Gamal Leaves (*Gliricidia sepium*) as Hydroponic Nutrition for Lettuce (*Lactuca sativa* L.)

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**Abstract.** Cultivating with a hydroponic system is an alternative with increasingly limited agricultural land. Gamal leaves contain nutrients that are suitable to be used as hydroponic nutrients for lettuce (*Lactuca sativa* L.). This article will explain the effect of Gamal leaves nutrition on the growth and productivity of lettuce using the hydroponic method. The method used in this study was a Completely Randomized Design (CRD) consisting of 5 treatments namely P1 = (negative control) only water, P2 = 20% Gamal leaf nutrition, P3 = 30% Gamal leaf nutrition, P4 = leaf nutrition 40% Gamal and P5 = (positive control) AB-Mix nutrition. The parameters observed consisted of plant height, number of leaves, leaf width and gross weight. Analysis with One Way ANOVA assisted by SPSS 17 and LSD advanced test. The results on the parameters observed and analyzed carried out had a real effect on all parameters. Gamal leaf nutrition treatment on plant height P4 and P2 were not significantly different from P2, the number of leaves and leaf width of P2, P3 and P4 were not significantly different, whereas the wet weight P4 had the highest value which is significantly different from other treatments.

1. **Introduction**  
   Indonesia is one of the tropical countries that have many resources, among others is natural resource [1]. Many plants are unknown by the community but those plants are beneficial. One of which is the Gamal plant (*Lactuca sativa* L.). Many gamal plants were found in the village area and be used as a green fence by the community. Every part of the Gamal plant can be used. The stem of the Gamal plant can be used as firewood and building material. The Gamal leaves can be used as animal feed [2], biopesticides [3–5], compost [6,7], and liquid organic fertilizer [8,9]. The community makes Gamal leaves as one of the very useful alternatives in agriculture to be used as liquid organic fertilizer. The Gamal leaves fertilizer consists of macro and microelements. The nutrients can dissolve quickly so that it can be absorbed by plants quickly. The nutrient of one-year-old Gamal plant consist of 3-6% N; 0.31% P; 0.77% K; 15-30% crude fiber; and 10% ash K [9]. The complete nutrient content contained in the Gamal leaves can be used as a basis for utilizing these leaves as hydroponic nutrients. Previous studies have only discussed how to use Gamal leaves as liquid organic fertilizer [8,9].

   Recently, agriculture land in Indonesia is limited due to the industrial and property development like construction of shopping centers, housing, road widening, and toll construction that consumes...
many paddy fields [10]. Due to the limited land for farming, a breakthrough with the hydroponic method is needed. Hydroponics is a method of planting without using soil media as a binding of various nutrients needed by plants [11]. One of the hydroponic techniques widely applied for the cultivation of vegetable crops is the Floating System Hydroponic Technique (THST) or also is called floating raft. The floating raft technique is hydroponic techniques placed on Styrofoam which are floated in a large pool containing nutrient solution [12]. Many lettuces were planted with hydroponic techniques. Lettuce is a long-day plant with the growth and development of more than 12 hours the intensity of the irradiation of light [13]. The demand for lettuce in Indonesia cannot be fulfilled due to the low production of lettuce. According to the National Statistics Agency (BPS) that lettuce exports in 2002 were 47,942 tons and increased to 55,710 tons in 2003 [14]. This description is basic for utilizing Gamal leaves as hydroponic nutrients for lettuce plants. This is a novelty and interesting in the field of hydroponics to use Gamal plants as a substitute for AB-Mix nutrition in hydroponics.

2. Materials and Methods
2.1 Materials
Materials used in this study were Gamal leaves, lettuce seeds, EM-4, sugar solution, AB-mix nutrition, and rice washing water (leri water).

2.2 Methods
Production of Gamal leaves nutrition
Production of Gamal leaves nutrient was started by preparing 1 big size bucket, 12.5 kg Gamal leaves cut into small parts, 19 L water, 1 L molasses, 4 L leri water, and 125 mL EM-4. All of the substances were mixed in the big size container. Then stir for 5-10 minutes with a wood stirrer, close the bucket tightly, make a hole in the bucket lid and insert the end of a hose into the bucket. The other end of the hose is inserted into a bottle containing water, the fermentation period was done in 25 days. After 25 days, organic fertilizer is separated using a filter. Finally, hydroponic nutrition was ready to be used.

The method used in this research is the experimental method to test some concentrations of Gamal leaves on the growth of lettuce plants. The data was processed using the analyzed variance Completely Randomized Design (RAL) model. There were 5 treatments and 4 repetitions. Lettuce planted was local species found in agricultural seed shops. In this study, researchers used 20 series of 160 plots hydroponic floating raft system. Every one series consist of 8 plots and 1 lettuce seed in every plot.

T1: negative control (water)
T2: 20% concentration of Gamal leaf nutrition (2L Gamal leaf nutrition + 8L water)
T2: 30% concentration of Gamal leaf nutrition (3L Gamal leaf nutrition + 7L water)
T4: 40% concentration of Gamal leaf nutrition (4L Gamal leaf nutrition + 6L water)
T5: positive control (AB Mix)

The growth and productivity of lettuce were observed in every week, from week 1 to week 3 the parameters were observed include plant height, a number of leaves, the width of leaves, and gross weight of lettuce then analyzed using One Way Anova test and follow-up tests using the LSD (Least Significant Different) test.

3. Result and Discussion
The result of content analysis for Gamal leaf liquid fertilizer is presented in Table 1.

| Parameter | Unit | Result | Method | SNI POC |
|-----------|------|--------|--------|---------|
| K         | %    | 8.02   | Inhouse Method | >0.20% |
| Ca        | %    | 0.34   | Inhouse Method | <25.50% |
| Mg        | %    | 0.01   | Inhouse Method | <0.60% |
| P         | %    | 0.03   | Inhouse Method | >0.10% |
Table 1 shows that the contents of 1 liter of Gamal leaves liquid fertilizer nutrition are K 8.02%, Ca 0.34%, Mg 0.01%, P 0.03%, N 0.11% and pH 5.05. Analysis of the nutrient content compared to the Indonesian National Standard (SNI) for the class of Liquid Organic Fertilizer (POC) nutrition K, Ca and Mg already meets the SNI even though N and P levels did not reach SNI quality standards. This is consistent with the results of previous studies which showed that chemical content analysis of the macro element of liquid organic fertilizer of Gamal leaves was N 0.24%, P 0.039%, and K 8.38% [9].

3.1 The Height of Lettuce

The results of observation of the growth and productivity of lettuce from week 1 to week 3 for plant height were analyzed by using a one-way ANOVA and LSD test as can be seen in Figure 1.

![Figure 1. The Height of lettuce](image)

The results of lettuce height were analyzed by the one-way Anova test and further tests using the LSD test can be seen in Table 2.

| Treatment          | 1st week | 2nd week | 3rd week |
|--------------------|----------|----------|----------|
| T1 (Negative control) | 2.86<sup>a</sup> | 4.65<sup>a</sup> | 6.08<sup>a</sup> |
| T2 (Fertilizer 20%)  | 6.09<sup>b</sup> | 9.28<sup>b</sup> | 10.34<sup>b</sup> |
| T3 (Fertilizer 30%)  | 6.83<sup>b</sup> | 9.87<sup>b</sup> | 10.75<sup>bc</sup> |
| T4 (Fertilizer 40%)  | 7.05<sup>b</sup> | 10.32<sup>b</sup> | 11.12<sup>c</sup> |
| T5 (Positive control)| 8.84<sup>c</sup> | 12.53<sup>c</sup> | 14.67<sup>d</sup> |

Note: The number are followed by the same letter in the same column are not a real difference

Table 2 showed that there is a significant influence on all treatment variation on height. Every treatment on height lettuce has significant influence. The result of the one-way ANOVA test is 0.000. There is a significant value that is p < 0.05, it is concluded that liquid fertilizer of Gamal leaves influences the growth and productivity of lettuce plants. The result of the LSD test with a 5% level to determine the effective concentration of the treatment.
The height of lettuce in the third week was a significant influence. Nutrition treatment of Gamal leaves the highest concentration is 40% and high 11.12 cm. The increase of height lettuce growth triggered by the nutrients contained in the Gamal leaves consists of nitrogen 0.11%, P 0.03%, and K 8.02%. The increase in plant height is due to the liquid organic fertilizer of Gamal leaves having the required elements such as N, P, K which are needed by plants.

3.2 Number of Lettuce Leaves

The next parameter observed was the number of lettuce which can be seen in Figure 2.

![Figure 2. Number of Lettuce Leaves](image)

| Table 3. LSD Test Results Amount of Lettuce Leaves at 5% Significance |
|---------------------------------------------------------------|
| Treatment | Week 1 | Week 2 | Week 3 |
|-----------|--------|--------|--------|
| P1(negative control) | 3.73 a | 3.93 a | 4.37 a |
| P2 (Gamal leaf Nutrition 20%) | 4.9 b  | 5.56 b | 6.18 b |
| P3 (Gamal leaf Nutrition 30%) | 5.33 b | 6.12 b | 6.62 b |
| P4 (Gamal leaf Nutrition 40%) | 6.15 b | 6.37 b | 7.25 b |
| P5 (positive control) | 7.81 c | 8.4 c  | 8.93 c |

*Note: The treatment followed by the same letter means that it shows not significantly different.*

The results Table 3 show differences in the number of lettuce leaves from each treatment from the first week to the third week. The highest level of measurement is on the positive control. The significant value of 0.000 is known from the One-Way ANOVA test (Table 3), which means that there is a significant effect of Gamal leaf nutrition on the number of lettuce leaves. Different doses affect different numbers of leaves as well. The highest number of leaves in the third week is P4 (Gamal leaf nutrition 40%). However, this number is below P5 (control +) which dominates the largest number of leaves in lettuce plants. The leaves in the P5 treatment look green and fresh, compared to some leaves that are treated, relatively yellowish-green and almost yellowing, this is due to the lack of element N in Gamal leaf nutrition, and when viewed from analysis of the nutrient content of Gamal leaf, the N content is still below the value of the Indonesian National Standard. Plant growth with characteristics such as slow growth, weak, stunted and decreased plant production, indicating that the plant lacks the element N.

3.3 Lettuce Leaf Width
The observation parameters of lettuce leaf width can be seen in Figure 3. The ANOVA analysis and LSD test (Table 4) show that the addition of Gamal leaf nutrition was not significantly different for each concentration. However, when viewed from the results of the average leaf width for each week an increase in leaf width, the highest value was in the third week of the P4 treatment which was 5.27 cm and the lowest value on the P2 treatment was 4.9 cm. Treatments P4, P3, and P1 were significantly different from negative control and positive control treatments. The lowest value in the negative control is found in the third week as wide as 4.01 cm. this is because negative controls do not get additional nutrients, only water and air bubbles are obtained from the aerator. The elements N, P, and K are very important nutrients because they affect the width and number of leaves in plants. While hormones play a role in regulating growth, besides that water plays a role in the development of leaf tissue cells.

![Lettuce Leaves Width (cm)](image)

**Figure 3. Lettuce Leaves Width**

| Treatment                      | Week 1       | Week 1        |
|-------------------------------|--------------|---------------|
| P1 (negative control)         | 2.08<sup>a</sup> | 2.27<sup>a</sup> | 4.01<sup>a</sup> |
| P2 (Gamal leaf Nutrition 20%) | 3.35<sup>b</sup> | 4.06<sup>b</sup> | 4.9<sup>b</sup>   |
| P3 (Gamal leaf Nutrition 30%) | 3.77<sup>b</sup> | 4.23<sup>b</sup> | 5.13<sup>b</sup> |
| P4 (Gamal leaf Nutrition 40%) | 3.94<sup>b</sup> | 4.68<sup>b</sup> | 5.27<sup>b</sup> |
| P5 (positive control)         | 6.07<sup>c</sup> | 6.68<sup>c</sup> | 9.13<sup>c</sup> |

**Table 4. LSD Test Results for Leaves Width of Lettuce at 5% Significance**

*Note: The treatment followed by the same letter means that it shows not significantly different*
3.4 Wet Weight of Lettuce

Based on the analysis results of the measurement of the wet weight of lettuce plants in Figure 4 obtained in the third week of harvest, the graph shows the differences in the wet weight of the lettuce plants in each treatment. P5 (control +) has the highest wet weight of 13.37 grams because AB-Mix has a complete nutrient for lettuce.

The LSD test results in Table 5 prove the wet weight of lettuce plants using Gamal leaf nutrition was not significantly different from negative control treatments but significantly different from positive control treatments. Lettuce plants in this positive control grow very well i.e., plants grow tall, the number of leaves and leaf width is relatively large, so the lettuce plants are the heaviest compared to other treatments. Salisbury and Ross said that the wet weight of a plant is related to how much water is absorbed, a compound that plants need in large quantities in each organ.

| Treatment                  | Average Wet Weight of Lettuce |
|----------------------------|-------------------------------|
| P1 (Negative Control)      | 1.46a                         |
| P2 (Fertilizer 20%)        | 1.75a                         |
| P3 (Fertilizer 30%)        | 2.83b                         |
| P4 (Fertilizer 40%)        | 4.03c                         |
| P5 (Positive Control)      | 13.37d                        |

Note: The treatment followed by the same letter means that it shows not significantly different

The research parameters measured were plant height, leaf width, number of leaves, and wet weight of lettuce plants. The P4 treatment had the best results followed by P3 and P2 which showed that the greater the concentration of Gamal leaf nutrition, the higher the productivity of lettuce. Gamal leaves nutrient to have K, Ca, Mg, P and N that need for the plant, but not enough for growing lettuce. Only K, Ca, and Mg is according to the standard of SNI for Liquid Organik Fertilizer. Kalium can improve the photosynthesis process, make efficient use of water, maintain turgor, form stronger rods, act as activators for various enzyme systems, strengthen roots so that plants are more resistant to lodging and increase plant resistance to disease [15]. Calcium has several benefits for plant growth. In addition to strengthening plants, the function of applying this fertilizer is to stimulate root growth, facilitate absorption of potassium, and as a limiting factor in cell wall formation [16]. Magnesium helps photosynthesis and respiration, increasing plant immunity against pests and diseases, and plant nutrition formation [17].

AB-Mix nutrition is used to positive control in this study because it already contains all the nutrients needed by plants. The AB-Mix nutrient has the contents of macronutrients N, P, K, Mg, Ca, and S then the microelements namely Fe, Mn, Zn, B, Cu, Cl, and Mo. Elements C, H and O are
obtained from air and water in sufficient quantities while other elements are obtained from the process of fertilization or nutrient solution [18].

In this research, the floating raft hydroponic system is very suitable for planting lettuce plants, because it is easy to apply, such as making it easier for plants to absorb oxygen and nutrients directly, in addition to handling pests and insects more easily controlled, also when it rains can be minimized.

4. Conclusion
Gamal leaves can be used as an alternative to organic hydroponics made from organic raw materials for floating raft hydroponic systems by providing a significant effect on the growth and productivity of lettuce plants.

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