

Production Efficiency of Organic Fertilizer from Different Composting Methods

Nyle A. Pardillo (MSc)

Northern Negros State College of Science and Technology-Escalante
Campus, Escalante City, Negros Occidental, Philippines
pardilloe@yahoo.com

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Abstract - Compost pit or natural composting is the common method of composting and the product as organic fertilizer is used as soil conditioner or fertilizer. Thus, this study focuses on the efficiency of different composting methods in terms of organic fertilizer produce, decomposition rate and economic viability. Combination of rice straws and sheep manure as substrates were used due to availability in the area. Four treatments employed and replicated four times. Treatment 1 is the natural composting, treatment 2 is the application of urea, treatment 3 is the application of indigenous microorganisms and treatment 4 is vermicomposting. Treatments were subjected in the analysis of variance using Randomized Complete Block Design. Comparison among means uses Least Significance Difference at 5% level. Results show that among four composting methods, application of IMO significantly produces organic fertilizer with 12.36 kilograms and higher decomposition rate of 61.81% among the other three composting methods. However, natural composting has higher return on expenses with 53.88% due to low expenses incurred. In terms of production cost efficiency, natural composting needs Php 13.00 to produce one kilogram of organic fertilizer, lower compared to others. Natural composting is recommended for the production of organic fertilizer due to low expenses and higher economic return though production was higher in the IMO applied composting. Further research on other composting methods in long run production to lower the expenses is also advised.

Keywords: composting methods, IMO composting, vermicomposting, decomposition rate, production cost efficiency

INTRODUCTION

Garbage and other waste materials have been seen to any places. Waste materials are classified as biodegradable and non-biodegrade. To address the problem in wastes disposal, waste segregation is implemented including the 3R's government program which are reduce, reuse and recycle. Non-biodegrade wastes have been reused and recycled to reduce its volume. On the other hand, composting is one of the measures conducted to reduce the volume of biodegrade wastes and recycled it into fertilizers as soil conditioner and improved soil fertility to produce healthy and productive plants.

Composting is a process where there is an accelerated bio-oxidation of different organic matters that pass through a thermophilic stage and microorganisms liberate heat, carbon dioxide and water [1]. Heterogeneous mixtures of these organic matters are transformed into a homogeneous and stabilized product of humus, called organic fertilizer.

Natural composting is a process of composting whereby wastes are piled up and let natural decomposition takes place. This is usually done in the

compost pit, thus other called this method pit composting. During this process, both thermophilic and mesophilic microorganisms transform the organic materials into a stabilized and sanitized humus, where thermophilic microorganisms sanitized the organic materials and mesophilic microorganisms degrade the materials in slower pace, [2]. The process in natural composting is too long since most of the biodegradable materials are not cut into smaller pieces for easy decomposition.

There are different methods employed to hasten decomposition of composting materials. Indigenous Microorganisms (IMO) from rice fermentation technique is widely used and easily adopted by farmers since rice as culture media for microbes are placed under the bushes or bamboo trees and no need to do laboratory inoculation for microorganisms [3]. Carbohydrate from rice is the main carbon source for the multiplication of these microorganisms. The microorganisms found in IMO believed to hasten decomposition and improved the nutrient content of the decomposed materials once it is applied. IMO is a beneficial soil microorganisms of filamentous fungi, yeasts and bacteria that could

produce mature compost in short time and believed to improve the nutrient content of the product [4].

Vermicomposting is one of the methods in decomposition that uses earthworms to eat the decompose materials and excrete wastes known as vermicast. Excrete wastes of any animals believed to have a high nutrient content once it passed through in the digestive system of the earthworms. Enzymes are added into the wastes and nutrients are well extracted from the ingested materials. Vermicompost as the organic fertilizer product is a combination of vermicast and the decomposed materials in the vermicomposting bin. Vermicompost is usually fine, highly fertile, porous, high water holding capacity, low C: N ratio and believed to have high nutrients content [5].

The production of organic fertilizer contains small amount of nitrogen and low mineralization rate needing more nitrogen for crop production [6]. Amount of nitrogen ranges from 0.05% to 2.5% at the maximum depending on the substrates used in producing organic fertilizer, as observed. However, some of the manufacturers fortified their organic fertilizers to increase the nitrogen content of their product. Fortification is the best alternative as small volume of organic materials will be used, less inorganic fertilizer will be applied in the soil and reduces the accumulation of non-nutrient ingredient in the soil [7]. This fortified compost shows a promising fertilizer as nitrogen rob will be avoided [8]. In this study, urea was applied in composting to increase the nitrogen content of the organic fertilizer. Urea has organic source due to its carbon content. It hastens the decomposition of the organic materials as C: N ratio was increased since optimal ratio is 30:1 for optimum composting and was employed as one of the methods in composting.

Farmers conducted different composting methods based on the simplicity of the methods, availability of materials and the capability of the farmers to do the method. The intricacy of the method determines the quality of the organic fertilizer output.

There are different researches published into the use of different sources to its effect in decomposition. However, limited researches published on the production efficiency of different composting methods in terms of yield and economic value which include income, profit and production costs.

OBJECTIVES OF THE STUDY

This study focuses on the four composting methods and which among the composting methods

could give high yield in terms of organic fertilizer production. Efficiency of the substrates to convert into organic fertilizer or decomposition rate will also be determined. Economic viability in terms of income, production costs efficiency and profit from the four composting methods will be determined. With this, farmers have the basis in choosing the best composting methods to produce organic fertilizer.

MATERIALS AND METHODS

This study utilized the use of sheep manure and rice straws. These materials were available in the school campus of Northern Negros State College of Science and Technology - Escalante Campus due to presence of its rice fields and sheep animals. Rice straws were dried for one week and shredded after a week. Sheep manure was collected, dried for three days and pulverized manually. The two organic materials were piled up alternately in the composting containers to have even distribution of nutrients once it was decomposed.

Preparation of Decomposing Agents

There were three decomposing agents used in this study; earthworms specifically African Night Crawlers, Indigenous Microorganisms (IMO) and urea fertilizer. Earthworms were collected from the existing vermicomposting facility in the campus. A 100 grams of earthworms were placed in every container of a particular treatment. IMO was prepared from cooked rice and placed under the bamboo trees. After one week, white molds were observed and collected, put in another container and mixed with crude sugar in a ratio of 1:1 and fermented for two weeks. After two weeks, two tablespoons of IMO were collected and mixed with one litre water. One litre of IMO was applied in every container of a particular treatment. On the other hand, one kilogram of urea was bought in the agricultural supply store in the locality for another treatment. One-fourth kilogram of urea was added in every container.

Treatment Preparation and Application

Ten kilos of shredded rice straws and 10 kilos of pulverized sheep manure were piled up alternately inside the composting container. The composting containers were placed in a cool shaded area and arranged randomly using the randomization of Randomized Complete Block Design (RCBD). The composting containers were saturated with water and tightly closed to have anaerobic process for 14 days. The composting containers were opened on the 15th day and

cooled for one day. On the 16th day, treatments were applied.

There were four treatments used in this study. Treatment 1 was natural composting and no decomposing agents applied. Treatment 2 was the application of urea fertilizers. One fourth kilogram of urea fertilizers or 5.75 kilograms nitrogen were applied upon piling up the decomposing materials in every composting container. Treatment 3 was the application of IMO in every replication. One litre of IMO was applied in every composting container. Treatment 4 was vermicomposting. A 100 gram of earthworms were placed in every composting container. The treatments were sprinkled with water every other five days to maintain moisture and made the environment more favourable for decomposition. Composting process was observed for two months.

Harvesting of Organic Fertilizer

After two months, the study was terminated and organic fertilizer as the product of decomposition was harvested. One week before the scheduled harvest date, sprinkling with water was stopped to avoid aggregation of humus. Humus should be dry to facilitate harvesting. The humus from every treatment was sieved using a 0.02 mm sieve. The harvested organic fertilizers were weighed, packed in a container sack and stored in a clean, cool, shaded and open place to maintain humidity.

Gathered Data

Harvested organic fertilizers from every treatment were weighed. There were 20 kilos substrates placed in every composting container for decomposition using the different methods as treatments. Yield of organic fertilizers were determined at harvest. Decomposition rate at harvest was determined by computing the yield divided by the weight of substrates subjected to decomposition. Economic viability was determined by recording all the expenses incurred in the production of organic fertilizers. Income was determined by yield multiplied to the existing market price of organic fertilizer in the locality. Profit was determined by subtracting income to costs. Production costs efficiency was computed by dividing costs to the yield of organic fertilizer.

Research Design and Data Analysis

The study was a simple experiment in Randomized Complete Block Design. There were four treatments applied in this study and replicated four

times. The gathered data such as yield, decomposition rate and economic viability were consolidated and analyzed using the analysis of variance of the Statistical Tool for Agricultural Research (STAR) Software. Comparison among means were done using the Least Significance Difference Test at 5% level of significance.

RESULTS AND DISCUSSION

Yield of Organic Fertilizer

Figure 1 shows the yield of different treatments. Organic materials applied with IMO resulted to high yield compared to other three composting methods. IMO applied composting have yielded 12.36 kilograms of organic fertilizer followed by natural composting with 11.31 kilograms, vermicomposting with 10.81 kilograms and urea applied with 10.56 kilograms.

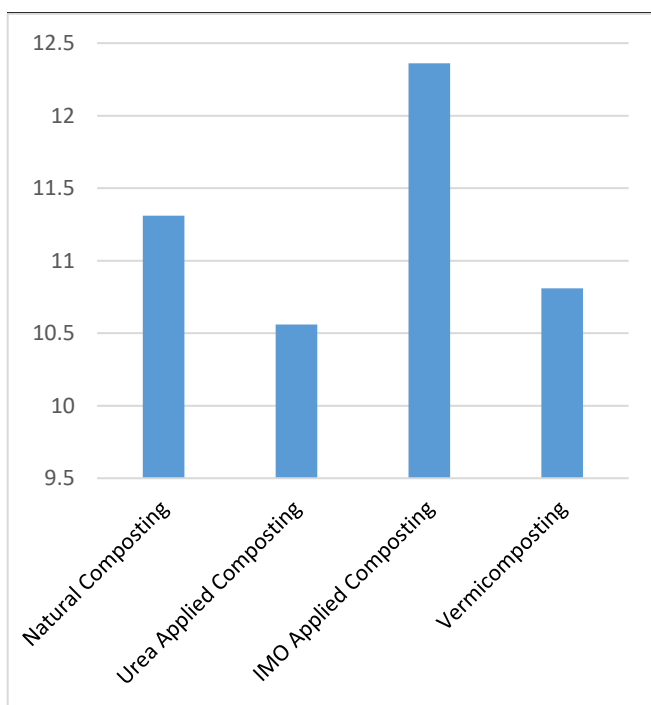


Figure 1. Yield of organic fertilizer from different composting methods

On the other hand, the efficiency of the substrates to convert into organic fertilizer or decomposition rate was high in treatment applied with IMO as shown in Figure 2 and recorded a 61.81% turnover of organic fertilizer from the decomposed substrates. It was followed with natural composting of 56.56%, vermicomposting of 54.06% and urea applied composting of 52.81%.

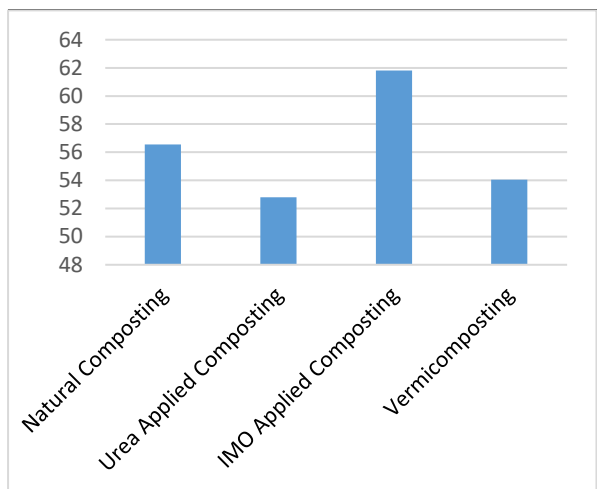


Figure 2. Decomposition rate of different composting methods

Table 1 shows that IMO applied composting is statistically higher in yield and decomposition rate compared to natural composting, urea applied composting and vermicomposting. The significance of yield and decomposition rate are attributed to the abundance of microorganisms present in the organic fertilizer. These microorganisms are minute yet abundant and contributed to the weight of harvested organic fertilizer. High yield of IMO applied composting was also supported with high decomposition rate recorded on this treatment. Abundance of IMO in the compost made the substrates decomposed faster with high organic fertilizer turnover. Yield and decomposition rate were supported by the study of Zakarya [9] where organic wastes applied with IMO has yield significance compared to other treatments after 60 days due to maturity and stabilization of organic wastes. The abundance of microorganisms present in organic materials hasten the decomposition, obtaining the highest decomposition rate among other treatments. In a different study, soil sprayed with IMO increased its microbial population [3]. This could be the reason why there are abundant microorganisms present in the organic materials that hasten decomposition and produced high volume of organic fertilizer.

Natural composting, vermicomposting and urea applied composting follow each other in yield and decomposition rate but no significance difference. These could be attributed to less microbial activity during the decomposition process of these treatments. Manaig [10] even concluded that decomposition efficiency depends on the substrate materials used as

these had different characteristics that differ from other substrate materials that could influence on the decomposition activity of the agents used in the composting methods. This could be the reason of low decomposition rate from natural composting, vermicomposting and urea applied composting.

Table 1. Comparison among means of different composting methods in terms of weight and decomposition rate.

Treatments	Weight (kg)	Decomposition Rate (%)
Natural Composting	11.31b	56.56b
Urea Applied Composting	10.56b	52.81b
IMO Applied Composting	12.36a	61.81a
Vermi composting	10.81b	54.06b

Means with the same letters are not statistically different

Production Income, Profit and Cost Efficiency

It is necessary to compute production income, profit and production costs in producing organic fertilizers to measure its efficiency in producing organic fertilizer. These could persuade farmers to practice organic fertilizer production since low costs will incur while producing more yield that will result to high income.

Figure 3 shows the income, expenses and net income in producing organic fertilizers. It was shown that IMO applied composting had higher income due to high yield of organic fertilizer with Php 247.25. It was followed with natural composting, vermicomposting and urea applied composting with Php 226.25, Php 216.25 and Php 211.25 respectively. The sequence of having high income was based from the yield it obtained as shown in Figure 1. Price of the produced organic fertilizer was valued at Php 20.00 per kilograms based on the prevailing market price in the locality.

On the other hand, high costs was observed in vermicomposting of Php 259.00 followed by IMO applied composting of Php 217.00, urea applied composting of Php 155.4. Natural composting had low expenses amounted to Php 147.00. High costs in vermicomposting was due to earthworms that were bought in the nearby source in the community and was valued at Php 80.00. IMO applied composting

valued the IMO production costs at Php 50.00. Urea applied composting valued urea that was bought in the agricultural store at Php 6.00. Natural composting follows the natural process of decomposition and no additional costs incurred. Rice straws and sheep manure were valued at 5 pesos per kilograms. Other costs are mostly labor costs in the production of organic fertilizers.

Net income was computed by subtracting the income to total expenses incurred in the production of organic fertilizers. Net income or profit is the money gained by the farmers after selling the organic fertilizers minus the expenses incurred during the production. Natural composting has a high profit gained of Php 79.25 followed by urea applied composting with Php 55.85 and IMO applied composting with Php 30.25. Negative profit was recorded in vermicomposting with (Php 42.25). Natural composting did not buy any decomposing agents and just rely on the natural process of decomposition having a high positive profit. Vermicomposting, IMO applied composting and urea applied composting used decomposing agents where vermicomposting had high costs incurred in buying earthworms having a negative profit followed by costs in producing IMO and then urea. However, earthworms will perpetuate and there is a possibility of low expenses incurred in the long run of production. Same will happen to IMO applied composting in the long run production of organic fertilizers.

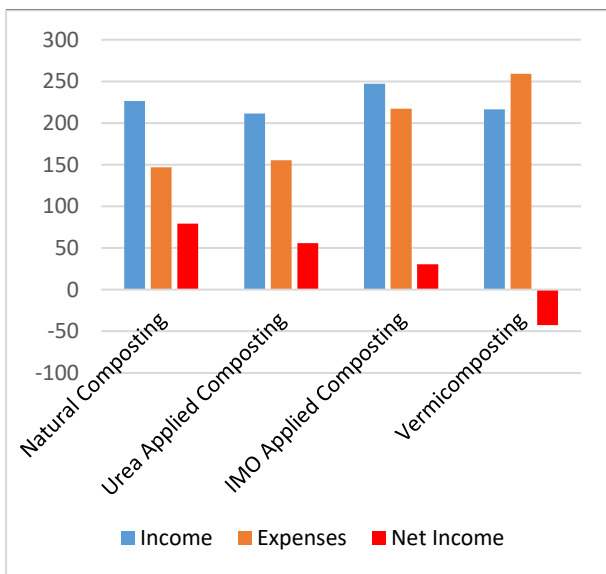


Figure 3. Production income, costs and net income in producing organic fertilizers at different composting methods

Production costs efficiency was computed by dividing the costs to the yield of organic fertilizers produced. This is to determine of which among the four composting methods could maximize its production at low expense in the production. Figure 4 shows that among the four composting methods, vermicomposting spent Php 23.96 to produce one kilogram of organic fertilizer. However, natural composting needs to spend Php 13.00 to produce one kilogram of organic fertilizer. IMO applied composting and urea applied composting have to spend Php 17.61 Php 14.74, respectively to produce one kilogram of organic fertilizer. Low production costs mean that small resources have been maximized to produce one kilogram of organic fertilizer product while high production costs mean that more resources are utilized for the production of organic fertilizers.

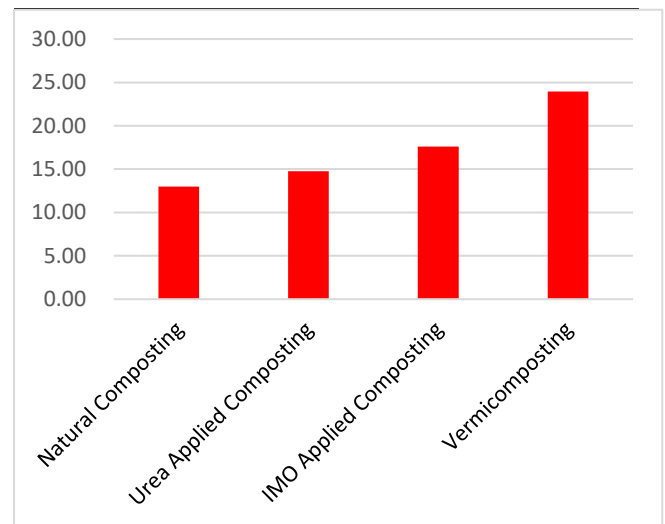


Figure 4. Production cost efficiency of four composting methods

Indigenous microorganisms (IMO) applied composting resulted to a significant increase in income compared to other composting methods as shown in table 2. Higher gross income was realized in IMO applied composting due to high decomposition rate resulted to high yield. However, natural composting exhibited higher profit and outstanding production costs efficiency compared to urea applied composting, IMO applied composting and vermicomposting. Natural composting did not apply decomposing agents having lower expenses with a production costs efficiency of Php 13.00 to produce one kilogram of organic fertilizer. Vermicomposting, on the other hand, shows negative

profit due to high costs in buying the earthworms having a production efficiency of Php 23.96.

Table 2. Income, costs and profit of four composting methods.

Treatments	Income	Profit	Efficiency
Natural Composting	226.25b	79.25a	13.00a
Urea Applied Composting	211.25b	55.85b	14.74b
IMO Applied Composting	247.25a	30.25c	17.61c
Vermi composting	216.25b	-42.75d	23.96d

Means with the same letters did not differ significantly

CONCLUSION AND RECOMMENDATION

Composting is a process where organic materials undergone into decomposition and produces the stable product humus commonly called as organic fertilizer. The quality of organic fertilizer varies with the intricacy of the composting methods, availability of the substrates and capability of the farmers. Different composting methods have been introduced to farmers. Vermicomposting is mostly introduced and widely researched based on the number of researches. Other farmers practiced IMO to the organic materials for decomposition while others determine the species of microorganisms that enhance the fertility of the soil. Urea is used to fortify the nutrient content of the organic materials and others used as supplementation to the organic fertilizer applied. Lastly, natural composting is used by the farmers who wanted a simple way of composting the organic materials.

Composting methods offer a wide benefits to the farmers and the environment. The increase in price of commercial fertilizer input paves the way of organic fertilizer as an alternative source of soil nutrient. It also gives importance to achieve the great potential for resource efficiency in addressing soil health and biodiversity [11]. Improper waste disposal will be addressed by waste treatment methods like composting to avoid piling up of biodegradable waste materials that will cause environmental hazards [9].

In this study, different parameters were determined like yield, decomposition rate and economic viability in producing organic fertilizers comparing the four composting methods. In terms of

yield and decomposition rate, IMO applied composting resulted to significant volume of organic fertilizer produced compared to the three other composting methods. As mentioned by Manaig [10], the efficiency of producing compost depends on the substrate materials used during the decomposition process. This statement could be the reason of no significance difference in decomposition rate of three composting methods as rice straw and sheep manure substrate did not favour the process. IMO applied composting also resulted to significant income due to high production. However, natural composting resulted to significant profit among the other composting methods due to low costs incurred in the process and it also has the low production cost, where Php 13.00 is needed to produce one kilogram of fertilizer. High production costs incurred by urea applied, IMO applied and vermicomposting were attributed to the costs of decomposing agents applied to the substrates.

It is suggested to use natural composting in short run production as it provides high return and has low production costs. However, it is also advised to explore the effectiveness of IMO applied and vermicomposting in the long run production of organic fertilizer to determine its viability in profit maximization by reducing production costs. Initial set-up for vermicomposting and IMO composting entail capital as earthworms and inputs in making IMO solution need to be bought. This procurement activity gives the method a high production costs but forecasted to incur low production costs in the long run of production as these materials are already present and the organisms perpetuated.

Results of decomposition rate ranges from 52 to 62% in just two months and recommended to extend the composting beyond two months to see higher percentage results. There is a need to explore the different combination of substrate materials as these influence the efficiency of composting. And lastly, there should be a proximate analysis on the nutrient content especially nitrogen, phosphorus and potassium on the compost product to determine the effectiveness of the decomposing agents in improving the nutrient status of the substrate material.

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