

Development of a Vermi Tea Brewing Machine

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Abstract –Vermicompost, a product of the composting system that utilizes earthworms for the decomposition of the biosolids and/or solid wastes is now considered in organic farming. But since it is applied in solid form, it is difficult for some plants to take up the nutrient contents. The liquid form is the vermi tea which facilitates the plants for fast absorption of the nutrients. The main objective of this study is to develop a vermi tea brewing machine taking into consideration system components and material specifications. Specifically, it aimed to establish the operating time of the machine and to evaluate its performance in terms of brewing efficiency and percent yield. The properties of the produced vermi tea were also evaluated. This is a developmental type of study which consists of development stage, preliminary testing stage and the performance testing stage. The vermi tea brewing machine comprised mainly of the cylindrical container, copper tubings, air pump, vermicompost container and support frame. During preliminary testing, the established machine's operating time was 24 hours. Performance testing of the machine resulted to 99.58% yield and the brewing efficiency was acceptable in terms of the dissolved oxygen after the process. Properties of the produced vermi tea were tested by accredited laboratories and resulted to ph of 4.23, total NPK of 0.033%, dissolved oxygen of 5.62 mg/L, total coliform of 4,500,000 CFU/ml, mold of 3,000 CFU/ml and yeast of 3,000 CFU/ml. These are acceptable values which indicated that it can be used to improve farming activities.

Keywords –brewing machine, nematodes, protozoans, vermi tea

INTRODUCTION

In the Philippine agricultural system, the use of fertilizers is a significant procedure that increases production which enables the country to have enough food, crops and other agricultural products. Even soil with no tillage can now be used in producing agricultural crops with the help of fertilizers. The use of fertilizers is believed to provide 30% to 50% of the increase in crop yields. However, due to the heightened importance and increasing demand, prices of these fertilizers reflect a consequential increase that has triggered an alarming impact especially for farmers who disburse personal funds for the said necessity.

The Filipino farmers, environmentalists, and those involved in agro-industrial activities are now reintroducing the concepts of organic farming. This type of system in farming promotes the utilization of organic fertilizers. These fertilizers came from organic

materials such as agricultural by-products, animal manures, green manures, domestic wastes and industrial wastes.

Composting, a process of decomposition of organic materials, plays a key role and is the major process in organic farming. A type of composting is vermicomposting. Vermicomposting is a method of treating solid wastes using earthworms (Oligochaete annelids) during the process of the decomposition of the organic substances found in solid wastes. African night crawler is considered as the most suitable in the Philippines. This was brought to the country by Rafael Guerrero III in 1982. Vermicomposting can also be called as earthworm conversion, vermistabilization, worm composting or annelidic consumption. Aerobic conditions are maintained by worms in the organic substances during the composting process. Vermicomposts or worm's castings are the products of this process. [1]

Since vermicompost is in solid form, it will be difficult for some plants to take up the nutrients out of it. Its nutrients are released slower compared to its liquid form. The liquid form is the vermi tea. Vermitea facilitates fast absorption of the nutrients into the plant.

Aerobic compost tea can dramatically increase production, reduce the need of water by seventy percent, reduce or eliminate soil compaction, eliminate the use of fertilizer, herbicides and pesticides, and re-invigorate diseased and dying plants. Application of aerobic compost tea is essentially the same as extracting the microorganisms that are abundantly present in the healthy and aerobic compost. They are then held in suspension and the fast growth of the microorganisms are enhanced through aerating vigorously and feeding the selected additives [2].

The function of the aerobic microorganisms is to actively enhance the microbiological character of the soil, its fertility and texture. They lessen the unpleasant smells and speeds up decomposition in compost piles. Poisons and pathogens are broken down into nutrients, that are useful to plants and used in controlling plant diseases.

The soil has full of microorganisms that support growth of plants. Bacteria, fungi, protozoa, amoebas, micro-arthropods and beneficial nematodes are the health-decomposers that are also present in soil. By applying aerobic compost tea, the strategy is to enhance the populations of beneficial microorganisms that will work to help the plants [3]. Nematodes are roundworms that are colorless, non-segmented, and do not have appendages. Nematodes can be predaceous, free-living, or parasitic. Entomopathogenic nematodes are safe for crops and animals but are very harmful to many important insect pests. This means that the application of nematodes does not require any equipment to ensure safety. Unlike other biological microorganisms which requires days or weeks to destroy insects, nematodes, can eradicate insects within 24 to 48 hours only as they work with their symbiotic bacteria. Nematodes are responsive to mass production. Application equipment such as sprayers of different types are not needed [3].

The protozoa require organic materials for nutrition. This type of nutrition is classified as holozoic nutrition. Nutrition intake is mostly done through a protozoan's mouth or cytosome or micropore. The metabolic pathways of protozoa are similar to those of

higher animals indicating that they also require the same types of organic and inorganic compounds [4].

Worm tea or vermi tea is a complex solution produced from worm castings. It contains microbes such as fungi, bacteria, protozoa and other useful nematodes. The worm tea, which is in liquid form, can easily be absorbed by the plants resulting to increase in level of plants' immunity [5]. The nutrients, vitamins and minerals needed by the plants are produced by these organisms present in vermi tea. The microbes in vermi tea serve as the food in the food chain of the other organisms found in the soil. Protozoa and nematodes are food for the bacteria and fungi. The worms eat bacteria laden soil particles. Thus, the life in the soil directly or indirectly merely depends on microbes.

The main objective of this study is to develop a vermi tea brewing machine using locally available materials. Specifically, it aims to fabricate a vermi tea brewing machine taking into consideration material specifications and system components, to establish the operating time, to evaluate the performance in terms of brewing efficiency, percent yield and properties of the produced vermi tea in terms of pH, nitrogen, phosphorous and potassium content, dissolved oxygen, total coliform count, yeast count and mold count.

MATERIALS AND METHODS

This is a developmental type of study. It employed engineering design, planning and analysis so that the different parameters involved in the project can be stated and given important considerations. Appropriate procedures were employed in order to meet the objectives set. The study involved three stages: the design and development stage, preliminary testing, and actual gathering of data. The first stage covered the consideration of the basis of development of a vermi tea brewing machine. All the needed information was gathered to fabricate the machine. The next stage was the preliminary testing. Different trials were done to establish the operating time. It included the time of aeration of vermicompost and water and aeration when added with sugar. This parameter was determined through microscopic microbial activity. This process was done during the 28-hour testing. The growth of microorganisms was observed every four hours of operation. The brewing time depended on the growth of the microorganisms present in vermi tea. When the nematodes were already dominant over the protozoans, the brewing

operation was stopped. In the actual gathering of data, all needed parameters were tested in the chosen laboratory center to evaluate the performance of the machine as to whether the properties of the vermi tea produced is within the standards. The basis of the brewing efficiency was the level of the dissolved oxygen present in the vermi tea after one hour of brewing and at the end of the brewing process. According to Dr. Joel Adorada, in order to conclude that brewing machine is efficient, the level of the dissolved oxygen must not be less than the range of 5-6mg/L.

The amount of dissolved oxygen indicating the characteristics of a water body is measured by Winkler Method. If the dissolved oxygen concentrations are high it means less pollution and high productivity. Titration is used in Winkler Method for this purpose. A sample bottle was filled completely with water to avoid presence of air. The dissolved oxygen in the sample was then secured by adding a series of reagents forming an acid compound. After that, with a neutralizing compound, it was titrated until it results to a change of color. Endpoint is change of color which coincided with the dissolved oxygen concentration in the vermi tea [6].

Percent yield refers to the volume of the produced vermi tea over the volume of the mixture of water, vermicompost and sugar. This was determined since there were undissolved vermicompost at the end of brewing.

The properties of the vermi tea were determined through the testing conducted by different laboratories depending upon their capabilities to conduct. The Regional Soils Laboratory tested the pH, nitrogen (N), phosphorus (P), and potassium (K). Optimal Laboratories Inc. tested the Total Coliform Count, Yeast Count and Mold Count. Coliform Plate Count Method was used in determining the Total Coliform Count. Pour plating was the method used in determining the yeast count and mold count. Lastly, Batangas Environmental Laboratory conducted the test on Dissolved Oxygen. The method called Winkler titration was performed.

RESULTS AND DISCUSSION

The fabricated vermi tea brewing machine is presented in Figure 1. It comprised of the cylindrical container, copper tubings, air pump, vermicompost container, faucet and support frame. The cylindrical container which holds the 30 liters of water is made of acrylic fiber glass. It has a diameter of 35 cm and a

height of 44 cm. There are three copper tubings that were shaped in helical form. These have different diameters of nozzles and lengths. The longest tube is 86 in. long and with the biggest diameter of nozzle. The next tube is 29.5 in. long and with middle sized diameter. The last tube is the shortest having the length of 16 in. and the smallest nozzle. This was constructed for better circulation of the air for brewing. All nozzles are positioned downwards the container to prevent the vermicompost from settling at the bottom. Air is supplied by an air pump. The vermicompost container is 10cm in diameter and has a height of 37cm made of PVC. It is drilled with 8mm diameter holes that serve as the passage of the vermicompost. It is then inserted in the hole of the cover of the cylindrical container and is closed with ametal cap. The faucet served as the outlet port of the produced vermi tea. The support frame serves as the foundation of the vermi tea brewing machine.

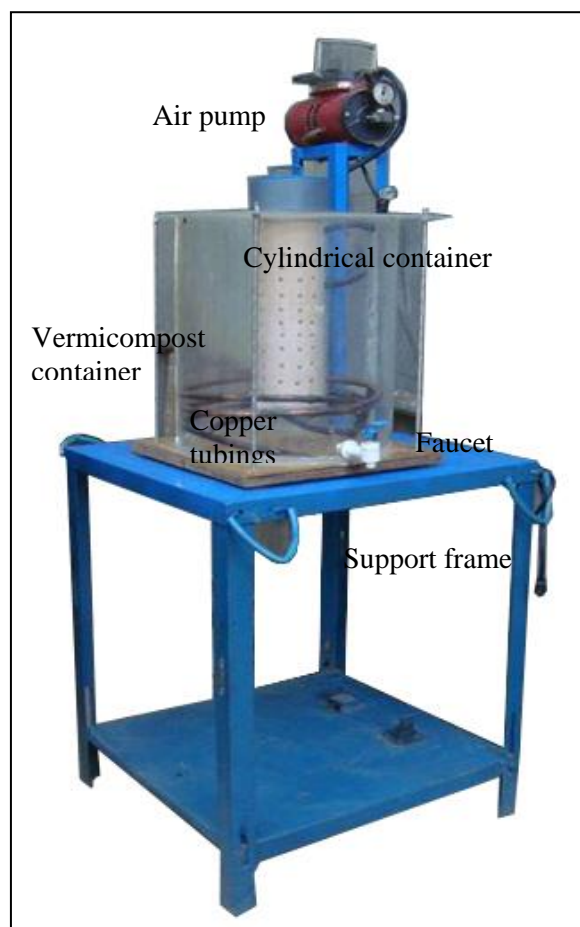


Fig. 1. Vermicompost tea brewing machine.

Results of Preliminary Testing

After the fabrication of the vermi tea brewing machine, preliminary testing was conducted. During this stage, operating time or brewing time of the vermi tea brewing machine was established in terms of the growth of the microorganism found in vermi tea. The test was conducted for 28 hours and samples were taken every four hours. The sample is then evaluated in terms of the microorganisms found using a microscope at National Red Cross – Batangas Chapter. Nematodes and protozoans were identified with the help of an expert. According to Dr. Joel Adorada, the vermi tea is at its effective state when there are more nematodes than protozoans. This was the reference used in establishing the operating time.

Table 1 shows the results of the preliminary testing. This was conducted for 28 hours from 4:30 PM to 8:30 PM of the next day.

Table 1. Results of Preliminary Testing

Time	Results
4:30 PM	No moving microorganisms found yet
8:30 PM	Few bacteria
12:30 AM	Increased number of bacteria with few protozoans
4:30 AM	Greater number of bacteria with few protozoans
8:30 AM	Many protozoans with few nematodes and a lot of bacteria
12:30 PM	Many protozoans with greater number of nematodes and increased bacteria
4:30 PM	Nematodes at their peak level with continuously increasing number of protozoans and bacteria
8:30 PM	Less number of nematodes with many protozoans and bacteria

It is shown in Table 1 that there are two main microorganisms present in the vermi tea. These are the nematodes and protozoans. The results presented were based on the interpretation of the pictures taken during the monitoring of the microorganisms’ growth. It resulted that the brewing time will be stopped after 24 hours of brewing, since the next four hours of brewing resulted to less number of nematodes and increased number of protozoans.

Results of Performance Testing

Performance testing of the vermitea brewing machine was conducted after achieving a successful trial test run and after the operating time has been

established. During this stage, brewing efficiency and percent yield were evaluated. The brewing efficiency was based on the level of dissolved oxygen in the vermi tea after four hours of brewing and after 24 hours of brewing. The effective limit must not be lower than 5-6mg/L. The samples were tested at the Batangas Environmental Laboratory through the Winkler titration method. Laboratory testing results showed that the dissolved oxygen after four hours and 24 hours of brewing are 6.65 and 5.62 mg/L, respectively. The result of the brewing process after 24 hours is within the limits which indicates that the brewing process is effective.

Percent yield was computed as the ratio of the volume of vermi tea produced to that of the volume of water with vermicompost. Average values from three trials with 31.32 L of vermi tea produced and 31.45 L of the input mixture resulted to 99.58% yield of vermi tea.

Properties of the Produced Vermi Tea

Table 2 presents the properties of the produced vermi tea. The properties were tested in different laboratories. The pH, Nitrogen, Phosphorus and Potassium were tested at Regional Soils Laboratory. Dissolved oxygen was tested at Batangas Environmental Laboratory. The Total Coliform Count, Yeast Count and Mold Count were tested by Optimal Laboratories, Incorporated.

Table 2. Properties of the produced Vermi Tea

Properties	Results
pH	4.230
Nitrogen, %	0.019
Phosphorous, %	0.002
Potassium, %	0.012
Dissolved Oxygen, mg/L	5.62
Total coliform count, CFU/mL	4,500,000
Yeast count, CFU/mL	3,000
Mold count, CFU/mL	3,000

It can be gleaned from the table that the produced vermi tea is acidic with pH value of 4.23. It has a total NPK value of 0.033% and dissolved oxygen of 5.62 mg/L.

The soil pH level does not directly affect the nematodes. Nematodes can exist at normal pH range of 4-6 provided that the soil pH is safe for the host plant growth. However, if the soil is acidic, the leaves became stunted and yellowish in color. These then results to decrease in growth and production yield. In

addition, if the soil is of adverse pH, the plants may be more vulnerable to diseases and fungal attacks. Generally, for vegetable is a pH of between 5.5 to 6.5 in mineral soil and 5.0 to 6.0 in organic soil is most favorable [7]. Nitrogen helps in supporting the roots of plants for more intake of water. Phosphorus regulates the synthesis of protein. It is also related with complex energy transformations in the plant. Potassium also increases the growth of roots and helps in photosynthesis. It also shows the count of bacteria present in the sample vermi tea of a 24-hr brewing. There are no standard values for these three bacteria. Too much of these bacteria are not good for plants. Since these kinds of bacteria have the tendency to increase as time passes by, and 24 hours is the least brewing time possible, the counts of these bacteria during that time were considered. Coliform can cause depletion of oxygen of plants if it is in large count. Yeast helps in the development of blossoms of plants, but excessive amounts may cause deleterious effects. Since molds are considered fungi, they are harmful to plants.

CONCLUSION AND RECOMMENDATION

The developed vermi tea brewing machine can be further utilized for the production of fertilizer that can be applied to different plants and to improve farming activities. The method of application to plants to fully obtain the benefits from vermi tea should be studied. Storage of the produced vermi tea and its shelf life can be investigated.

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