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Efficacy of Milkfish (*Chanos Chanos*) Bones as a Liquid Fertilizer on Plant Growth of Lettuce (*Lactuca Sativa*)

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A B S T R A C T

Milkfish bone wastes are disposed of in Philippine fish markets. This neglects their potential as a resource especially when they are proven to contain a generous amount of calcium. This problem prompts the researchers to propose milkfish bones be used as an inexpensive and efficient liquid fertilizer. The experimental set-up consists of 28 lettuce plants divided into four groups with seven replicates each: three experimental groups (Group A, B, and C) and positive control (Group D). The treatments included milkfish bone solution and water. 3 different dilutions of milkfish bone solution were prepared and Group B was tested for a mineral content test. Growth parameters such as plant height, stem diameter, and the number of leaves were measured during the monitoring period and fresh weight was measured after the monitoring period. Results indicated that there is no significant difference between the four treatments in all growth parameters. Liquid milkfish fertilizer lacked the amount of N and P nutrients needed to enhance lettuce plant growth and the concentrations used in this study may not be significant enough to yield results. However, the mineral content test showed that the fertilizer does contain certain minerals, thus further research should be done to determine its viability.

Keywords: milkfish bones, Agusan del Norte, liquid fertilizer, food waste, lettuce, mineral content

1. INTRODUCTION

Milkfish (*Chanoschanos*) is an important food staple in the Philippines as it is one of the most widely consumed fish in the country. Other than its remarkable taste, many would recognize it for the large number of bones it contains. With this, deboning became a common practice provided by local fish sellers as a way to manage this inconvenience during consumption. This procedure makes milkfish bones one of the food waste at disposal in local markets. However, this neglects the potential of milkfish bones as a resource as milkfish farming in the Philippines has been increasing significantly these past few years with around 400 thousand MT produced annually based on the local (figures) data provided by the Bureau of Fisheries and Aquatic Resources (BFAR) ranking second only after Indonesia (Seafood TIP, 2020). This might suggest that the availability of disposed milkfish bones has also increased. Bones are a type of inedible food waste, as such, studies have been conducted with the aim to utilize them. There are studies that use milkfish bones as a calcium source in the form of flour to add calcium to the diet. In an Indonesian study by Darmawangsyah et al (2016), the results show that the calcium concentration of the pastry fortified with milkfish bone meal increases as more bone meal is added.

Essential plant nutrients are mainly applied to soil and plant foliage for achieving maximum economic yields. However, this granular application takes some time to break down, which is the reason it is recommended to use a liquid concentrated form when a more immediate and economic application is needed. Additionally, Johnson et al. (2001) suggested that supplying N to peach trees using a combination of soil and foliar N fertilizers leads to optimal plant responses and limited environmental pollution risks.

Minerals for plants can be found in organic fertilizers. They enhance the soil's physical, chemical, and biological qualities, which could greatly enhance plant growth and development. Fertilizers must contain the three primary macronutrients which are Nitrogen (N), Phosphorus (P), and Potassium (K). In a comprehensive pot experiment with two controls, without and with basal NPK application, Oprica et al. (2014) showed that foliar application of a mix of N, P, K, Fe, Cu and Mn enhanced nutrient content in leaves and seeds of maize and sunflower, while increasing yield by 50 % over the basal application of NPK alone. So, to assess the potential of a fertilizer, it must contain the three primary macronutrients.

Lactuca sativa, commonly known as lettuce, is considered one of the high value commercial crops in the country. It is famous for being used in salads and for its short maturation period (20 days). In the Philippines, lettuce is predominantly grown in Benguet, Bukidnon and Cavite (Tagaytay). The production in the Cordillera region in 2010 was 1,486.15 MT from a production area of 160 hectares and the country had produced 3,634.12 MT from 465.98 hectares (BAS, 2010). A plant like this would be most fit as a recipient of organic fertilizer application, especially with its accessibility and attainable growing requirements.

Despite liquid fertilizer being fairly practiced in gardening and farming, there are yet to be studies conducted on the liquid form of application of minerals from milkfish bones and if primary macronutrients are found in such. With the availability of milkfish bone wastes, the production of organic fertilizer from this food waste would provide efficient use of these resources. This is in line with achieving the world’s Sustainable Development Goals (SDGs), specifically Responsible Production and Consumption (SDG 12) and Climate Action (SDG 13) as food waste is a significant contributor to greenhouse gas emissions.

1.1Milkfish

Milkfish (*Chanoschanos*), locally known as “Bangus”, is one of the most widely consumed fish in the Philippines. An average Filipino consumes about 2kg of milkfish accounting for 7.5% of the total fish consumed per year (Marte, 2010). Milkfish is cultured in a wide range of environments using a variety of culture methods such as through fishpond, fish cage, and fish pen. In particular, Caraga region contributed the most to the milkfish production for brackish water fish cage in 2019 (BFAR, 2020).

Fishbones in general have a high calcium and phosphorus content. In particular, they are rich in calcium carbonate making them a good alternative source of low-cost calcium carbonate, especially as they are generated in large amounts as solid waste from fish production activities (Corrêa&Holanda, 2019). The backbone of milkfish makes up 10-15% of the fish's whole-body weight (Wulandari&Kusumasari, 2019). Because of this, a practice called deboning in local fish markets. It is a tedious process wherein 170 intermuscular bones are removed. As a consequence, deboned milkfish or “boneless bangus” is a popular product of milkfish. This also leads to other processes that utilize the excess from trimming such as fishballs, milkfish lumpia, quekiam, embutido, and chicharon made from the skins (Yap et al, 2007).

However, not all of this waste from the deboning process are reused as some places do not have the capability to do so. This waste would usually be disposed of and consequently, end up in landfills. In a study regarding food waste of dining establishments in the Philippines, the majority of businesses chose to dispose of food waste as garbage compared to donating and composting as a more efficient alternative (Angchua, et al, 2019). Bone meal is made from finely crushed or ground animal bones such as fishbones. It is rich in calcium and phosphorus; hence it can be used as an organic fertilizer for plants. According to Salitus et al. (2017), milkfish bone meal contains 35.22% protein, 9.68% calcium, 30.47% ash, and 23.06% fat. In another study by Bakhtiar et al. (2019), it was found that 2.9 grams of milkfish bone meal contain 5.24% calcium and 2.36% phosphorus.

There are studies conducted that utilize milkfish bones as a calcium source. Milkfish bone in the form of flour has been used as a fortification to add calcium and protein to food such as rice crackers (Eris et al, 2020; Jannah et al, 2020). The addition of milkfish bone into the products increased the calcium content. In a study by Darmawangsyah et al, 2016), the higher concentration of milkfish bone meal added in pastries increases the ash and calcium levels.

1.2Fertilizers

There are two types of fertilizers; organic and inorganic. Organic fertilizer is made from organic matter such as plant and animal remain. It slowly releases nutrients and organic matter into the soil. This benefits root growth by improving soil aeration, water, nutrient holding capacity, and soil texture (Missouri Botanical Garden, n.d.). On the other hand, inorganic fertilizer is made from non-living matter such as mining rocks and is produced through chemical reactions. The nutrients provided by this fertilizer are readily available during active growth.

The Philippine National Standards for Organic Agriculture contains a list of allowed fertilizers and soil conditioners. Fertilizers that contain plant, animal, mineral, microbiological, and other related sources used for fertilization practices must be based on this standard. For substances of animal origin, specifically blood meal, bone, and other meal brought in from other sources and without preservatives, the origin of materials should be disease-free for it to comply with the standards (Philippine National Standards, 2016).

Fertilizers can be applied on the ground and on the leaves through liquid or dry and solid form. Granular/pellet fertilizer, which is in dry and solid form, is commonly used by the majority of farmers (Greenhouse, 2019). This fertilizer contains nutrients that are gradually released into the soil during the growing period of the plant. Liquid fertilizer is a formulation of nutrients needed by the plant. This fertilizer is known for its ease to blend in with the products added to the soil and its speed compared to granular fertilizers. In a study on basils by Wijaya and Teo (2019), the liquid form of the eggshell fertilizer performed better than the solid form. Numerous studies also support this based on the results of their studies as they recommend applying fertilizer in its liquid form.

Liquid fertilizer can be applied through the foliage. Foliar fertilizer is a form of fertilizer in liquid form that is applied by spraying the fertilizer on the leaves. Conventional theory says that essential minerals can be absorbed through the pores in the leaf cuticle called stomata, yet recent research shows that these pores are extremely small and lined with negative charges which could dictate the type of nutrient transported (Trinklein, 2019). However, the availability of foliar-applied nutrients does not continue for the rest of the growing season. Foliar applications are only good for correcting mid-season deficiencies or supplementing soil-applied nutrients (Isleib, 2021).

1.3Primary Macronutrients

Macronutrients are a must in plant growth as they provide what’s necessary to nourish the plant. There are 13 macronutrients and they are divided into two: primary and secondary. The three primary macronutrients are Nitrogen, Potassium, and Phosphorus.

Nitrogen is crucial for plant development due to its basic function in protein synthesis and energy metabolism. The plant takes up nitrogen in the form of nitrate. The growth of plants is intimately correlated with this macronutrient. It is necessary to produce chlorophyll and photosynthesis. The aerial zone of the plant, which is the section that people can see, is where nitrogen is most active. It encourages cellular division. A lack of nitrogen causes a loss of vitality and color. Starting at the bottom of the plant, growth becomes sluggish and the leaves begin to fall off.

Phosphorus has been shown to facilitate the transfer of energy from sunlight to plants, promote early-stage root and plant growth, and accelerate the maturity of plants. It prefers to flower in the aerial zone. Although phosphorus is also required for the plant to grow, it plays a considerably larger role during the flowering phase. Energy is transported and stored by phosphorus. It enhances the plant's overall health and strengthens its resistance to unfavorable climatic conditions. The creation of organic compounds and the efficient execution of photosynthesis both depend on phosphorus. Lack of phosphorus leads to late, insufficient flowering, browning, and wrinkling of the leaves, as well as a general lack of vigor.

Potassium is involved in the management and movement of the plant's reserve materials. Potassium has been shown to enhance the robustness and disease resistance of plants, facilitate the formation and translocation of starches, sugars, and oils within plants, and potentially improve the quality of fruits produced by plants (NSW Government, 2017). It boosts cell tissue strength, boosts photosynthesis, and turns on nitrate absorption. Potassium promotes blooming as well as the production of enzymes and carbohydrates. In turn, this increases the plant's resistance to unfavorable conditions, including cold temperatures, and prevents wilting. Therefore, a lack of potassium makes plants less resistant to dry spells, frosts, or fungal infections. As a result, other nutrients like calcium, magnesium, and nitrogen become out of balance. Dark stains show up on the leaves when there is a potassium deficiency.

1.4Secondary Macronutrient (Calcium)

Plant tissue walls absorb calcium, which stabilizes the cell wall and promotes cell wall development. Additionally, calcium is essential for root health, growth of new roots and root hairs, growth of cells, and the development of leaves. Promoting the production and expansion of roots, it increases plant vigor. Calcium helps minerals stay in the soil longer and move through the soil more easily. It aids in the development of seeds and neutralizes harmful chemicals in plants. A calcium deficiency results in yellow and brown patches on the leaves because calcium stabilizes and controls many distinct processes. Additionally, it generally decreases plant development.

Water-soluble calcium is an alternative source of calcium that can be made from household materials that contain almost insoluble calcium such as calcium carbonate. This is commonly made by home gardeners using vinegar and eggshell. When the calcium carbonate from eggshells is mixed with a weak acid, that is the acetic acid from the vinegar, the chemical reaction converts the calcium into an available form (Chang et al, 2013).

There are also other similar practices of using eggshells and vinegar as foliar spray. Another method named “CalPhos,” an abbreviation of Calcium Phosphate, also uses the same method except for the ratio of the vinegar and eggshell may vary and are usually in 5:1 part. This one is particularly popular and can be found in YouTube videos and blog sites (Marketing, 2016). However, phosphorus only constitutes 3% of the eggshell and this method may likely contain little phosphorus despite its name.

1.5NPK Ratio for Lettuce

The N-P-K-ratio measures how much nitrogen (chemical symbol N), phosphorus (P), and potassium the product contains in terms of volume (K). For instance, a 16-16-16 fertilizer has 16% nitrogen, 16% phosphorus, and 16% potassium. 25% nitrogen, 4% phosphorus, and 2% potassium make up a 25-4-2 formula. These elements must all be present in fertilizers; if any are absent, the ratio will display a zero for that nutrient. (For example, a 12-0-0 fertilizer has nitrogen but no phosphorus or potassium.)

The many items marketed as "general-purpose fertilizers" either include an equal proportion of each main nutrient (for example, an N-P-K ratio of 12-12-12) or slightly more nitrogen than phosphorus and potassium (such as a 12-8-6 product). There are different kinds of fertilizers, all of which aim to provide for the basic needs of the majority of plants throughout the growing season. One kind, utilized when growth is vigorous, is primarily nitrogen-based. When you want to encourage lush growth or make your lawn greener in the spring, you frequently use such products with N-P-K ratios like 16-6-4.

One of the most crucial minerals to consider while producing lettuce is nitrogen. In addition to having a direct impact on how rapidly and how tall the leaves of plants grow, it also has an effect on how much food is produced and processed by the developing plants (Hasan, M. R., Tahsin, A. K. M. M., Islam, M. N., Ali, M. A., &Uddain, J., 2017). Nitrogen is a crucial component for lettuce plants because they essentially only have leaves. Lettuce nutrition solution should contain about 5 percent nitrogen, which is the maximum advised level. Another one is phosphorus. For lettuce, a phosphorus ratio of between 15 and 20 is typically advised (Jamie, 2022).

Synthesis:

Milkfish bones contain a generous amount of calcium which means it has a great potential to be a calcium source. As they are disposed of in landfills every day, all that calcium goes to waste. One of the ways to reuse these bones would be turning them into fertilizer which would be liquid fertilizer as it is efficient and convenient. They should also be assessed for their macronutrient contents when they’re prepared as a fertilizer as they have the potential to have said macronutrients. It is important that nitrogen and phosphorus are present, too, as they help enhance lettuce growth.

II. METHODOLOGY

2.1Preparation of Set-Up

Twenty (29) lettuce seedlings were obtained from the nursery/greenhouse in Pigdaulan from the Department of Agriculture in Butuan City. The seedlings were transplanted in separate 10-liter pots with the same soil. They were placed in a location at least one foot apart from each other to let them breathe. They were kept in a greenhouse provided by the Department of Agriculture in Butuan City. The plants were placed where they were reached by morning or afternoon sunlight away from disturbing elements. The seedlings were watered adequately before and immediately after transplanting. All of the plants were taken care of similarly in order to avoid errors.

The potting medium was prepared prior to transplanting the plants. The potting medium consisted of 50% garden soil, 25% topsoil, and 25% vermiculture as recommended by the experts from the Department of Agriculture. The potting medium was 25kg all in all which was enough for 29 lettuce plants and one extra kilogram was set aside for soil analysis.

2.2Preparation of Fertilizer

Milkfish bones were procured from the local fish market in Langihan, Butuan City which provides milkfish deboning services. The bones were cleaned to remove the excess flesh and residue that might be left in the bone frame. The process by Chang et al (2013) was followed in creating the milkfish bone liquid fertilizer. However, changes were adopted. Specifically, the time for fermentation was set to exactly seven (7) days instead of adjusting the time based on the state of the solution, and white vinegar was used instead of rice vinegar.

The production of the milkfish bone liquid fertilizer started with breaking the milkfish bones into small pieces. Afterward, they were roasted in a pan on low heat for 45 minutes until they turned dry and slightly burnt but not charred. The roasted bones were then added into a container along with white vinegar in a 1:10 ratio by weight. The solution was covered with a breathable cloth and stored in a cool, dark place for 7 days. Lastly, the solution was strained through a colander to remove the solid bits. This was stored in a cool and dry area out of direct sunlight.

According to Chang et al., they are usually first diluted with water in a 1:1000 ratio otherwise the acidity will damage the plants. In this study, different dilution ratios were used during the experiment.

2.3Research Design

Lettuce (Lactuca sativa) seedlings were procured and randomly distributed to each of the set-ups using Complete Randomized Research Design. Set-ups using different concentrations were made as shown in the table below.

Milkfish Bones		
Group	Sample	Concentration
A	1	1:1000
	2	
	3	
	4	
	5	
	6	
	7	
B	1	1:500
	2	
	3	
	4	
	5	
	6	
	7	
C	1	1:250
	2	
	3	
	4	
	5	
	6	
	7	

Positive Control		
D	1	N/A
	2	
	3	
	4	
	5	
	6	
	7	

Figure 1. Randomised Complete Block Design

Twenty (28) lettuce plants were used as experimental units. The plants were divided into two groups: the control group and the milkfish bone fertilizer group. The milkfish bone group was separated into 3 groups; each with different concentrations and 7 replicates 1:1000, 1:500, and 1:250. The control group with the remaining 5 plants had water as their treatment and the milkfish bone group (experimental) had the milkfish bone fertilizer as their treatment. They were treated and monitored for 31 days.

The fertilizers were applied by spraying near the roots. This was done biweekly (Monday and Thursday) during the late afternoon to avoid the evaporation of the liquid fertilizers and ensure product absorption. The amount of fertilizer sprayed was decided to be 2.1 ml as it covers the foliage of the plants.

2.4Mineral Test

N, P, K, and Calcium levels, along with the pH level and total organic carbon, of the 1:500 fertilizer was tested in Regional Soils Laboratory, Taguibo, Butuan City. The soil mixture used for the implementation was tested using Routine and STK analyses.

2.5Data Collection

Two types of data were gathered: during the growing period and after. During the growing period which is 31 days, the plant height, leaf number, and stem diameter were noted three times per week (preferably Monday, Wednesday, and Saturday). The lettuce plants were harvested after 31 days and the plant height, leaf number, stem diameter, fresh weight, and leaf parameters were measured. The harvesting was done by manual removal using hands. The plant weight is measured by taking the plant to a weighing scale. The leaf length and leaf width were measured using a tape measure.

2.6Statistical analysis

The plant growth of lettuce treated with milkfish liquid fertilizer and tap water was observed for 31 days. An analysis of variance test was conducted in order to determine if there was a significant difference between the treatments, milkfish liquid fertilizer and tap water, using one-way ANOVA.

III. RESULTS AND DISCUSSIONS

3.1Mineral Content of Foliar Fertilizer

The milkfish liquid fertilizer does not contain sufficient amounts of N and P which are both contributors to plant growth (see Table 1). This is an indicator that the fertilizer will not function adequately as lettuce requires a high rate of nitrogen for growth and development (Hasan, M. R., Tahsin, A. K. M. M., Islam, M. N., Ali, M. A., &Uddain, J., 2017). Additionally, the results above indicate that the fertilizer contains more potassium than calcium as opposed to the original deduction that it contains a huge amount of calcium.

Table 1. Results of Mineral Content Test

Constituents	**As received basis**	**Methodology**
Total Nitrogen (N), %	Below Detection Limit	Kjedahl Method

Total Phosphorus (P), ppm	1.08	Vanadomolybdate Method
Total Potassium (K), ppm	88.0	Aqua-regia digestion
pH	6.00	Direct measurement, pH meter
Total Calcium (Ca), ppm	31.9	Aqua-regia digestion
Total Organic Carbon, %	0.010	Walkley-Black Method

3.2 Soil Chemical Test Report

The soil mixture which is comprised of 50% garden soil, 25% topsoil, and 25% vermiculture as recommended by the experts from the Department of Agriculture has very high and sufficient amounts of available nutrients (see Table 2). This ensures that the lettuce seedlings were growing in a healthy medium.

Table 2. Results of Soil Chemical Test

Constituents	As received basis	Methodology
pH	6.36	
Texture	Light	
Organic Matter, %	7.3	
Available Phosphorus (P), ppm	311	
Extractable Potassium (K), ppm	3709	
Calcium (Ca), ppm	29301	Aqua-regia digestion

3.3 Plant Height

All replicates were growing in a positive trend with regards to their height (see Figure 2). The results from the analysis indicate that there is no significant difference between the four (4) groups as demonstrated by One-Way ANOVA, $F(3,13.2) = 0.488$, $p = 0.697 < 0.05$. Thus, it can be concluded that all four treatments are equally effective with regard of the plant height of the host plant obtained.

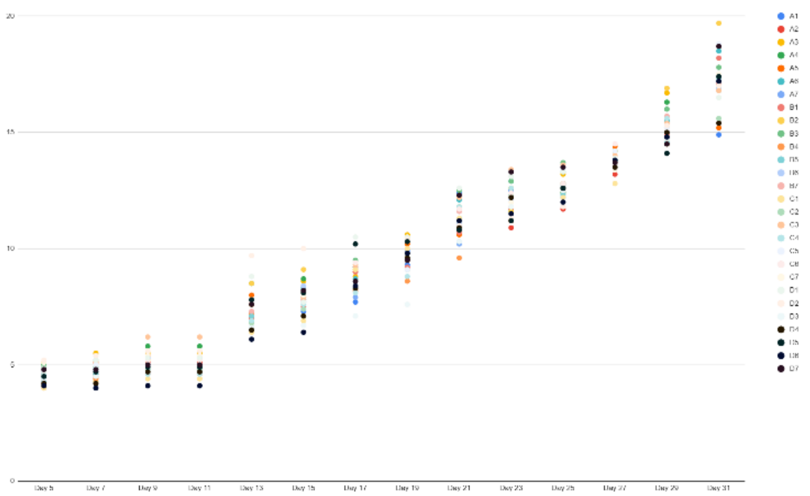

Figure 2. Scatter plot graph of plant height measurements

3.4 Stem Diameter

The stem diameter of all replicates increased steadily (see Figure 3). The results from the analysis indicate that there is no significant difference between the four groups as demonstrated by One-Way ANOVA, $F(3,13) = 1.728$, $p = 0.210 < 0.05$. Thus, it can be concluded that the four treatments are equally effective with regard to the stem diameter of the plant host obtained.

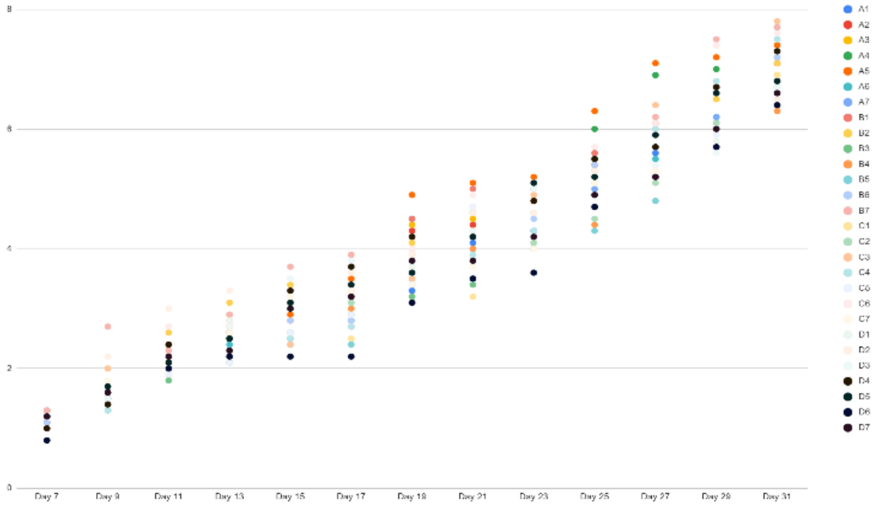

Figure 3. Scatter plot graph of stem diameter measurements

3.5 Total Number of Leaves

The stem diameter of all replicates increased steadily (see Figure 4). The null hypothesis tested by the Kruskal–Wallis analysis is that the four treatments have the same effect on the total leaves of the plant host obtained. Therefore, the samples are random samples from the same or identical population distributions. The obtained Kruskal-Wallis statistic is interpreted as a chi-square value and is shown to be not significant, $\chi 2$ (df = 3)= 1.25, p> 0.01. Thus, it can be concluded that the four treatments are equally effective with regard to the number of leaves of the plant host obtained.

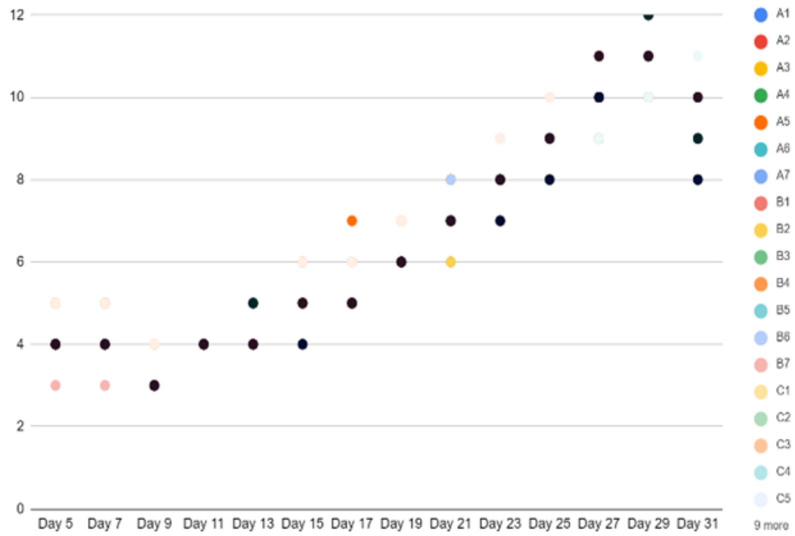

Figure 4. Scatter plot graph of the total number of leaves counted

3.6Fresh Weight

Fresh weights of the plants were of similar value (see Figure 7). The results from the analysis indicate that there is no significant difference between the four groups as demonstrated by One-Way ANOVA, $F(3,12) = 0.786$, $p = 0.525 < 0.05$. Thus, it can be concluded that the four treatments are equally effective with regard to the fresh weight of the plant host obtained.

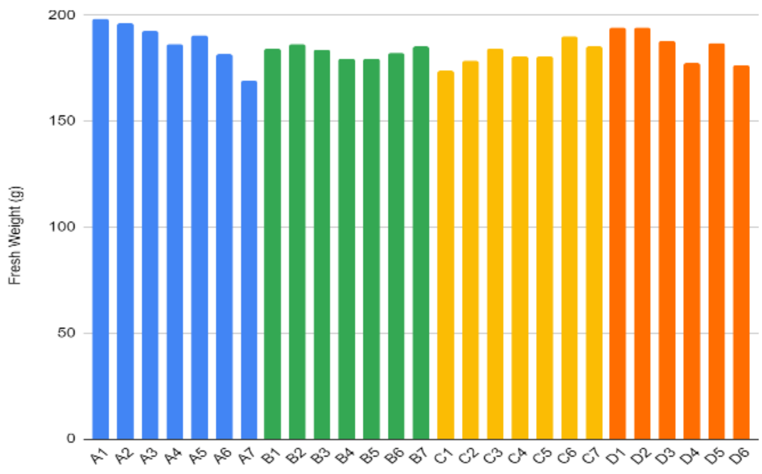

Figure 7. Bar Graph of Fresh Weight

IV. SUMMARY, CONCLUSION AND RECOMMENDATIONS

4.1 Summary

The experimental set-up consisted of four groups in which three are experimental and one is negative control. The experimental groups consist of Group A (treated with 1:1000 milkfish fertilizer), Group B (treated with 1:500 milkfish fertilizer), and Group C (treated with 1:250 milkfish fertilizer). The negative control is treated with tap water. 28 replicates were grown and were equally distributed to four categories with 7 plants each. The lettuce plants were constantly monitored for 4 weeks in the greenhouse area provided by the Department of Agriculture in Ampayon, Butuan City, Agusan del Norte. 2.1 ml of treatment (whether it be milkfish fertilizer or tap water) was applied every Monday and Thursday. Plant height, stem diameter, and the total number of leaves were measured every 2 days. Leaf parameters (during the last 3 days of the growing period) and fresh weight (after the growing period) were also taken note of. Statistics analysis of the data indicated that all four treatments were equally effective with regard to all parameters on the lettuce plants.

4.1.1Assumption Checks

Table 4. Normality Test Results

Normality Test (Shapiro-Wilk)

	W	p
Plant Height (cm)	0.949	0.183
Total Leaves	0.907	0.017
Stem Diameter(mm)	0.960	0.347
Fresh Weight (g)	0.952	0.227

Note. A low p-value suggests a violation of the assumption of normality

Interpretation:

For the Shapiro-Wilk tests, the computed significance level of Plant Height, Stem Diameter and Fresh Weight are 0.183, 0.017, and 0.227 respectively are greater than 0.05. Therefore, normality can be assumed.

However, the computed significance level of Total Leaves is 0.017 < 0.05. Thus, normality cannot be assumed.

Table 5. Levene Statistic Results

Homogeneity of Variances Test (Levene's)

	F	df1	df2	p

Plant Height (cm)	0.627	3	24	0.605
Stem Diameter(mm)	1.538	3	24	0.230
Fresh Weight (g)	2.876	3	24	0.057

Interpretation:

For Levene Statistic, the significance value of Plant Height, Stem Diameter and Fresh Weight are 0.605, 0.230 and 0.057 respectively are greater than 0.05 which indicates that the requirement of homogeneity of variance has been met.

4.1.2One-Way ANOVA

Table 6. Plant Height, Stem Diameter, and Fresh Weight ANOVA Results

One-Way ANOVA (Welch's)

	F	df1	df2	p
Plant Height (cm)	0.488	3	13.2	0.697
Stem Diameter(mm)	1.728	3	13.0	0.210
Fresh Weight (g)	0.786	3	12.0	0.525

Interpretation:

Plant Height

The results from the analysis indicate that there is no significant difference between groups as demonstrated by One-Way ANOVA, $F(3,13.2) = 0.488$, $p = 0.697 < 0.05$.

Stem Diameter

The results from the analysis indicate that there is no significant difference between groups as demonstrated by One-Way ANOVA, $F(3,13) = 1.728$, $p = 0.210 < 0.05$.

Fresh Weight

The results from the analysis indicate that there is no significant difference between groups as demonstrated by One-Way ANOVA, $F(3,12) = 0.786$, $p = 0.525 < 0.05$.

One-Way ANOVA (non-parametric)

Table 7. Total Leaves ANOVA Results

Kruskal-Wallis

	χ^2	df	p
Total Leaves	1.25	3	0.741

Interpretation:

The null hypothesis tested by the Kruskal–Wallis analysis is that the four treatments have the same effect on the total leaves of the plant host obtained. Therefore, the samples are random samples from the same or identical population distributions. The obtained Kruskal-Wallis statistic is interpreted as a chi-square value and is shown to be not significant, $\chi 2$ (df = 3)= 1.25, p> 0.01. Thus, it can be concluded that the four treatments are equally effective with regard to the number of leaves of the plant host obtained

4.2 Conclusion

There is no significant difference between the plants treated with liquid milkfish fertilizer and plants treated with tap water. This may be due to the mineral content of the milkfish fertilizer in which there was no nitrogen detected and there was an insufficient amount of phosphorus detected. These two elements are important in enhancing the growth and development of lettuce plants (Hasan, M. R., Tahsin, A. K. M. M., Islam, M. N., Ali, M. A., &Uddain, J., 2017) and their absence in the milkfish fertilizer indicates that it is not an effective fertilizer, at least to lettuce. Another reason for the ineffectiveness of the fertilizer may be the fact that existing tutorials on making liquid fertilizers have concentrations higher than the ones in this study that used the method from the study conducted by Chang et al., 2013. Therefore, it is possible that the choice of concentrations in this study was not significant enough to yield results. On the other hand, results showed that milkfish fertilizer contains a sufficient amount of potassium, more so than calcium, and this can be utilized for future studies.

4.3Recommendations

Based on the results obtained in the study, the following are recommended for improvement of findings:

1. Mix in organic matter rich in nitrogen or phosphorus to curate a fertilizer to be used for a specific plant.
2. Include a plant tissue analysis of the plants and the effects of the fertilizer on this.
3. Use higher concentrations of milkfish fertilizer.

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