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Food Waste as Alternative Natural Fertilizer for Okra Plants (Abelmoschus Esculentus L.)

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ABSTRACT

Many food preparation areas generate leftover food from vegetables, fruits, and meat. Consequently, the abandoned food will produce an unpleasant odour, attracted wild animals that roam around and disturb the residents. In this study, a combination of food waste; for instance, fruits, vegetables, and meat was used as a natural fertilizer for okra plant and the growth performance of the okra plant was analysed by measuring the plant height and the diameter of the stem. Three major components were used as compost fertilizer, namely brown sugar, food waste, and water, in ratio 1:5:10, respectively. The liquid fertilizer produced from the composted food waste was applied to okra plants in various dilution concentrations (0%, 5%, 10%, 15%, and 20%). After ten weeks, the okra plant gave the highest growth and bigger diameter of 61.80 cm and 0.78 cm, respectively, indicating that the growth performance of the okra plants increased rapidly and healthily using the highest dilution. The effect of nutrients on okra plants was determined by nitrogen ammonia (NH_3-N), phosphate (PO_4^{3-}), and nitrate (NO_2-N) analysis. The composted fertilizer showed that the application of natural fertilizer is beneficial to human and can contribute significantly to the conservation of the environment.

Keywords: Food waste, natural fertilizer, okra plant, and compost

1. INTRODUCTION

Plants need fertilizers for their rapid growth [1-2]. Fertilizers can be classified into organic and chemical fertilizers [3-5]. Based on reported studies, organic fertilizers are more effective than chemical fertilizers [6]. Organic fertilizers are made from organic materials such as plants, meat and papers (Hussain et al., 2018). Meanwhile, chemical fertilizers such as NPK fertilizers contain chemicals that will affect plant growth [7-8].

Organic fertilizer helps to keep plants healthy because the amount in nutrient is more balanced. It also affects the soil properties that helps to enhanced nutrient mobilization from organic and chemical sources and decomposition of toxic substances. Other than that, organic fertilizer also produces food to encourage the growth of beneficial micro-organisms and earthworms and the also help to defeat certain plant diseases, soil borne diseases and parasites [9]. The larger

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volume of organic fertilizer needed To provide enough nutrients for the growth, because it is low in nutrient content. Furthermore, it is too slow for the nutrient to release to meet crop requirements.

Meanwhile, the effect of chemical fertilizer to the growth of the plant is usually fast because the nutrients are immediately soluble to the plant. The price is slightly cheaper and more reasonable than organic fertilizer [10]. Chemical fertilizer also high in nutrient content. The disadvantage for the chemical fertilizer is nutrients are easily lost from soils through fixation, leaching or gas emission and can lead to reduced fertilizer efficiency [11].

Organic fertilizers can solve environmental problems [12-13]. For example, the disposal of food waste and vegetable waste will release unpleasant odours to the environment [14]). In addition, problems like air pollution can also occur. The objective of this study is to produce organic fertilizer from composted food waste. Therefore, leftover foods such as vegetables waste and meat were composted to produce organic fertilizers [15]. This organic fertilizer is excellent and recommended because it has the nutrients needed for rapid plant growth [16].

2. MATERIAL AND METHODS

2.1 Compost Materials

The food wastes were collected from the residential college cafeteria of Universiti Tun Hussein Onn Malaysia (UTHM). The materials for composting comprised of wet and dry things. Green vegetables and meat were selected as wet materials while dry materials include old newspaper and dry leaves. The end product of composting was analysed using HACH DR6000 Spectrophotometer to obtain the content of nutrients in liquid fertilizer which are nitrogen ammonia (NH_3–N), phosphate (PO_4^{3-}) and nitrate (NO_3^-).

2.1.1 Composting Method

Three major components, namely brown sugar, food waste (see Figure 1) and water were mixed in the ratio of 1:5:10 [17]. The composition of each component were 300 g of brown sugar, 1500 g of food waste and 3000 mL of water. This compost mixture was mixed in a 5L airtight container with top open loader and covered with black tape to avoid direct sunlight that will reduce nutrients (See Figure 2). The container was left for two months to allow for anaerobic and aerobic degradation of the composted food waste. This will cause the food waste to liquify. After two months, the liquid from the composted food waste was collected for further used and for analysis.

Figure 1. Materials needed for food waste composting.

Figure 2. Covering the container with black tape.

Preparation of the compost started by cutting the vegetables and old newspapers into small pieces to increase the surface area [18]. Then, 350 g chicken meat was added into the mixture as a catalyst for the anaerobic and aerobic process [19]. This was followed by addition of 300 g brown sugar. The brown sugar acts as a food for the bacteria in the compost. Next, a bottle of Yakult was added into the mixture as an extra material in the compost [20]. It helps the growth of plants effectively [21]. The composting process work most effectively if the materials contain carbon to nitrogen ratio of 30 to1. After Yakult, 3 L of water was poured into the 5 L container and mixed well. The compost mixtures were left and only opened every two weeks to stir and release the gas to prevent the container from an explosion. Finally, the liquid was drawn out from the container and poured back into it for every two weeks (See Figure 3). This approach was done to ensure the occurrence of aerobic degradation process of the composted food waste [22].

Figure 3. Drawing out liquid to ensure the occurrence of aerobic degradation.

2.2 Analysis of Content in the Liquid Compost

Since the compost is mature or after two months of fermentation, it has sour smell and grey in colour. Since the compost is the organic liquid fertilizer for plants, it must contain the nutrients that a plant requires [15]. The nutrients that plants require in large amount are called

macronutrients such as Nitrogen, Nitrogen Ammonia, Phosphorus, Nitrate, Potassium, Calcium, Magnesium, and Phosphate [23-24]. The compost liquid was analysed for nitrogen ammonia, nitrate and phosphate using HACH Methods provided by HACH Company, 10th Edition 2019 for nitrate, 9th Edition 2017 for nitrogen ammonia, and 9th Edition 2014 for phosphate. While for the nutrient content in plant growth, the sample of liquid fertilizer is taken to the lab every once a week for 10 weeks period but due to the Covid-19 pandemic that occurred, only 4 week of results were to be recorded because of the Movement Control Order (MCO) that took place from 18th March 2020. The pH of soils was also recorded to make sure the soils in the good condition because the soils also give effect to the performance of plants [25-26].

3. RESULTS AND DISCUSSION

The physical observations were made once every week for 10 weeks period. The recorded data on the height of plants and the diameter of stem were plotted and shown in Figure 4. The height of plant is measured from bottom to the shoot of the plant using measuring tape, while the diameter of the stem is measured 10cm from bottom for every plant by using digital Vernier.

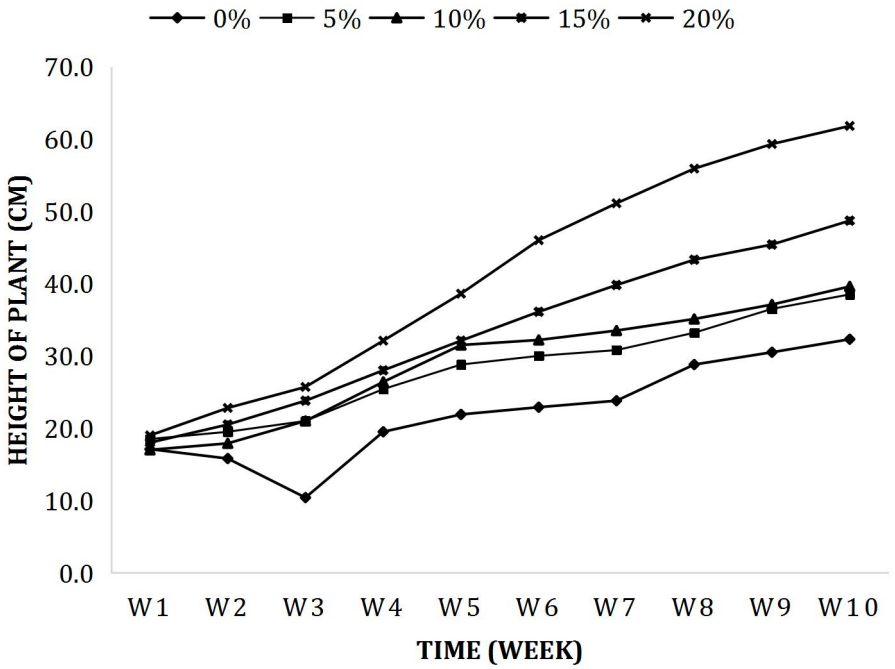


Figure 4. The development of plants in terms of height for every dilution percentage.

Figure 4 shows that plants with fertilizer at 20% dilution demonstrated the most significant increase reached the highest average at which is 61.80cm and the stem diameter (0.78cm) based on Figure 5.

Then, for height of plant, sample at dilution 20% showed significant increase in average height of plant compared to other dilutions, especially on week 10 which is 61.8cm followed by dilution 15% which is 48.7cm that is shown at Figure 4. The development of plants growth for diameter and high is simultaneously occur on okra plant, it is indicating the application of natural fertilizer can enhance the physical development of plant. In the meantime, nutrient content that is measured from the liquid fertilizer is nitrogen ammonia, phosphate and nitrate (See Figure 6) to identify the nutrient content in the liquid fertilizer.

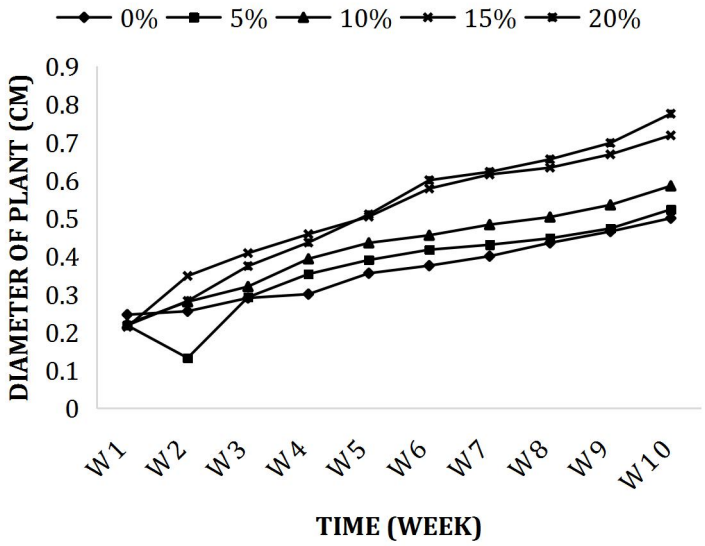
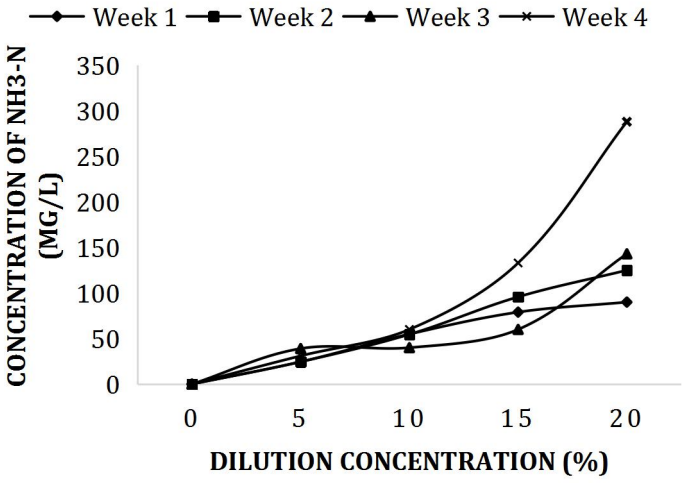
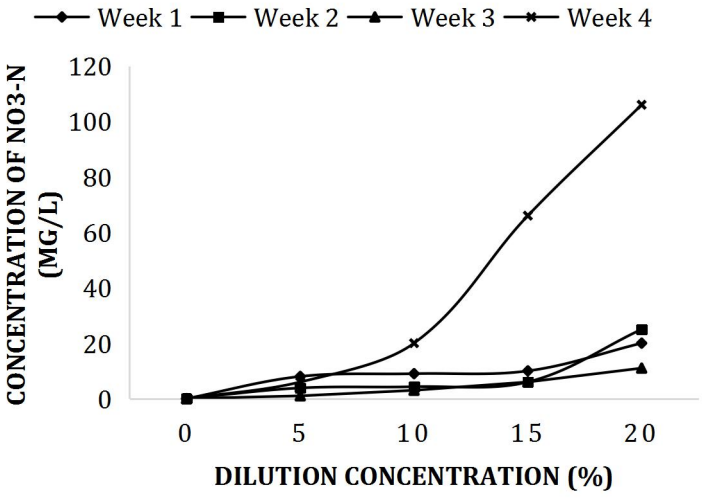


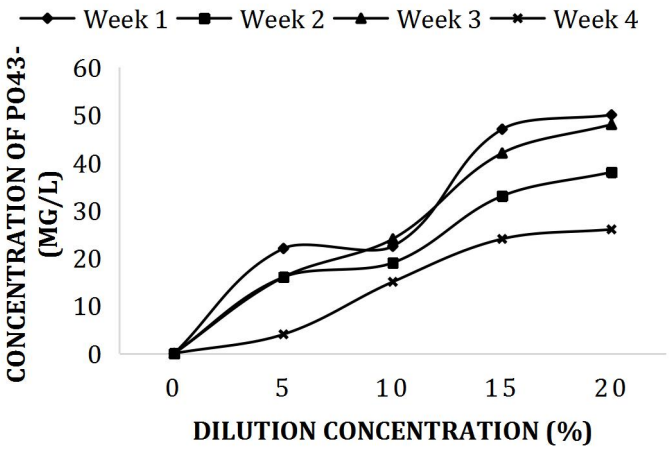
Figure 5. The development of plants in terms of diameter for every dilution percentage.



(a)



(b)



(c)

Figure 6. The concentration of liquid fertilizer, (a) nitrogen ammonia (NH_3-N), (b) phosphate (PO_4^{3-}), and (c) nitrate (NO_3-N).

Figure 6 (a) shows that the values of nitrogen ammonia, NH_3-N increase every week due to the increasing of dilution percentage. The highest reading of NH_3-N was observed at dilution 20% for Week 4 that is 288 mg/L of NH_3-N. Meanwhile, the phosphate (PO_4^{3-}) content for all dilution increased with time as shown in Figure 6 (b) with 20% dilution gave the highest phosphate concentration (50 mg/L). As for nitrate, Week 4 shows increment in all dilutions as shown in Figure 6 (c). The highest value of nitrate in Week 4 was obtained at 20% dilution which is 106 mg/L of NO_3-N. Meanwhile, the readings for nitrate were inconsistent due to nitrification–denitrification process in the composted liquid fertilizer [27].

In the beginning of the project, pH of the soil was measured in ratio of 1:1 (100 g of soil: 100 mL of distilled water). The soil was left for one night before being tested for pH value. The pH of soil was determined using pH meter in laboratory. The soil consisted of clay, loam and silty. The average soil pH for each dilution concentration is 6.22, which is an ideal pH for plant growth [28].

Figure 7. The fruit from the use of the composted fertilizer.

From the result that has been achieved, the higher concentration of dilution, the higher values of nitrogen ammonia (NH_3-N), phosphate (PO_4^{3-}) and nitrate (NO_3-N) (Islam et al., 2017). The observation for the growth of plants showed that the high performance (See Figure 7) of plant growth at dilution 20% of liquid fertilizer cause of high of nutrient composition due to bio-electrochemical processes [27, 29-31].

4. CONCLUSION

On the purpose of using food waste as fertilizer can affect the growth performance of the plants because it contains the composition required by the plants. The study has shown that the method of food composting added with water, brown sugar and Yakult is able to enhance the presence of the phosphorus, nitrogen and nitrate in the liquid fertilizer. The study had successfully used the composted fertilizer on okra plants at various dilution concentration. The 20% dilution was the best fertilizer that can be used to enhance the plant growth because it gave its heights and diameter of 61.80 cm and 0.78 cm, respectively. This proved that the application of this natural fertilizer can benefits to humans and can make a significant contribution to the conservation of the environment. This study developed a solution for organic yet economic fertilizer, which can be applied to plant growth promotion in practical agricultural production. The involved mechanisms are expected to achieve positive impacts of this product towards the agricultural communities for further investigation.

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