International Journal of Eco-Agriculture and Sustainable Technologies
Volume1, Issue1, 2025

Quality evaluation of the physicochemical characteristics of vermiwash produced from various sources throughout time

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Research Article

Date of Submission: 25-10-2025 Date of Acceptance: 24-11-2025 Date of Publication: 29-12-2025

ABSTRACT

evaluation of the physicochemical characteristics of vermiwash produced from various sources throughout time in storage. Asian Journal of Agriculture 2: 52–57. In addition to preserving our health, organic farming is essential for increasing the amount and quality of crops produced using sustainable agricultural methods. Vermiwash has the potential to be one of the most important elements in organic farming and in lowering the massive levels of environmental contaminants. During a three-month storage period with monthly evaluations, the physicochemical properties of vermiwash from various sources (Jamun, Neem, and Grass combined with cow dung) were to be determined and compared to a fresh sample. Electrical conductivity (EC) increased in the first month but then decreased with time, with a significant difference ($p=0.05$) between the treatments after three months. Over the course of the storage time, total dissolved salts dropped, and significant differences between the treatments were noted. At $p=0.05$, the storage period showed that $F(7, 21) = 3.9>2.49$ Fcrit. and $F(3, 21) = 3.8>2.49$, respectively. Potassium rose, with T7 being the greatest, whereas phosphorus declined. Magnesium varied throughout the duration but died at the conclusion of the storage period, but calcium exhibited a significant difference ($p=0.05$) between the treatments. The ferrous content analysis showed a significant difference ($p=0.05$, $F(7, 21) = 3.8>2.48$ Fcrit.) and a significant difference ($p=0.05$, $F(3, 21) = 6.8>3.0$) with an increase at the conclusion of the storage period. Since the overall nutritional content deteriorates with time, it is recommended to utilize fresh vermiwash to get the most nutrients.

Keywords: Cattle dung, vermicompost, micronutrients, organic materials, soil, vermiwash

INTRODUCTION

The negative effects of trash disposal are becoming more and more evident on a worldwide scale. Every day, a variety of waste products are created. Some are recyclable and valuable in several industries, including agriculture and other economic sectors. Bio-fertilizers made from organic waste are one example. We have been concerned about the disposal of organic waste from many sources, including home, agricultural, and industrial, since it creates an unsightly and harmful environment for the locals. For both urban and rural people, this leads to economic and environmental issues. In order to produce organic manure that is usable for agricultural purposes, it may be necessary to recycle organic waste (Aira et al. 2007; Ansari 2012). An increasingly popular method of recycling organic waste is composting, which increases food yield in an eco-friendly manner (Ansari & Jaikishun 2010; Ansari 2012). Numerous composting methods provide answers for the organic waste generated on a daily basis. One such method is vermicomposting, which not only lowers organic waste but also encourages more economical, efficient, and ecologically friendly agricultural growth (Ismail 2005; Ansari 2012; Manyuchi et al. 2012). Vermicomposting is the process of creating compost using earthworms, which typically reside in the soil, consume biomass, and expel earthworm cast. The organic substrates are broken up by the earthworms, which also greatly boost microbial activity and accelerate mineralization. According to Domínguez (2004), Ismail (2005), Ansari (2012), and Manyuchi et al. (2012), vermicompost is a finely split peat-like substance with exceptional structure, porosity, aeration, drainage, and moisture-holding ability. Vermiwash is a liquid fertilizer that may be applied as a foliar spray and is obtained when water passes through a worm action column (Ismail 2005; Ansari 2011).The tree known as jamun (Syzygium cumini (L.) Skeels) is widely distributed in Guyana. It is a member of the Myrtaceae family. This tree has lanceolate and whole leaves. 9.1% crude protein, 4.3% fat, 17% crude fiber, 1.3% calcium, and 0.29% phosphorus make up the leaves. It is said that the leaves have therapeutic qualities (Datta 1969). An additional beneficial food source for earthworms is neem (Azadirachta indica A. Juss). It is a member of the Meliaceae family. Earthworms benefit from neem. Earthworm populations in greenhouse potting soil were boosted by neem leaves and seed kernels. Nutrient-rich neem also helps earthworms grow fatter. In contrast to vermicomposting utilizing mango leaves, another research revealed that vermicomposting neem is completed at a high pace because the earthworm densities are quite large (Datta 1969). Earthworms provide organic carbon, nitrogen, inorganic phosphorus, potassium, and magnesium to the soil via their excreta, also known as worm castings. (Picón and Teisaire 2012; Ansari 2011; Hendrix and Bohlen 2002). Vermiwash, a liquid that is collected when water passes through a column of soil that has been manipulated by worms, is a highly helpful foliar spray. It is a mixture of earthworm excretory and secretory products, soil organic molecules that are beneficial to plants, and soil micronutrients. Additionally, vermiwash has modest biocidal properties (Ansari 2012). Vermiwash is mostly composed of magnesium, chloride, calcium, organic carbon, nitrate, nitrogen, phosphorus, and carbon. Vermiwash also contains proteins, lipids, amino acids, and carbohydrates (Ansari and Jaikishun 2010; Sundaravadivelan et al. 2011; Ansari 2012).

MATERIALS AND METHODS

Materials

Vermiwash units were installed at the biology lab of the University of Guyana's Faculty of Natural Sciences. Before being added to the vermiwash unit, the mature leaves—grass clippings, neem, and jamun leaves—were gathered from the university campus and allowed to air dry fully. NARIE (National Agricultural Research and Extension Institute, Guyana) provided the cattle dung. Vermiwash underwent chemical analysis at the Central Laboratory of the Guyana Sugar Corporation. The biological lab at the University of Guyana was used to turn vermiwash into powder and store it.

Procedures

Nine buckets were used to set up the vermiwash unit. To make collecting easier, the buckets were set on a pedestal and secured with taps about an inch from the bottom. Each bucket had a 25 cm layer of coarse sand at the bottom, followed by a 25 cm layer of shattered pebbles. The basic filter bed was then allowed to settle by allowing water to pass through these layers. The filter bed was covered with a layer of loamy soil that was 20–30 cm thick. Twenty-five earthworms were added to the soil in each of the eight containers. The soil in the buckets containing the earthworms was covered with 150g of cattle dung and a total of 75g of specific organic materials (Control: Cattle dung, T1: Grass clippings, T2: Neem leaves, T3: Jamun leaves, T4: Grass clippings + Neem leaves, T5: Neem + Jamun leaves, T6: Grass clippings + Jamun leaves, T7: Grass clippings + Neem + Jamun leaves). To keep the earthworms wet, the units were emptied and watered every two days. Each month, certain amounts of organic material were introduced and units were tracked (Ansari and Jaikishun 2010; Ansari 2012).

Collection and storage of vermiwash

Three hundred milliliters of vermiwash were collected during four months of unit setup and maintenance. The gathered vermiwash was put into identically sized bottles and kept in a dark, dry, and cold location. To ascertain its efficacy, storage was conducted over a three-month period. Each month, vermiwash made from various organic sources was collected and preserved. The physicochemical characteristics of vermiwash were measured every month and included pH, electrical conductivity, total dissolved salts, turbidity, nitrogen, accessible phosphate, potassium, exchangeable calcium, exchangeable magnesium, iron, and manganese (Homer 2003; AOAC 2012).

RESULTS AND DISCUSSION

After three months of storage, a drop in electrical conductivity (EC) was observed. For the third month of storage, T1 was shown to exhibit a drop with a little rise. Similar to T5, T2 showed a notable rise in the first month before declining in the second and third months. In the second and third months, T4 increased, but in the last month, it fell. Nonetheless, electrical conductivity increased in treatments 3 and 7, with a notable rise in T7. The mix of organic material employed increased the amount of ions in the sample, which led to an increase in T7 (Figure 1). Anova Two-Factor without replication analyses for EC across treatments and time showed a significant difference with $p=0.05$, $F(7, 21) = 3.7>2.49$ Fcrit, and $F(3, 21) = 3.5>3.1$ Fcrit, respectively. Najar and Khan (2010) speculate that the rise in EC may have resulted from the release of several mineral salts in readily accessible forms, including potassium, ammonia, and phosphate, as well as the weight loss of organic waste. Additionally, an increase in ions causes a solution's electrical conductivity to rise. The conductivity of the solution increases with the amount of dissolved solids present. This occurs as a result of the solids dissolving into ions that are both positively and negatively charged and electrically conductible in proportion to their concentration. The foundation for identifying the presence of solids like potassium, magnesium, calcium, etc. in a solution is electrical conductivity. The lower EC might indicate that the vermiwash samples have less soluble particles, such as salts (ions). The increased rate of organic matter loss and the resulting release of various minerals and salts might be the cause of a drop in EC (Chauhan and Singh 2012). Three months later, the pH has increased (Figure 2). It is evident that the control saw a rise in the first month, followed by a slow decline in the second. While the pH of T1, T2, T4, T5, T6, and T7 gradually increased over the course of the three months, T3's pH increased during the first month and then decreased after the first and second months. In the form of nitrogenous feces, earthworms provide a variety of nutrients. For sample pH across treatments and time, Anova Two-Factor without replication analysis revealed a significant difference with $p=0.05$, $F(7, 21) = 4.6>2.48$ Fcrit, and $F(3, 21) =$

4.9>3.1 Fcrit, in that order. Najar and Khan (2010) claim that the breakdown of ammonia, which makes up a significant amount of the nitrogenous materials expelled by earthworms, is the cause of the pH rise over time. The pace at which chemicals dissolve and are absorbed is controlled by pH. One of the most crucial soil properties is its pH. characteristics that impact nutritional availability. Micronutrients are often less accessible in high pH soils, whereas macronutrients are generally less available in low pH soils. Therefore, in order to facilitate nutrient absorption, vermiwash must have a pH when applied to soils (Domínguez 2004; Ansari and Rajpersaud 2012; Degefe et al. 2012). Following three months of storage, a general decline in the total dissolved salts in vermiwash was seen. Overall, T1 and the control exhibited a decline, while the remaining samples showed a rise after the first month and a subsequent decline in the second month. T4 did, however, exhibit a significant rise in the second month and a subsequent decline in the third. The third month saw a significant rise in T7. Overall, the amount of total dissolved salts decreased, however there were varying variations in the content (Figure 3). Given the connection between electrical conductivity and total dissolved salts, a drop in TDS might be the result of a higher rate of organic matter loss. And as a result, various mineral salts are released. Anova Two-Factor without replication tests for TDS across treatments and time showed a significant difference at p=0.05, with F (7, 21) = 3.9>2.49 Fcrit. and F (3, 21) = 3.8>2.49, respectively. Dissolved ionic minerals are included in TDS, which are the inorganic dissolved solids in a liquid. Both cations (such magnesium, calcium, iron, nitrogen, and potassium) and anions (like phosphates, fluorine, and chlorine) are crucial components. Plant photosynthesis may decline as a result of an increase in total dissolved salts (Datta 1969; Jensen 1999; Domínguez 2004; Degefe et al. 2012). After three months, the vermiwash's overall turbidity increased. Nonetheless, a typical pattern of turbidity decreasing in the first month and then increasing in the second and third months was seen. Despite the general rise in turbidity, there was variation for the samples (Figure 4). At p=0.05, an Anova Two-Factor without replication analyses for turbidity among the treatments and time showed that F (7, 21) = 2.6>2.5 Fcrit. and F (3, 21) = 4.1>2.2, respectively, had a significant difference. This suggests that more insoluble substances are released over time and across the various treatments. Turbidity and water reduction may result from suspended particulates in a liquid (Tiwari 2015).

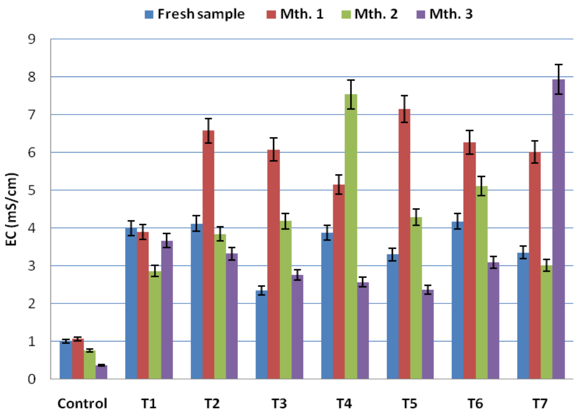

Figure 1. Effect of storage period on the Electrical conductivity

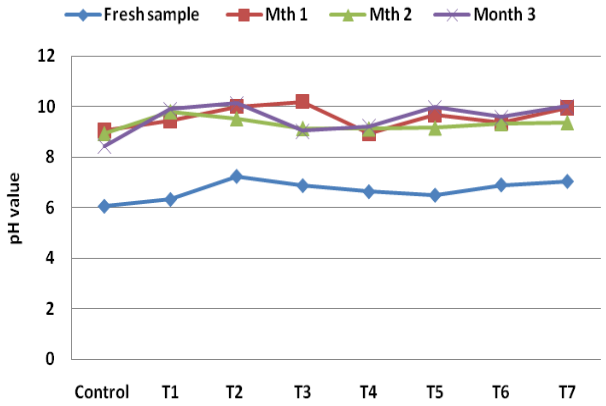

Figure 2. Effect of storage period on the pH of vermiwash

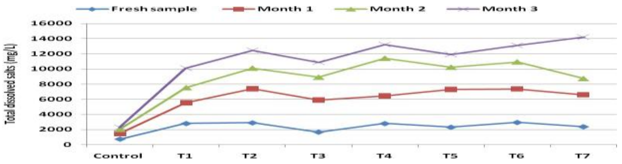

Figure 3. Effect of storage period on the Total Dissolved Salts (TDS)

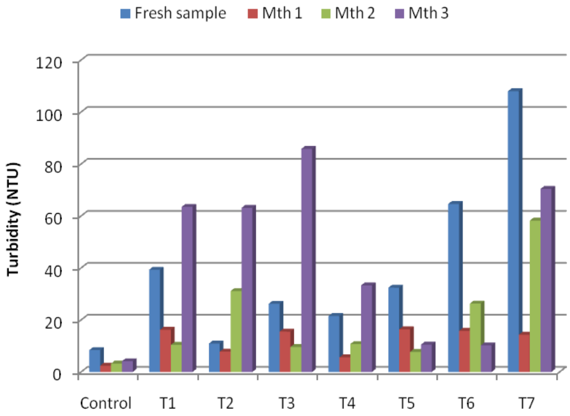

Figure 4. Effect of storage period on the turbidity of vermiwash mixture

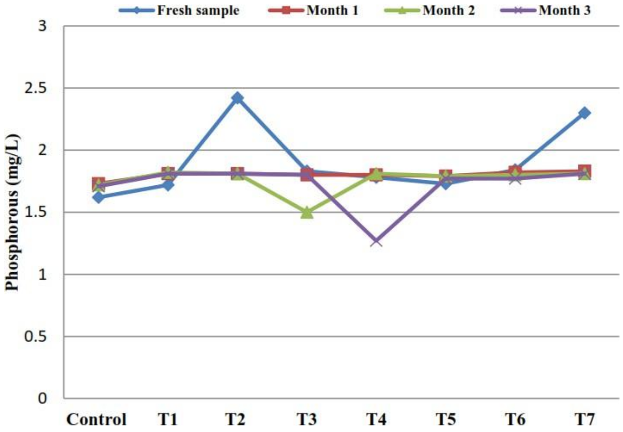

Figure 5. Phosphorous content of vermiwash during the storage period

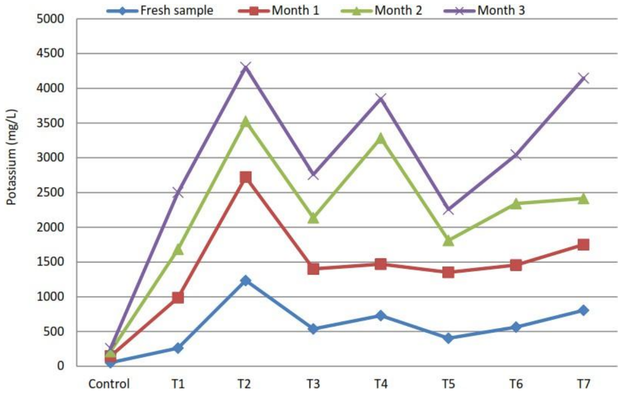

Figure 6. Potassium content during the storage period

Over the course of the three months, the total phosphorous content dropped for most of the treatments. Phosphorus levels in the control group progressively rose after the third month before somewhat decreasing. The potassium content in T2, T3, T4, and T6 exhibited a fluctuating pattern; nevertheless, a decrease was seen after three months of storage for the vermiwash. However, T1 and T5 showed a little increase after the third month (Figure 5). The Anova Two-Factor without replication analyses for P between the treatments and the three-month period revealed no significant difference, with p=0.05, F (7, 21) = 1.5<2.48 Fcrit, and F (3, 21) = 1.8<3.1, respectively. Likewise, amount of K in the T1, T3, T5, T6, and T7 units, but by the end of the three-month period, there was an overall increase. K concentrations rose considerably in T1 and T5, but very slightly in T3 and T6. T7's potassium content significantly rose as a result of using all organic components, whereas the potassium level in the control group dropped. However, K typically rose (Figure 6). Anova Two-Factor without replication analyses revealed a significant difference (p=0.05, F (7, 21) = 4.0>2.48 Fcrit.) in K among the treatments, although an insignificant difference (p=0.05, F (3, 21) = 0.9<3.12 Fcrit.) was seen over time. Earthworm-processed waste material exhibited a high concentration of exchangeable potassium due to enhanced microbial activity throughout the vermicomposting process, which in turn improved the rate of mineralization (Nath et al., 2009). The high potassium content is caused by the cast of earthworms and the profusion of symbiotic bacteria in the stomach, which work together to generate mucus and water. The breakdown of ingested organic components may quicken as a consequence of the release of accessible metabolites. The exchangeable potassium enrichment of the vermiwash was enhanced by these metabolites. The decrease in potassium in T2 and T4 may be due to leaching of this soluble element after the application of water for collection (Ansari and Rajpersaud 2012; Chauhan and Singh 2012; Degefe et al. 2012). Overall, the control group's calcium content dropped. Overall, samples T1, T2, T4, T5, and T6 had higher calcium concentrations. T1 and T2 showed a steady drop, whilst T4 and T5 showed a considerable increase for months 1 and 2, followed by a significant reduction for the third month. The value of T6 varied, although it declined following the previous month. The calcium concentration rose in the third month, despite variations in the T3 and T7 levels as well. Anova Two-Factor without replication analysis for Ca across the treatments revealed a significant difference (p=0.05, F (7, 21) = 3.3>2.48 Fcrit.) but no significant change with time (p=0.05, F (3, 21) = 2.8>3.0 Fcrit.). Najar and Khan (2010) state that gastrointestinal processes linked to calcium metabolism are thought to be the primary source of the elevated inorganic calcium content in worm cast. A percentage decrease in calcium might be caused by leaching of this soluble element by the excess water drained through for collection {Table 1} (Domínguez 2004; Najar and Khan 2010; Degefe et al. 2012). All of the samples showed an overall percentage increase in magnesium. Although there were erratic variations for the control, a final drop in magnesium level was noted. For the first month, every sample—aside from T1—showed a significant rise. However, the second month saw a decline, while the third month saw a rise. However, following the third month, the magnesium concentration decreased rather than increased in T3, T4, and T5 (Table 1). Mg among the treatments showed a significant difference (p=0.05, F (7, 21) = 5.7>2.48 Fcrit.) according to Anova Two-Factor without replication studies, and the duration also showed a significant difference (p=0.05, F (3, 21) = 8.12>3.0 Fcrit.). The transformation of this mineral into a form that plants can use during transit through the earthworm's digestive tract may be the cause of the rise in magnesium (Najar and Khan 2010; Ansari 2011; Degefe et al. 2012).All of the treatments showed an overall increase in iron, however after the third month, T5 showed a decline in comparison to the fresh sample. All of the treatments showed varying changes, but the Fe content eventually increased. The period was considerably different (p=0.05, F (3, 21) = 6.8>3.0), and the Anova Two-Factor without replication analysis for Fe across the treatments showed a significant difference (p=0.05, F (7, 21) = 3.8>2.48 Fcrit.). One essential factor required for the production of chlorophyll is iron (Fe) (Quaik et al. 2012). It was discovered that vermiwash made from several organic sources—such as jamun, neem leaves, grass clippings, and cattle dung—was quite effective at providing the essential macro and micronutrients. Excellent levels of the nutrients necessary for healthy plant growth and development were shown by physicochemical analysis of the various treatments. Plants can readily access and use the macro and micronutrients included in vermiwash. Previous studies have shown this. Two earthworm species were used to create vermiwash from various leaf litters in order to determine its physicochemical, nutritional, and biochemical characteristics. In addition to providing vital nutrients for plants, vermiwash is also very effective in providing carbohydrates, proteins, lipids, and amino acids—all of which are critical for plant development (Ansari 2008; Ansari and Sukhraj 2010; Sundaravadivelan et al. 2011; Manyuchi et al. 2012). As a result, the quality of the vermiwash generated varied depending on the leaf litter but improved with the length of vermicomposting. Depending on the species and kind of material consumed, earthworms may digest nutrients, such as energy, from a variety of sources with varying degrees of efficiency. The utilization of organic materials derived from plants and animals, which may be very effective in terms of nutritional quality, may also contribute to the quality of vermiwash. It has been shown that an excellent source of nutrients to increase agricultural production is the organic, degradable waste from plants and animals (Domínguez 2004; Ansari 2011; Sundaravadivelan et al. 2011; Degefe et al. 2012). In conclusion, it is also evident that vermiwash performs at its peak during the first month, but with time, the quality declines. Vermiwash's physicochemical characteristics include a high mineral content and key elements in the requiredamounts that might be easily accessible for the development of plants. It is evident from the quality of vermiwash made using leaf litter from three distinct plants—grass, jamun, and neem—that food quality has a significant impact on vermiwash potential. The kind and grade of organic material utilized may have an impact on the vermiwash's quality. It has been shown that organic, biodegradable waste from plants and animals is a valuable source of nutrients to increase production. Because the nutritional content of vermiwash is enough for plant development and concurrently promotes favorable environmental qualities, it may be very effective in organic farming.

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