



Growth Performance and Survival of Malabar Spinach (*Basella alba*) Applied with Different Volume of Seawater

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Aims: The study focused on growth performance and survival of Malabar Spinach (*Basella alba*) applied with different volume of seawater, in Brgy. Bolila, Malita, Davao Occidental.

Study Design: A experimental research design was employed in the study to determine indicators that were formulated to know the survival, number leaves and growth performance of the Malabar Spinach (*Basella alba*). Completely randomized design technique was employed for data gathering. (ANOVA) for analyzing. Mean, percentage and average frequency used in analyzing the findings of the data.

Place and Duration of Study: The study was conducted between April 14, 2021 and May 31, 2021.

Methodology: The experiment was arranged completely randomized design with three replicates for each treatment. There was one plant in each pot and five treatments in each replicate. CRD (Complete Random Design) with (5) treatments and replicates of three (3). The treatment was the

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following: Treatment 1 – tap water, Treatment 2 – 5ml seawater, Treatment 3 – 10ml seawater and 10ml tap water, Treatment 4 – 15ml seawater and 15 tap water, Treatment 5 – 20 ml seawater and 20 ml tap water.

Results: Overall growth performance of Malabar Spinach showed that treatment 5 gained the highest value of mean, with 150 pots in terms of final increment on the Growth (height). In terms of number of leaves on the Growth of Malabar Spinach vegetable, treatment 5 obtained the highest value of mean in replicate 3, and treatment 1 which exhibited lowest value of mean. In terms of Survival Rate of Malabar Spinach (*Basella alba*), treatment 5 obtained the highest value of mean in sampling period with the corresponding final growth of effect with different ratio treatment of sea H₂O samples and common water samples. Based on the results on the effect of seawater on the survival rate of Malabar Spinach, the result showed that treatments obtained the highest value of mean in terms of growth. In terms of number of leaves, Treatment 1 (tap water) obtained the highest value of mean. In terms of Survival, Treatment 1 obtained the highest value of mean

Conclusion: The result showed that treatments obtained the highest value of mean in terms of growth. In terms of number of leaves, Treatment 1 (tap water) obtained the highest value of mean. In terms of Survival, Treatment 1 obtained the highest value of mean. Based on the statistical One Way ANOVA, the results revealed that there is a statistically significant difference of growth performance of Malabar Spinach from the six treatments. The result showed that treatment 5 was the highest value of mean from the sampling period given. The results also revealed that there is no significant difference on the number of leaves, length and survival of Malabar Spinach vegetable as applied with different volume of seawater in six sampling of the study.

Keywords: *Basella alba*; growth performance; seawater; survival rate.

1. INTRODUCTION

Malabar spinach, especially in zones adjacent to major tropical areas and bays, historically attracted human settlements. It offers opportunities and access in farmer and commerce and location advantage Also rich agricultural lowlands and agricultural products. Malabar Spinach vegetable plant municipalities are endowed with rich fresh products that can be able to sustain livelihood and subsistence of its populace for decades. The economics returns from these agricultural resources-dependent activities cannot be underestimated [1]. The need for the improvement of the rich agricultural resources must have an integrative effort with the local government units, communities and other stakeholders as active participants towards the enhancing the awareness for the group of people who shares agricultural products. A major reason for this diverging development path can be found 2 in differing local elite structures which emerged as a result of different historical experiences [2]. Malabar spinach are fluctuating and open environments process, and are being influenced by new, narrow migration areas that link the most active and valuable products on Earth with the land and yard. It has a positive role in metabolizing minerals as well as antioxidant activities and could be a fit for farmers supported agriculture members, especially consumers seeking more unique

vegetables We see the closely intertwined relationships between growth performance and survival of Malabar spinach, amplifying the most critical issues of limits and equilibrium, biodiversity and growth in today's world [3]. Davao Region is endowed with rich vegetable resources as well as an environmental condition that is most befitting to human habitation. The ladder of development within the plant in Davao Region steadily climbed in the last few decades trigger the transformation which is now enjoyed by locals, agricultural resources, products and the like. Davao Occidental is geographically located at the southwestern tip of the Davao Region in Mindanao, from which its name was derived. Davao Occidental has vast agricultural lands, though mountainous but could grow almost all kinds of crops. It has fresh products of vegetable and marine resources, aside from its lengthy coastlines where beautiful beaches can be found. It is basically blessed by nature that yields enough food for its people [4]. This study conducted the experimental research on the growth performance and survival rate that featuring treatments and replicate of Malabar Spinach that needs to be conserved in sustaining future generation. This study is first conducted in Brgy. Bolila, Malita, Davao Occidental. It is envisioned that a well-documented environmental data can help to design appropriate resource management strategies in the area given. It is hoped that the findings, as

the results of the study will be able to suggest more agricultural possibilities for the collaborations of the agencies and barangay on the formulation of a more holistic approach addressing growth performance and survival rate.

1.1 Objectives of the Study

This study was conducted to observed and determined, the growth performance and survival rate of Malabar Spinach (*Basella alba*) applied with different volume of seawater as treatment fertilizer in Brgy. Bolila, Malita, Davao Occidental. Specifically, it aims to: 1. Determine the effect of seawater on the growth performance (cm/day) of Malabar Spinach vegetable plant; 2. Determine the effect of seawater on the survival rate (%) of Malabar Spinach vegetable plant; and, 3. Determine the significant difference of seawater on the growth and survival of Malabar Spinach vegetable plant.

1.2 Significance of the Study

Associated with the creation of the study are the benefits and advantages particularly, in indicating the growth performance and survival in the following;

1.2.1 Community

This study may help them in indicating the key component of agricultural sustainability, useful effect of seawater and tap water through experimental procedure and the fact that, this is towards effective concentration of soil salinity.

1.2.2 Farmer

This study may help provide information to develop and implement agricultural activities and implement big opportunities in terms of economic resources productivity. Environmental awareness will be encouraged to embrace agricultural producer using less and no chemicals associated with.

1.2.3 Agricultural organization

Concerning on the environmental preservation, the study may help generate activities and solutions addressing environmental improvements. The results of the study will supplement them the guidelines in attaining sustainable livelihood.

1.2.4 Future researcher

This may serve as basis references for future recommended studies.

1.3 Scope and Limitation of the Study

This study was limited on the effect of seawater on the growth performance and survival growth of Malabar Spinach (*Basella alba*) plant. Plant samples were planted on different pots and area of experiment is located in Barangay. Bolila, Malita, Davao Occidental. The study was conducted on April 14, 2021 until May 31, 2021. Almost 49 days or one month and a half more.

1.4 Definitions of Terms

1.4.1 *Basella alba*

It is climbing growth vegetable with oval to heart-shaped leaves which grow along a read to purple stem leaves are thick fleshy and a vegetable plant that can with stand seawater tolerance.

1.4.2 Growth performance

It pertains to height or length of a particular sample plant.

1.4.3 Seawater fertilizer

It is natural, inexpensive fastest and easiest fertilizer use in a home garden.

1.4.4 Survival rate

Existence of vegetable plant to survive at a certain period of time from the start of treatment.

2. METHODOLOGY

2.1 Research Locale

This study was conducted in Barangay Bolila, Malita, Davao Occidental with a coordinate of 40°02'N, 28°23'E: and elevation of 462.2 m above sea level.

The area, is safe and can be a good study area since it can acquire full sunlight of the sample vegetables.

2.2 Research Design

Experimental research design was employed in the study. The experiment was arranged

completely randomized design (CRD) with three replicates for each treatment. There was one plant in each pot and five treatments in each replicate. CRD (Complete Random Design) with (5) treatments and replicates of three (3). The treatment was the following: Treatment 1 – tap water, Treatment 2 – 5ml seawater, Treatment 3 10ml seawater and 10ml tap water, Treatment 4 – 15ml seawater and 15 tap water, Treatment 5 20 ml seawater and 20 ml tap water.



Fig. 1. Location map of Barangay Bolila, Malita, Davao Occidental

2.3 Sampling Design and Technique

A completely randomized design was used. With this design samples were randomly assigned to treatments.

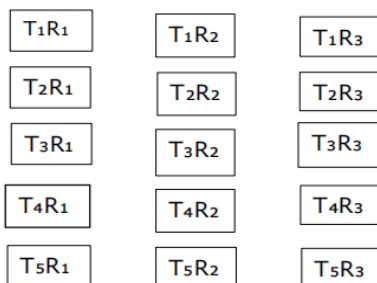


Fig. 2. The experimental lay-out of the study using completely randomized design

2.4 Experimental Preparation

The researchers will plant a stem of Malabar Spinach (*Basella alba*) 10cm in a 150 pots of loam soil at Brgy. Bolila, Malita, Davao Occidental. The researchers will observe daily growth of the Malabar Spinach vegetable and its number of leaves. Vegetable plants were

watered with seawater once a week. Every treatment contains 3 replicates and each pot has 1 replicate of stem Malabar spinach vegetable sample. In treatment 1, the samples will be showered with tap water alone. In treatment 2, 5 ml of seawater will be added to the replicates without tap water. In treatment 3, 10 ml of seawater and 10 ml of tap water will be showered to the sample. In treatment 4, 15 ml of seawater and 15 ml of tap water will be poured out to the sample and in treatment 5, 20 ml of seawater and 20 ml of tap water will be added to each plant. A total of 50 ml of seawater are added to the samples.

2.5 Data Gathering Procedure

This study had undergone the following procedures in data gathering. First and foremost, letter was asked from the Department Chairman of Teachers Education Program (TEP) of Southern Philippines Agri-Business and Marine and Aquatic School of Technology (SPAMAST), presented to Brgy. Captain of Bolila, Malita, Davao Occidental for accommodation. When accepted cordially, the researchers introduced the objectives and purpose of the study. Afterwards, the experimental processes were administered with enough time allocation for the to study given data. Part I introduced the length by its treatment of the plant followed by Part II number of leaves which covers every sampling period. Next was Part III that covers the survival rate and last part explained thoroughly by the researchers were the different data, the concentration of every treatment and ratio. Once the data were retrieved, Data coding, tabulation, analysis and interpretation follows.

2.6 Statistical Analysis

Sample size of 150 pots as a minimum number of Malabar spinach plant were studied. All data were analyzed by Analysis of Variance (ANOVA) to test the effect of different ratio treatment of sea water samples and common water samples. Tukey's test was used to determine specific differences between treatment means.

2.7 Percentage and Average Frequency Mean

This was used in describing the growth performance of Malabar spinach vegetable plants as applied with different concentration of seawater, number of leaves on the growth of Malabar spinach vegetable (*Basella alba*) as applied with different volume of seawater, and

survival rate of Malabar Spinach vegetable (*Basella alba*) as applied with different volume of seawater. The mean was employed to determine the average of quantitative data of the number of leaves, length and survival rate.

3. RESULTS AND DISCUSSION

3.1 Growth Performance of Malabar Spinach Vegetable Plants as Applied with Different Concentration of Sea Water

Table 1 showed the result of the study on the growth increment (cm/day) of Malabar spinach (*Basella alba*) in (cm) as applied with different volumes of seawater in different samples. The treatment that will exhibit the best in terms of growth increment is treatment 5. The mean total is 43 in terms of number growth in all sampling periods. In terms of treatment 4, 39.7 mean, in treatment 3, 38 mean, in treatment 2, 36.7, and the remaining treatment 1, 35. The data on measured responses, by length/ or inches, showed a significant difference in the growth and survival rate of Malabar spinach plants, and stem centimeters marginally significant. The significance for leaf chlorophyll content and leaf length, respectively used. According to Karthik and Shaziya, [5] the mixing of seawater and tap water at the rates used in these experiments may be sustainable over a long period, and soil salinization may occur unless soils are of light texture and sufficient good quality freshwater or water rain is available to lower and higher the salinity of soil between successive vegetable. Surface and ground waters, which can be used for planting, contain varying quantities of dissolved salts. The extensive use of well water results in the intrusion of seawater, and the water becomes increasingly [6]. Water results in an increase in soil salinity [7], which may have positive effects on the growth of plants [8]. According to Al-Maskri, Grattana, and Grieveb, [9], salinity is one of the main factors limiting plant growth and yield. Salinity is also able to produce improvements in vegetable quality despite lower growth efficiency [10], and improvements in quality are particularly important for consumer satisfaction [11]. Nitrogen, one of many elements required by all plants for growth, is used by plants in relatively large quantities. In cases of natural salinity, Na is often accompanied by chloride, which competes with nitrate [12]. However, high chloride levels in water may reduce nitrate absorption and

accumulation in leaves (Miceli, Kamble, and Gacche, 2003). Oxalic acid is synthesized in conjunction with the reduction of nitrate, and it balances the pH of plant cells [13]. Oxalic acid is synthesized by a wide range of plants [14]. Masters, Kendall, J. M. and Osborn, H. et al., [15] reported that plants growing in (high) saline areas accumulated secondary compounds (oxalate, tannins). The oxalate content in halogeton (*Halogeton glomeratus*) was greatly increased by adding NaCl to the nutrient solution [16].

3.1.1 Number of leaves

Though the rest of the treatments are equal, in number of leaves the highest mean is treatment 5, 49.7. The other treatment got lowest value of mean. Plant growth was significantly high in the medium of fertilized plants followed by the high, low and control mean rates as shown in Table 2. In Malabar spinach, stem diameter was similar and continuously rose throughout the crop duration irrespective of the applied seawater and tap water rates. Plants under salt stress conditions tend to decrease the number of leaves due to environmental factors limiting the productivity of plants caused by high conditions of soil salinity [17]. Plants irrigated either with tap water or saline water with different concentrations have enhanced photosynthetic pigments. This increase in chlorophyll contents might be due to the availability of higher levels of amino acids to the treated plants as amino acids help to increase the chlorophyll content and this may lead to the increase in different growth criteria [18].

3.2 Survival Rate of Malabar Spinach Vegetable Plant

In Table 3, the number with the highest survival rate is treatment 1 with a mean value of 21. Treatment 2 had a mean value of 18.68, Treatment 3 with a mean value of 12.97. Treatment 4 and 5 with a mean value of 13.41 and 13.94 respectively. There was an increase in plant height, number of leaves and survival rate of the seawater and tap water applied on plants respectively compared to the control plants. The effect of seawater in relation to survival, relates to the effects of the fertilizer that was being used by different treatments and also the water-soluble formulas as a controlled process to get the main growth of the plant [19]. The rest takes the factors accordingly; growth indicators include stem thickening of Malabar spinach (*Basella*

alba) that may have been diluted due to the substitution of seawater extracts consuming the product can help provide the recommended of vitamins, leaf area, root development and distribution of nutrients elements given by its plant [20].

3.3 Statistical Analysis on the Significant Difference of Seawater on the Growth and Survival of Alugbati Vegetable Plant Growth

Table 4 shows the analysis of variance on the growth (height) of Malabar spinach vegetables as applied to different volume of seawater. The result revealed, a p-value of 0.00 which revealed that, Treatment 5 (20 ml seawater and 20 ml tap water) was significantly higher than the other treatments under study. This means that the application of treatment is not compatible and performs better. This finding is supported by Chowdhury, Kamble, and Gacche, [21]. The finding is supported by Chowdhury et al., [21], Bosh et al., (2011) and Baca et al., (2004) that soil with a concentration of salt improved the growth performance of Malabar Spinach vegetable plant. Additionally, R. Munns [22] found that the control of salinity in the different plants strongly affects the environmental condition (soil).

3.4 Growth of Malabar Spinach (*Basella alba*)

Table 5 depicts the variance analysis on the growth of Malabar spinach vegetables when different volume of seawater was used. Revealed, a p- value of 0.00 which is less than the 0.05 level of significance, which means that there is a significant difference on the growth of Malabar spinach vegetables as applied with different volumes of seawater. This further means that the different treatments under study was not comparable. Thus, the hypothesis is rejected. Apparently, the Tukey's test results revealed that, Treatment 1 (tap water) is significantly higher than other treatments under study. This also indicates that the application of treatment was not compatible and performed better on the growth of Malabar spinach vegetable. The findings in the number of leaves supported by Aguru, Giuliano, and Pages, [23], that similar results of increased leaf production were compared between the concentration and

composition of Malabar spinach vegetable plant. As stated by, Garcia, James, Davenport, and Munns, R. et al., [24] salt may affect plant growth indirectly, because it decreases the rate, but also the size and density. This results in a decrease in the characterization of soil varieties through the variation in the amounts of diluted due to the substitution with "Malabar spinach leaves".

3.5 Survival

The Table 6 showed the analysis of variance on the survival of Malabar spinach vegetables as applied to different volume of seawater. The result revealed, a p-value of 0.00 which is less than the 0.05 level of significance, which means that there is a significant difference in the analysis of variance on the survival of Malabar spinach vegetables as applied with different volumes of seawater. This further explains that the different treatments under study are not comparable. Thus, the hypothesis is rejected. Apparently, the Tukey's test results revealed that, Treatment 1 (tap water) is significantly higher than other treatments under study. This means that the application of treatment is not compatible and performs better on the growth of Malabar spinach vegetables. Abubakar and Haque, [25] revealed in their study that, these methods have specific characteristics that make them appropriate for certain compounds and conditions. One of the advantages was nurturing, economic resources and institutional attributes that allow to build and strengthen agricultural and natural resources when it comes to determining the plant survival, which includes as increase in leaf survival. The survival of Malabar spinach vegetable plant may survive or died depending on the plant species and/or environmental factors. Additionally, Xiong, Schumaker, and Zhu, [26], showed that that the relative survival rate in salt treated plants is slower. It implies that the most abundant plant survival exerts a strong influence over the occurrence and concentration of other different plants. In contrast, the value of having component of soil and many salts has effects on communities that far exceed their abundance. The importance of plant nutrients would be predicted based upon their occurrence in an environment. The plant nutrients influence the presence and abundance of other organisms through their process of soil salinization relationships [27].

Table 1. Final increment on the growth (height) of Malabar spinach vegetable (*Basella alba*) as applied with different volume of seawater

No. of leaves	Treatment	R ₁	R ₂	R ₃	Mean
Initial	T ₁	11.4	11.6	12	35
Sampling	T ₂	11.8	12.4	12.5	36.7
	T ₃	12.6	12.8	12.6	38
	T ₄	12.8	13.7	13.7	39.7
	T ₅	13.8	13.4	14.8	43

Table 2. Number of leaves on the growth of Malabar spinach vegetable (*Basella alba*) as applied with different volume of seawater

No. of leaves	Treatment	R ₁	R ₂	R ₃	Mean
Sixth	T ₁	14.3	14.4	14.6	43.3
Sampling	T ₂	14.3	15	15.1	44.4
	T ₃	15.3	15.4	15.6	46.6
	T ₄	15.7	16	16.2	47.9
	T ₅	16.3	15.5	16.8	49.7

Table 3. Survival rate of Malabar spinach vegetable (*Basella alba*) as applied with different volume of seawater

Treatment	Sampling	Mean	Final growth
Treatment 1	5.03	6.30 8.00 10.37 11.33 13.40	21.00 13.67
Treatment 2	5.10	6.47 8.67 10.47 11.73 13.60	18.68 13.63
Treatment 3	5.10	6.70 9.13 10.60 12.50 14.33	12.97 14.73
Treatment 4	5.20	7.17 9.40 10.73 13.40 14.37	13.41 14.43
Treatment 5	5.27	7.40 9.83 10.90 13.77 15.57	13.94 15.63

Table 4. Analysis of variance on the growth (height) of Alugbati vegetable as applied with different volume of seawater

Particular	Mean	p-Value	Decision
Treatment 1	16.70 ^d	0.00	Reject Hypothesis
Treatment 2	17.33 ^{cd}		
Treatment 3	17.83 ^{bc}		
Treatment 4	18.43 ^b		
Treatment 5	19.60 ^a		

Note: Having the same superscript has no significant difference between treatment at 5% level of significance

Table 5. Analysis of variance on the growth of Malabar spinach vegetable as applied with different volume of seawater

Particular	Mean	p-Value	Decision
Treatment 1	9.33 ^e	0.00	Reject Hypothesis
Treatment 2	8.67 ^{cd}		
Treatment 3	8.00 ^c		
Treatment 4	8.33 ^b		
Treatment 5	8.33 ^a		

Table 6. Analysis of variance on the Survival of Malabar spinach vegetable as applied with different volume of seawater

Particular	Mean	p-Value	Decision
Treatment 1	9.33 ^e	0.24	Reject Hypothesis
Treatment 2	8.67 ^{cd}		
Treatment 3	8.00 ^c		
Treatment 4	8.33 ^b		
Treatment 5	8.33 ^a		

4. CONCLUSION

This study aimed to determine the growth performance and survival of Malabar Spinach (*Basella alba*) applied with different volume of seawater, in Brgy. Bolila, Malita, Davao Occidental. Based on the results, the main findings in growth performance in terms of final increment (height) in 150 pots with the highest value of mean was treatment 5 and treatment 1 was the lowest. The data further impart the plant limiting factors that will affect its high salinity levels in the soil. Along with these effects, the plant reduced its growth, development and survival as the value of their treatment and replicates depends on the concentration value of seawater and tap water resources available for agriculture, which have been declining in quantity.

In terms of the number of leaves on the growth of Malabar spinach vegetable, treatment 5 has the highest value of mean, and treatment 1 which exhibited the lowest value of mean. As a result, plants experience water stress, which in turn reduces leaf expansion. The effects of salinity stress can be observed immediately after salt application and are believed to continue for the duration of exposure. The majority of each treatment is used to assess the value of environmental factors such as drought and high salinity in the root zone, as well as practices that increase and decrease water uptake and change nutrient absorption ratios. In terms of the survival rate of Malabar spinach vegetables (*Basella alba*), the result showed that each treatment ranges from 24-28. In mature leaves due to high Na^+ , which affects plants by disrupting protein synthesis and interfering with the development of salt stress within a plant, all the major processes such as photosynthesis and, protein synthesis and energy and lipid metabolism are affected and many plants have evolved several mechanisms either to exclude salt from their cells or to tolerate its presence within the cells. The result of the analysis of variance on the survival of Malabar spinach vegetables as applied with different volume of seawater in the study area lead to conclusion, that in growth, the result showed that in treatment 5, has the highest value of mean, which dominates these major strengths of Malabar spinach vegetables in agricultural resources. All soils contain salts. Salts are a common and necessary component of soil, and many salts (e.g. nitrates and potassium) are essential plant nutrients.

In terms of the number of leaves, Treatment 1 has the highest mean value and Treatment 3 has the least value of mean. There were identified in agricultural resources and ecology that are composed of Malabar spinach vegetable and other salts derived from minerals that will increase soil salinity. Among the various sources of soil salinity, there are in fact several genes controlling salinity tolerance in the different species whose effect interact strongly with environmental conditions and may increase or decrease depending on the plant species and/or environmental factors.

In terms of survival, Treatment 1 got the highest value of mean and the lowest value of mean observed from, Treatment 3. The result showed that every treatment has three replicates with a corresponding value of mean, average frequency and percentage. The majority of the data gathered as result of their treatment and replicates. The value of each treatment depends on the concentration value of seawater and tap water resources available for agriculture, which have been declining in quantity. The majority of each treatment is used to assess the value of environmental factors such as drought and high salinity in the root zone, as well as practices increase that and decrease water uptake and change nutrient absorption ratios. And also, benefit from sustainable and livelihood facilities offered by the Local Government unit. There were also present of infrastructures in the agricultural matters in Brgy. of Bolila such as organization in line with agriculture and nursery processing with plants.

There were identified agricultural resources and living things in the study area that are composed of plants, and various parts of the plants are used for treatment of diseases as well as for different healing activities of human beings. The results of growth performance and survival rate in the study area leads to a conclusion that impacts every value of mean and manufacturing dominates the agricultural resources of Brgy. Bolila. The survival rate, the problem and opportunities combined, is the major strength found in the Brgy. Bolila are the aesthetics of vegetable plant products, the good climate, the availability of high-quality soil that has the potential to create varieties and the availability agricultural resources that aid and help reduce agriculture's environmental and economic problems.

5. RECOMMENDATION

Based on the results and findings of the study, the following recommendations were derived;

1. Local Government should implement more agricultural plants to develop their particular skills, especially in community actions in terms of embracing new instructional strategies and making various activities that enhance people in sustainable agricultural planning to lessen the problem of the increasing concentration of using inappropriate fertilizer.
2. Barangay Local Government should invite the Department of Agriculture and together with other agencies to develop and train on different skills that can contribute to their basic needs. And some of programs such as the Planting of seedlings and planning of building Malabar spinach (*Basella alba*) Nursery will help eradicate the problem regarding depletion of growing natural resources.
3. Officials of the barangay should undertake a parallel study to determine other factors that may help develop the livelihood program of the community in order to attain effective and useful research.
4. Additional other agricultural plants should be studied and will be implemented to the community so that they will be effective in sustaining such seawater as means of watering and for easy availability.
5. The researchers should be be accommodating to plans and projects in the unique calling program.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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