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Comparison of Vermicompost and Vermiwash Bio-Fertilizers from Vermicomposting Waste Corn Pulp

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Abstract**—**Vermicomposting is the conversion of organic waste into bio-fertilizers through the action of earthworm. This technology is widely used for organic solid waste management. Waste corn pulp blended with cow dung manure was vermicomposted over 30 days using *Eisenia fetida* earthworms species. pH, temperature, moisture content, and electrical conductivity were daily monitored. The feedstock, vermicompost and vermiwash were analyzed for nutrient composition. The average temperature and moisture content in the vermi-reactor was 22.5◦C and 42.5% respectively. The vermicompost and vermiwash had an almost neutral pH whilst the electrical conductivity was 21% higher in the vermicompost. The nitrogen and potassium content was 57% and 79.6% richer in the vermicompost respectively compared to the vermiwash. However, the vermiwash was 84% richer in phosphorous as compared to vermicompost. Furthermore, the vermiwash was 89.1% and 97.6% richer in Ca and Mg respectively and was 97.8% richer in Na salts compared to the vermicompost. The vermiwash also indicated a significantly higher amount of micronutrients. Both bio-fertilizers were rich in nutrients specification for fertilizers.

Keywords**—**Vermicompost, vermiwash, nutrient composition.

I. Introduction

VERMICOMOSTING technology is the decomposition of organic waste into nutrient rich vermicasts through the combined action of earthworms and microorganisms by which the earthworms also increase in number, size and weight [1], [2]. Vermicomposting technology has been recently applied to waste corn pulp blended with cow dung manure as feedstock as a solid waste management [1]. Vermicasts produced from vermicomposting are reported to be rich in nitrogen (N), phosphorous (P), potassium (K), and heavy metals [1]-[4].

Furthermore, another by-product from the vermicomposting process, which is the leachate, has also been reported to be rich in NPK composition [2], [4], [5]. This leachate is also termed vermiwash and is brownish in color [6]. The vermiwash is formed due to the movement of water in the worm bin from the increased moisture content due to the heat generated during the vermicompost process. This water absorbs the earthworm body secretions, enzymes, plant growth hormones and other nutrients from the organic waste to form the vermiwash which can be easily absorbed by plants [4], [5]. Nitrogen (N), phosphorous (P), and potassium (K) are the primary (macro) nutrients found in any fertilizer [7]. The nitrogen is necessary for promoting growth of leaves and stems. In addition, nitrogen gives plants their dark color and improves the quality of foliage [7], [8]. Phosphorous stimulates plant growth, flower development and plant maturity [7], [8]. Lastly, potassium increases the plant's disease resistance and vigor, water usage efficiency and improves the quality of seed and fruit [2], [7], [8].

Fertilizers also contain secondary nutrients which include calcium (Ca), magnesium (Mg), and sulfur (S). These are required in little amounts as compared to the primary nutrients but are also critical in plant development [7], [8]. Ca improves nitrogen metabolism, reduces plant respiration, and promotes microbial activity. Mg is the major element in chlorophyll production; it also enhances the utilization and mobility of phosphorous and also acts as an activator for many plant enzymes. S forms the integral part of amino acids, aids in seed production and is also essential in chlorophyll formation.

Furthermore, fertilizers contain micronutrients which include iron (Fe), copper (Cu), zinc (Zn), Boron (Bo), Molybdenum (Mo), Manganese (Mn), and Chlorine (CI). These are required in small amounts by the plants are equally important for plant development as the primary or major nutrients [7], [8]. Fe promotes formation of chlorophyll, acts as an oxygen carrier promotes reactions that involve cell division and growth. Cu acts as a catalyst for plant processes, increases the carbohydrate content in plants, promotes color intensity, and also improves the flavor of fruits and vegetables. Zn promotes the growth of plant hormones and enzyme system and also aids in seed formation. Bo promotes plant maturity and is essential for seed and cell wall formation. Mo is essential for the conversion of inorganic phosphates to organics forms in the plant. Mn functions as part of certain enzyme systems and aids in chlorophyll synthesis. Lastly CI promotes maturity of small grains.

This study focused on the comparison of two bio-fertilizers which are vermicompost and vermiwash obtained from vermicomposting waste corn pulp blended with cow dung manure. This technology was employed as a solid waste

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management technology. Corn pulp is the major staple food in Southern Africa and it constitutes about 54 tons per annum of the total organic waste disposed of per annum in Zimbabwe [1]. However, the comparison of these nutrients in vermicompost and vermiwash from waste corn pulp as the feedstock in vermicomposting are still yet to be understood. In this work, the physicochemical properties of the vermicompost and vermiwash were compared. In addition, the primary, secondary and micronutrient composition of the two bio-fertilizers were compared.

II. Materials and Methods

A. Materials

Waste corn pulp from the Institute Canteen was blended with cow dung from a nearby farm in the ratio 6:1. A total of 7kg was used as feedstock. The feedstock was placed in a vermi-reactor and vermicomposted for 30 days. 200g of *Eisenia fetida,* an epigeic species of earthworms were added into the feed at day 1 so as to start the vermicomposting process. The vermi-reactor used in this work had three chambers and was obtained from Full Cycle, South Africa (see Fig. 1). The vermi-bin was made of plastic and had pores to allow migration of earthworms from one chamber to the next. The detailed description of the vermi-bin is given by Manyuchi et al., [1].

Fig. 1 Vermi-bin used during the vermicomposting process

B. Methods

The pH and electrical conductivity were measured by the Hanna Instrument. The pH was determined daily by measuring 5g of the vermicompost which was then mixed with 10ml deionized water and allowed to settle for ten minutes for determination of the pH. For the vermicompost electrical conductivity, 5g of the vermicompost was mixed with 10ml of deionized water and allowed to settle for 10 minutes before measurement. Moisture content was determined daily by taking 5g of the vermicompost and heating it to 105◦C for 5 minutes. An alcohol thermometer was used for daily temperature determination in the vermicompost during the 30 day vermicomposting period. The vermicompost was harvested from the worm bin at day 30. *Eisenia fetida* worms were transferred to other vermi-bins to initiate the vermicomposting processes. An average of 80mls of the vermiwash was collected daily and was transferred to a 10L tank for storage under standard room conditions.

Primary, secondary, and micronutrients composition in the vermicompost and vermiwash were determined at the beginning of the vermicomposting period in the feedstock and at day 30 in the vermicompost and vermiwash. Nitrogen, phosphorous, secondary and micronutrients in the vermicompost and vermiwash were determined by the Shimadzu 1800 ultraviolet visible light spectrophotometer. The potassium content was determined by the Shimadzu AA 7000 atomic absorption spectrophotometer.

III. Results and Discussions

The feedstock was characterized to determine its nutrient composition and the results are indicated in Table I. The same nutrient composition was identified in vermicompost feedstock containing cow dung and grass clippings by Ansari and Sukhraj [10].

TABLE I
Characterization of the Feedstock Nutrient Composition

Nutrient	Feedstock composition
N	2.64%
K	5.01%
Ca	13.23ppm
Na	3.01ppm
Mg	2.36ppm
Cu	0.44ppm
Fe	145.67ppm
Mn	1.53ppm
Mn	1.53ppm

A. Physicochemical Characteristics of the Vermicompost and Vermiwash

The odorless brown vermicompost obtained (see Fig. 2) had an average moisture content of 42.5% and temperature of 22.5◦C during the vermicomposting period. The odorless brown vermiwash obtained (see Fig. 3) had a density of 984 kg/m^3 and viscosity of 1.089cP at 17◦C.

Fig. 2 Vermicompost obtained from waste corn pulp blended with cow dung manure

Fig. 3 Vermiwash obtained from waste corn pulp blended with cow dung manure

pH is a measure of the hydrogen ion concentration in a solution. The pH slightly increased in both the vermicompost and vermiwash to about day 21 and started to decrease at day 30. In average, the vermicompost had a higher pH as compared to the vermiwash. The vermicompost had an average pH of 7.13 whereas the vermiwash had a slightly basic pH of 8.0. The trend in the pH and electrical conductivity results are in agreement to Nath et al., [9], who indicated a higher pH of 6.12 in the vermicompost as compared to 7.11 in vermiwash.

Electrical conductivity is a measure of the total dissolved salts in a substance. The electrical conductivity showed a general decrease in both the vermicompost and vermiwash throughout the vermicomposting period. This can be explained due to increased moisture content in the vermi-reactor as the vermicomposting period increased affecting both the conductivity in both bio-fertilizers [1]. The electrical conductivity was 24.9% higher in the vermicompost compared to the vermiwash. The vermicompost had an average conductivity of 70,320µS/cm whilst the vermiwash had an average conductivity of 52,843µS/cm. The pH and electrical conductivity results are in contradiction to the work of Quaik et al., [2], who observed a higher pH and electrical conductivity in the vermiwash compared to the vermicompost obtained from cow dung manure.

B. Primary Nutrients Composition in Vermicompost and Vermiwash

The nitrogen and potassium content was 57% and 79.6% higher in the vermicompost as compared to the vermiwash respectively (Fig. 4). However the phosphorous content was 84% higher in the vermiwash compared to the vermicompost (Fig. 4). Ansari and Sukhraj [10] had the same observation with a 98% and 92% difference in the nitrogen and potassium content respectively. However, they also indicated a 90% higher phosphorous content in the vermicompost compared to the vermiwash.

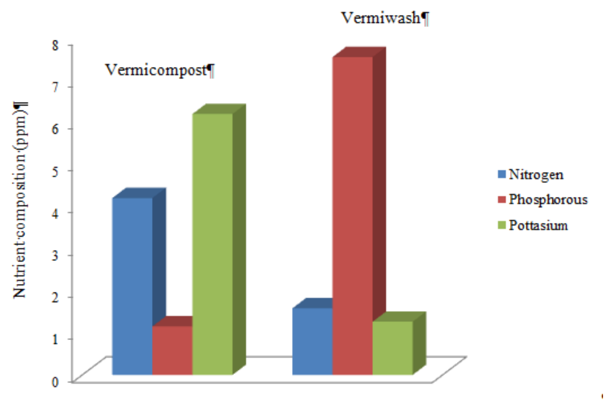

Fig. 4 Primary nutrients composition in vermicompost and vermiwash

C. Secondary Nutrients Composition in Vermicompost and Vermiwash

No sulphur was detected in both the vermicompost and the vermiwash. Ca was 89.1% higher in vermiwash as compared to vermicompost (Fig. 5). Furthermore, the Mg content was 97.6% higher in vermiwash as compared to vermicompost (Fig. 5). Ansari and Sukhraj [10] detected no sulphur in the two bio-fertilizers and also indicated a 4% higher Mg content in the vermiwash compared to the vermicompost. However, their Ca content was 40% higher in the vermicompost than the vermiwash.

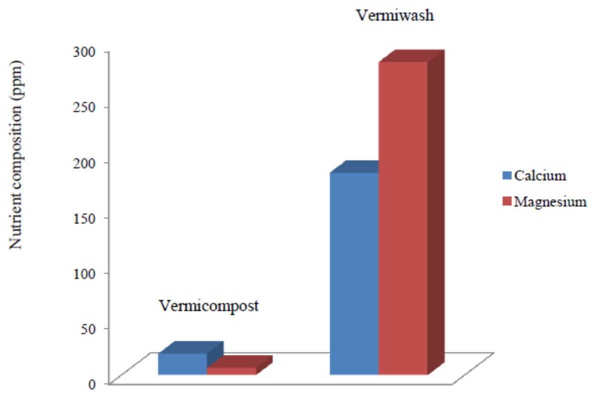

Fig. 5 Secondary nutrients composition in vermicompost and vermiwash

D.Micronutrients Composition in Vermicompost and Vermiwash

Four micro nutrients were identified in the vermicompost and vermiwash which are Cu, Fe, Mn and Zn. Bo, CI, and Mo were not identified in the bio-fertilizers (see Table I). The Cu, Fe, Mn and Zn were 98%, 100%, 98.8% and 74.1% richer in vermicompost as compared to vermiwash respectively (Fig. 6). Ansari and Sukhraj [10] observed the same results for Mn and Zn, however their Cu and Fe composition was higher with almost the same values in the vermiwash compared to the vermicompost.

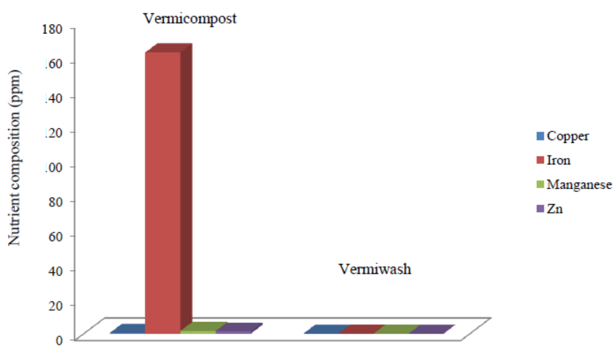

Fig. 6 Micro nutrients composition in vermicompost and vermiwash

E. Sodium Salt Content in Vermicompost and Vermiwash

Both the vermicompost and vermiwash contained some sodium (Na) salts. The Na content was 97.8% higher in vermiwash as compared to vermicompost. Na can stimulate plant growth and can be used as an alternative in cases where potassium is deficient. The same result was obtained by Ansari and Sukhraj [10] when they tested the bio-fertilizers from grass clippings and cow dung. The total available salts were 68% higher in the vermiwash compared to the vermicompost.

IV. Conclusion

Vermicompost and vermiwash bio-fertilizers were obtained from vermicomposting waste corn pulp blended with cow dung manure. The pH and electrical conductivity was higher in the vermicompost compared to the vermiwash. The nitrogen and potassium content were 57 % and 79.6 % higher in the vermicompost as compared to the vermiwash respectively. However, the phosphorous content was 84 % higher in the vermiwash as compared to the vermicompost. The vermiwash was 89.1% and 97.6 % richer in Ca and Mg as compared to the vermicompost. Furthermore, the vermiwash was 97.8% rich in sodium content compared to the vermicompost. However, the vermicompost was rich in micronutrients compared to the vermiwash.

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