, the proponents could explore more varieties of fertilizers to determine an alternative and mix the fertilizer with manure or vegetable waste to boost the crop's nutrients further.

6. Conclusion

Based on these results, the researchers still recommend using the coffee ground as a fertilizer because, based on the computed data, the percentage of each fertilizer does not have a huge gap, especially on the taste, as this criterion is the most important for people who get their food on planting. In conclusion, the One way ANOVA shows that the distributions of physical criteria in the "Kangkong" group differ significantly from one another. The decision for the Human preference criterion is indicated. Due to these decisions, there is insufficient evidence to conclude that the independent variable has no significance on the dependent variable.

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