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Research Article

ESTIMATION OF PHYSICO-CHEMICAL PARAMETERS OF DIFFERENT COMBINATIONS OF BUFFALO DUNG WITH CANE SUGAR BAGASSE BY VERMIC ACTIVITY OF EARTHWORM *LAMPITO MAURITII*

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ABSTRACT

Overpopulation, pollution, industrialization, and urbanization are the main contributors to environmental deterioration and the production of solid waste. There are many ways to reduce the amount of organic waste that is disposed of in landfills. This covers vermicomposting, recycling, and composting of organic materials. With the aid of earthworms, vermicomposting is one of the most effective, affordable, and environmentally sustainable ways to turn organic wastes into high-quality manure. This study is aimed to investigate the physico-chemical alterations of sugarcane bagasse mixed with various combinations of buffalo dung following the processing of the earthworm *Lampito mauritii*. After vermic activity of *Lampito mauritii*, different combinations of sugarcane bagasse combined with buffalo dung showed a substantial decline in pH, EC, TOC, and C/N ratio and a significant rise in TKN, TK, TAP, and TCa when compared to the initial feed mixture. There was significant increase in total kjeldhal nitrogen (TKN) 46.25% in SCB+BD (1:1), total avilable phosphorus (TAP) 52.63% in SCB+BD (2:1), total potassium (TK) 35.13% in SCB+BD (1:1), total calcium (TCa) 52 % in BD and significant decreased in C:N ratio 69.74% in SCB+BD (1:1), total organic carbon (TOC) 54.82% in BD, electrical conductivity (EC) 54.16% in BD of final vermicompost with respect to initial feed mixture. The pH of initial feed mixture in all the combination tends to decrease. According to the findings, *Lampito mauritii* speed up the mineralization process and transformed manures into castings with increased nutritional content. These composts are suitable for use in agricultural fields since they have a low C: N ratio and high nutritional content, which will improve crop output.

Keywords: *Lampito mauritii*, Physico-chemical parameter, Sugarcane bagasse, Vermic activity.

INTRODUCTION

The management of organic waste is currently a major concern on a global scale because improper disposal of waste can have negative effects on the environment (Singh and Singh, 2023), including offensive odours, groundwater contamination, and the spread of communicable disease like cholera, malaria and tuberculosis in human (Sharholy *et al*., 2007; Arumugam *et al.,* 2017). Animal produce massive amounts of organic waste, which poses major issues for society. An enormously significant sector of the Indian economy is the sugar mill sector, which also produces a number of byproducts in addition to sugar. According to Duque *et al*. (2015), the world produces 175.1 million metric tonnes of sugarcane, and each tonne of processed sugarcane yields 280 kg of SCB (Restrepo-Serna *et al*., 2018). Sugarcane bagasse (SCB), a fibrous substance left over after the process of extracting sap from sugarcane straws, is one such addition (Zhang and Sun, 2016). Bagasse residue, press mud, and effluent utilization and disposal are frequently issues. In most cases, SCB acts as a structural regulator, controlling the water content and oxygen concentration by creating larger porous spaces in the vermicomposting mass. Other organic wastes in this category include industrial sludge and poultry manure (Sen and Chandra, 2007; Bhat *et al.,* 2014). Due to the enormous number of micropores and large surface area of SCB, it also absorbs and helps hold on to N, P, and other plant nutrients (Tsui and Juang, 2010).

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Vermicomposting is a viable method for converting organic waste into environmental friendly products. It is a bio-oxidative process that combines the work of bacteria with earthworms. A vermicomposting process is a viable and beneficial reusing method. Vermicompost has more enzyme activity, a better microbial population that benefits plants, more intense and efficient lignocellulose breakdown, and higher concentrations of humic acid and soluble main nutrients than standard compost products (Gong *et al*., 2018a). Earthworms significantly contribute to the improvement of soil fertility by enhancing the physical, chemical, and biological characteristics of the soil (Siddiqui *et al*., 2022; Singh *et al*., 2022). Worm castings are also beneficial for the fertility and health of the soil (Papafilippaki *et al*., 2015). Organic materials can be rapidly broken down into tiny, stable molecules that are readily absorbed by plants by the help of microorganisms and hydrolyzing enzymes released by the gut of earthworms (Gong *et al*., 2019).

Anecic earthworm *Lampito mauritii* is geophytophagous in nature and lives in the topsoil. *Lampito mauritii* is widely distributed in India in different agro-systems of Punjab, Rajasthan, Tamil Nadu, Pondicherry, Uttar Pradesh (Karmegam and Daniel, 2007; Tripathi and Bhardwaj, 2004). *Lampito mauritii* is resilient to a wide range of environmental conditions, including changes in soil moisture and temperature (Prakash, 2017). Anecic earthworms travel to soil layers with better conditions in order to avoid cold temperatures. About conditioning anecic species are ideal for organic waste from canteens, domestic, municipalities, farm etc. (Gergs *et al*., 2022). Previous studies have investigated the ecology and decomposition effectiveness of *Lampito mauritii*. Research has demonstrated that the organism *Lampito mauritii* can vermicompost a variety of organic wastes (Suthar and Singh, 2008).

Keeping in view of the above facts, the objective of this study was to assess the changes in the physico-chemical parameter of waste mixture; i.e sugarcane bagasse mixes with buffalo dung in various ratios, after the processing of the earthworm *Lampito mauritii*.

MATERIAL AND METHODS

Collection and rearing of the earthworm *Lampito mauritii*

The cultured earthworm, *Lampito mauritii* from the Vermiculture Laboratory of the Department of Zoology, Deen Dayal Upadhyay, Gorakhpur University, Gorakhpur were used for the experiment. In the laboratory vermibed were pepared by using garden litter with buffalo dung on a cemented surface for the experiment.

Collection of buffalo dung and sugarcane bagasse

Buffalo dung was collected from the farm houses located at different places of Gorakhpur. Cane sugar bagasse was collected from Pipraich sugar mill, Gorakhpur, U.P. Cane sugar bagasse was used for vermicomposting as well as feeding material for earthworms. For up to 10 days, these organic wastes were spread out in a layer and exposed to sunlight to get rid of the various harmful organisms and noxious gases (Garg *et al.*, 2005; Nath and Singh, 2009).

Experimental setup

A cemented earth surface was used for the experiment. Two kilograms of binary combination of buffalo dung and sugar cane bagasse in different ratio i.e. SCB+BD (1:1), SCB+BD (1:2), SCB+BD (2:1), SCB+BD (1:3), SCB+BD (3:1) as well as BD and SCB alone . The size of each vermibed was kept on 30 cm x 30 cm x 10 cm at room temperature in dark. The vermicomposting beds were turned over manually every 24 hours for 10 days in order to eliminate volatile substances. After this, 20 newly hatched ones of *Lampito mauritii* were introduced into each bed. After vermicomposting of 90 days, sample from each vermibed were collected again and composting was terminated because the residuals of bedding materials in the treatments had beed eaten up by *Lampito mauritii*. For further analysis the collected dried and homogenized samples were grind into fine particles. Each experiment was replicated at six times.

Chemical analysis

Using a 1:10 (w/v) double distilled water suspension of each sample that had been mechanically stirred for 30 minutes and filtered through Whatsmann No. 1 filter paper, the pH and electrical conductivity were evaluated, Total organic carbon was measured using the Nelson and Sommers method. The sample was digested using conc. H_2SO_4 and conc. $HClO_4$, (9:1 v/v), in accordance with Bremmer and Mulvaney's procedure (1982), and total khjeldahl nitrogen (TKN) was measured. Using molybdenum and sulfuric acid in a colorimetric analysis, total phosphorus was determined (Garg *et al*., 2005). By using a flame photometer, the total potassium was calculated.

Statistical Analysis

All experiments were replicated at least six times to ensure consistency in the results. Analysis of variance was used to determine the significant difference between the combinations; student's t-test ($P < 0.05$) was used to determine which bedding type was more homogeneous in terms of reproduction and growth from the control (Sokal and Rohlf, 1973).

RESULTS AND DISCUSSION

Table 1 showed how the pH value changed in the initial feed combinations as well as in the vermicompost made by combining sugarcane bagasse and buffalo dung through vermic activity. The maximum decrease in pH ranged from 8.5 ± 0.03 to 6.7 ± 0.02 (21.17%) was observed in combination of sugarcane bagasse with buffalo dung in the ratio of 1:2 whereas, the minimum significant decrease 6.6

± 0.02 to 6.2 ± 0.06 (6.06%) was obtained in the sugarcane bagasse (Table 1, Figure 1). According to Ndegwa *et al*. 2000, the mineralization of nitrogen and phosphorus into nitrites/nitrates and phosphate caused the pH of various mixes of feed material to fall. The pH drop that occurs during vermicomposting is also probably caused by the microorganisms' synthesis of CO_2, ammonia, and organic acid (Sharma *et al*., 2011). Due to the production of fulvic acid and humic acid, low pH in the finished product may also happen after processing earthworms (Chauhan and Singh, 2012). In comparison to the initial feed mixtures, the final EC of all the vermibed after *Lampito mauritii* processing was much lower (Table 1, Figure 1). Maximum decrease of 54.16 % (2.4±0.04 to 1.1±0.02) and minimum decrease of 40 % (2.0 ±0.06 to 1.2 ±0.02) were observed in buffalo dung and SCB+BD (1:3) respectively. According to Ansari and Rajpersaud (2012), The EC of the initial materials decreased significantly as the vermicomposting process continued until a lower EC was reached.

As compared to their initial level, the total organic carbon (TOC) in all vermibeds substantially decreased (Table 2, figure 2). According to Kaushik and Garg (2003) different industrial sludges undergo vermicomposting and loss 20-45% of their TOC in the form of CO_2. Earthworms are fed on organic matter and subjected to microbial degradation throughout the vermicomposting process. Maximum decrease of 54.82 % (510.9±0.26 to 230.8±0.23) and minimum decrease of 9.97% (550.6±0.24 to 495.7±0.25) were observed in buffalo dung and SCB respectively. Earthworms also have an impact on the nitrogen cycle alteration in manure, according to Umar and Sharif (2013), who also suggested that organic carbon loss may change as nitrogen levels are increased. During the vermicomposting of sugar mill sludge, Prakash and Karmegam (2010) and Bhat *et al*., (2014) have also noticed a decrease in TOC. Earthworm activity resulted in a reduction in TOC because of the loss of CO_2 (Suthar and Singh, 2008).

All of the buffalo dung and sugarcane bagasse feed combinations showed a noticeably higher TKN concentration (Table 2, Figure 2). Among all the combination of buffalo dung and sugarcane bagasse, maximum increase of TKN was observed in the combination of SCB+BD (1:1) which is 46.25% (4.3±0.02 to 8.0±0.03) and minimum increase of TKN was observed in the combination of SCB+BD (1:3) which is 12.50% (6.3± 0.08 to 7.2± 0.08). The rise in TKN in the final product during the processing of earthworms may be caused by mineralization and the addition of various byproducts or assimilatory products by the earthworm (Chauhan and Singh, 2012). Nitrogen addition in the form of mucus nitrogen secretory material, growth stimulatory hormones, and enzymes from the gut of earthworms may be caused by losses of organic carbon (Tripathi and Bhardwaj, 2004). During vermicomposting, organic C generally decreases while total N coverage increases (Kizilkaya and Hepsen, 2007; Fatehi and Seaygan, 2010).

The C:N ratio demonstrates the stability and mineralization of waste during the vermicomposting process. The decline in the C:N ratio was brought on by increased carbon loss through microbial respiration in the form of CO_2, as well as an increase in nitrogen and stabilization of waste by worm action (Hait and Tare, 2011; Vig *et al*., 2011; Hanc and Chandimova, 2014). After the processing of earthworm *Lampito mauritii* the maximum decreased of the C:N ratio was 69.74% (111.7± 0.47 to 33.8± 0.14) which was observed in the combination of SCB+BD (1:1) and minimum decrease of 26.83% (211.7± 1.05 to 154± 1.32) which was observed in SCB (Table 3, Figure 3). Earthworms speed up humification during vermicomposting, which causes the C: N ratio to fall (Suthar, 2006; Dores Silva *et al*., 2011).

During the processing of *Lampito mauritii*, the total potassium concentration in every combination of feed mixture increased considerably. Among all the combinations of buffalo dung and sugarcane bagasse, maximum increase of TK was observed in the combination of SCB+BD (1:1) i.e 35.13% (2.4± 0.02 to 3.7± 0.03) and minimum increase of TK was observed in the SCB i.e 12.50% (3.5± 0.06 to 4.0± 0.06) (Table 3, Figure 3). Kaviraj and Sharma (2003) found that during vermicomposting, *Lampito mauritii* and *Eisenia fetida* both enhanced the amount of TK by 10% and 5%, respectively. The rise in TK in bagasse is consistent with the findings of Adi and Noor (2009), who found that the solubilization of insoluble potassium was brought about by the production of acid during the microbial decomposition of waste. Suthar (2008) and Yadav *et al*. (2010) also noted that the potassium concentration was noticeably raised by vermicomposting trash.

Total phosphorus was greater in final vermicompost than initial vermibed mixture (Table 4, Figure 4). The maximum TAP was observed in the combination of SCB+BD (2:1) i.e 52.63% (2.7±0.05 to 5.7±0.06) and minimum increase was observed in BD i.e 25% (5.1±0.01 to 6.8±0.04). Vermicompost contains increased phosphorus content, indicating phosphorus mineralization by earthworms (Suthar, 2009). The phosphorus content of the composted mixture was later enhanced by earthworms as a result of the acid that was produced by microorganisms during the decomposition of organic waste (Pramanik *et al*., 2007). According to Ndegwa *et al*. (2000), an increase in TAP is related to worms, processing time, and feed material quality. Total calcium is significantly higher in all the final vermicompost compared to the initial feed mixtures of buffalo dung with sugarcane bagasse (Table 4, Figure 4). Maximum increase of 52% of calcium was observed in buffalo dung (1.2±0.02 to 2.5±0.03) and minimum increase of 9.67% calcium observed in SCB+BD (3:1) (2.8±0.05 to 3.1±0.03). The increased concentration of inorganic calcium in worm cast is thought to be predominantly caused by gut processes connected to calcium metabolism (Garg *et al*., 2006).

Table 1. Concentration of pH and EC in initial feed mixtures and final vermicompost of buffalo dung mixed with sugarcane bagasse in different combination.

Combinations	pH			EC		
	IFM	VC	% decrease	IFM	VC	% decrease
BD	8.4 ± 0.06	6.7 ± 0.02*	20.23	2.4 ± 0.04	1.1 ± 0.02*	54.16
SCB	6.6 ± 0.02	6.2 ± 0.06*	6.06	2.9 ± 0.05	1.6 ± 0.09*	44.82
SCB+BD(1:1)	7.6 ± 0.02	7.0 ± 0.02*	7.89	2.7 ± 0.03	1.6 ± 0.08*	40.74
SCB+BD(1:2)	8.5 ± 0.03	6.7 ± 0.02*	21.17	2.4 ± 0.04	1.3 ± 0.03*	45.83
SCB+BD(2:1)	7.7 ± 0.02	6.5 ± 0.04*	15.58	3.1 ± 0.03	1.5 ± 0.03*	51.61
SCB+BD(1:3)	8.2 ± 0.04	6.9 ± 0.03*	15.85	2.0 ± 0.06	1.2 ± 0.02*	40.00
SCB+BD(3:1)	7.8 ± 0.04	7.2 ± 0.05*	7.69	3.3 ± 0.04	1.8± 0.01*	45.45

Each value is the mean ± SE of six replicates. IFM = Initial Feed Material, VC = Vermicompost, BD = Buffalo Dung, SCB = Sugarcane Bagasse

*Significant ($P < 0.05$)‘t’ test between before and after vermicomposting in 30.0 x 30.0 x 10.0 cm^3 area of vermicompost bed.

Table 2. Concentration of TOC and TKN in initial feed mixtures and final vermicompost of buffalo dung mixed with sugarcane bagasse in different combination.

Combinations	TOC (G/Kg)			TKN (G/Kg)		
	IFM	VC	% decrease	IFM	VC	% increase
BD	510.9± 0.26	230.8± 0.23*	54.82	6.1± 0.03	8.0± 0.03*	23.75
SCB	550.6± 0.24	495.7± 0.25*	9.97	2.6± 0.01	3.2± 0.03*	18.75
SCB+BD(1:1)	480.5± 0.26	270.6± 0.23*	43.68	4.3± 0.02	8.0± 0.03*	46.25
SCB+BD(1:2)	493.7± 0.23	263.8± 0.20*	46.56	5.5± 0.03	7.7± 0.04*	28.57
SCB+BD(2:1)	506.5± 0.48	361.1± 0.25*	28.70	4.8± 0.01	7.5± 0.02*	36.00
SCB+BD(1:3)	457.0± 0.73	320.5± 0.24*	29.86	6.3± 0.08	7.2± 0.08*	12.50
SCB+BD(3:1)	527.4± 0.10	440.4± 0.25*	16.49	5.1± 0.02	8.8± 0.04*	42.04

Each value is the mean ± SE of six replicates. IFM = Initial Feed Material, VC = Vermicompost, BD = Buffalo Dung, SCB = Sugarcane Bagasse

*Significant ($P < 0.05$) ‘t’ test between before and after vermicomposting in 30.0 x 30.0 x 10.0 cm^3 area of vermicompost bed.

Table 3. Concentration of C:N ratio and TK in initial feed mixtures and final vermicompost of buffalo dung mixed with sugarcane bagasse in different combination.

Combinations	C:N ratio			TK (G/Kg)		
	IFM	VC	% decrease	IFM	VC	% Increase
BD	83.7± 0.46	28.8 ± 0.09*	65.59	5.1 ± 0.04	6.6 ± 0.04*	22.72
SCB	211.7± 1.05	154.9 ± 1.32*	26.83	3.5 ± 0.06	4.0 ± 0.06*	12.50
SCB+BD(1:1)	111.7± 0.47	33.8 ± 0.14*	69.74	2.4 ± 0.02	3.7 ± 0.03*	35.13
SCB+BD(1:2)	89.7± 0.56	34.2 ± 0.18*	61.87	3.0 ± 0.04	4.5 ± 0.03*	33.33
SCB+BD(2:1)	105.2± 0.41	48.1 ± 0.12*	54.27	2.3 ± 0.03	3.0 ± 0.05*	23.33
SCB+BD(1:3)	72.5± 0.73	44.5 ± 0.48*	38.62	3.4 ± 0.03	4.8 ± 0.06*	29.16
SCB+BD(3:1)	103.4± 0.25	50.0± 0.24*	51.64	2.1 ± 0.04	2.6 ± 0.03*	19.23

Each value is the mean ± SE of six replicates. IFM = Initial Feed Material, VC = Vermicompost, BD = Buffalo Dung, SCB = Sugarcane Bagasse

*Significant ($P < 0.05$) ‘t’ test between before and after vermicomposting in 30.0 x 30.0 x 10.0 cm^3 area of vermicompost bed.

Table 4. Concentration of TAP and TCa in initial feed mixtures and final vermicompost of buffalo dung mixed with sugarcane bagasse in different combination.

Combinations	TAP (G/Kg)			TCa (G/Kg)		
	IFM	VC	% Increase	IFM	VC	% Increase
BD	5.1 ± 0.01	6.8 ± 0.04*	25.00	1.2 ± 0.02	2.5 ± 0.03*	52.00
SCB	2.3 ± 0.08	4.0 ± 0.06*	42.50	2.5 ± 0.02	2.8 ± 0.08*	10.71
SCB+BD(1:1)	3.1 ± 0.02	5.1 ± 0.06*	39.21	2.2 ± 0.04	2.6 ± 0.09*	15.38
SCB+BD(1:2)	4.0 ± 0.04	5.6 ± 0.04*	28.57	1.5 ± 0.03	2.1 ± 0.05*	28.57
SCB+BD(2:1)	2.7 ± 0.05	5.7 ± 0.06*	52.63	2.4 ± 0.03	2.9 ± 0.03*	17.24
SCB+BD(1:3)	4.5 ± 0.06	7.1 ± 0.03*	36.62	1.4 ± 0.04	1.9 ± 0.02*	26.31
SCB+BD(3:1)	2.9 ± 0.03	4.8 ± 0.02*	39.58	2.8 ± 0.05	3.1 ± 0.03*	9.67

Each value is the mean ± SE of six replicates. IFM = Initial Feed Material, VC = Vermicompost, BD = Buffalo Dung, SCB = Sugarcane Bagasse

*Significant ($P < 0.05$) 't' test between before and after vermicomposting in 30.0 x 30.0 x 10.0 cm^3 area of vermicompost bed.

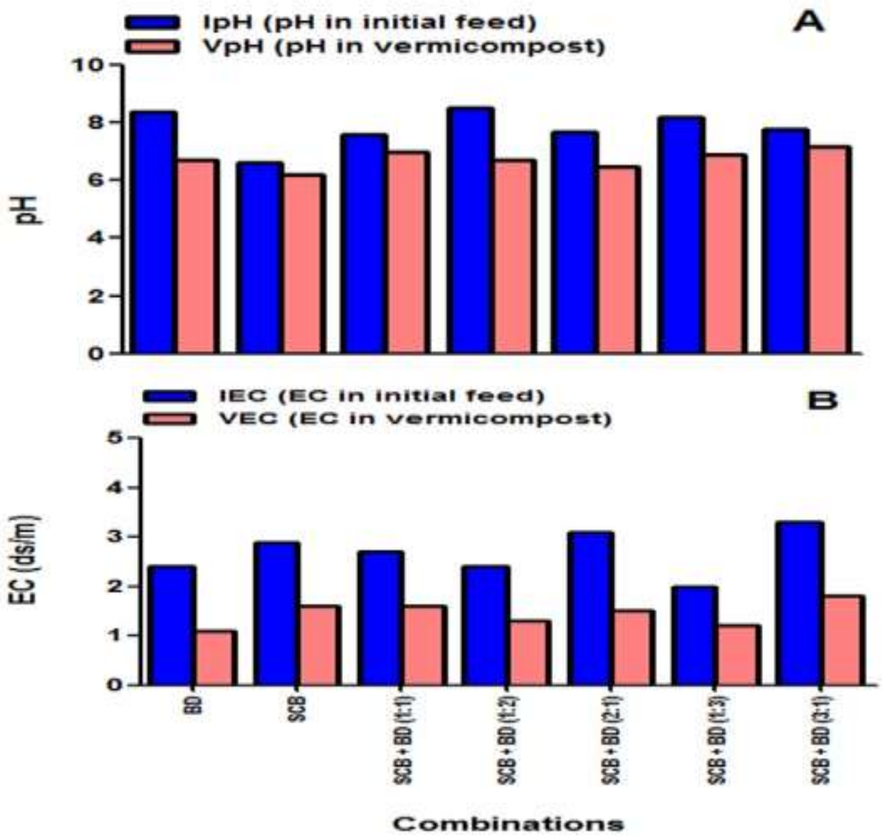

Figure1. Concentration of pH (A) and EC (B) in initial feed material and the vermicompost of different combinations of buffalo dung with sugarcane bagasse by *Lampito mauritii.* IpH= pH in initial feed material, VpH= pH in vermicompost, IEC= electrical conductivity in initial feed material, VEC= electrical conductivity in vermicompost, BD= buffalo dung, SCB= sugarcane bagasse.

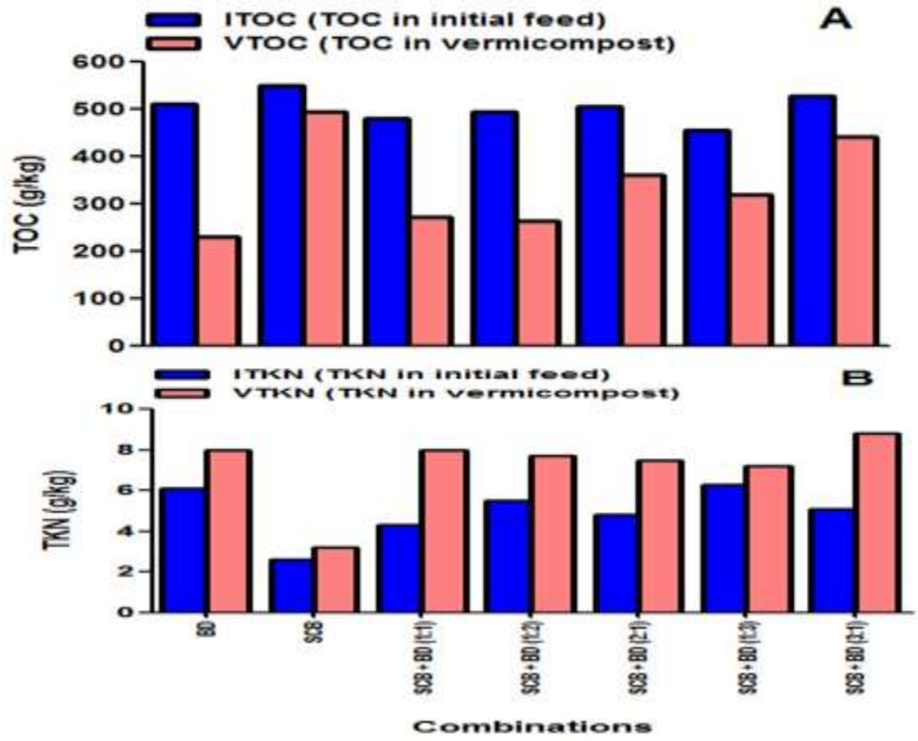

Figure 2. Concentration of TOC (A) and TKN (B) in initial feed material and the vermicompost of different combinations of buffalo dung with sugarcane bagasse by *Lampito mauritii* . ITOC= total organic carbon in initial feed material, VTOC= total organic carbon in vermicompost, ITKN= total kjeldahl nitrogen in initial feed material, VTKN= total kjeldahl nitrogen in vermicompost, BD= buffalo dung, SCB= sugarcane bagasse.

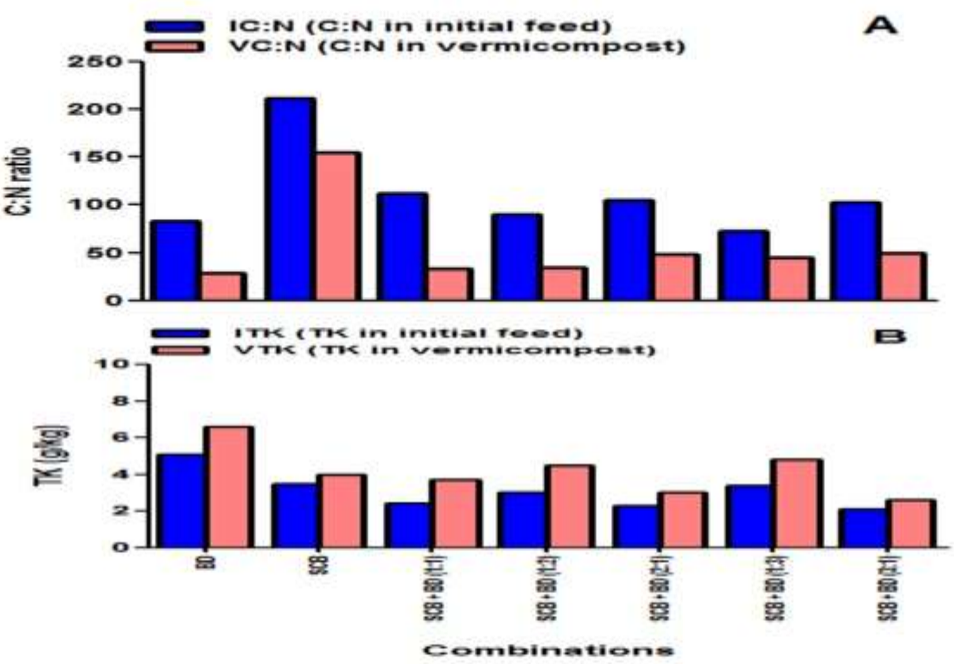

Figure 3. Concentration of C/N ratio (A) and TK (B) in initial feed material and the vermicompost of different combinations of buffalo dung with sugarcane bagasse by *Lampito mauritii.* IC/N= carbon to nitrogen ratio in initial feed material, VC/N= carbon to nitrogen ratio in vermicompost, ITK= total potassium in initial feed material, VTK= total potassium in vermicompost, BD= buffalo dung, SCB= sugarcane bagasse.

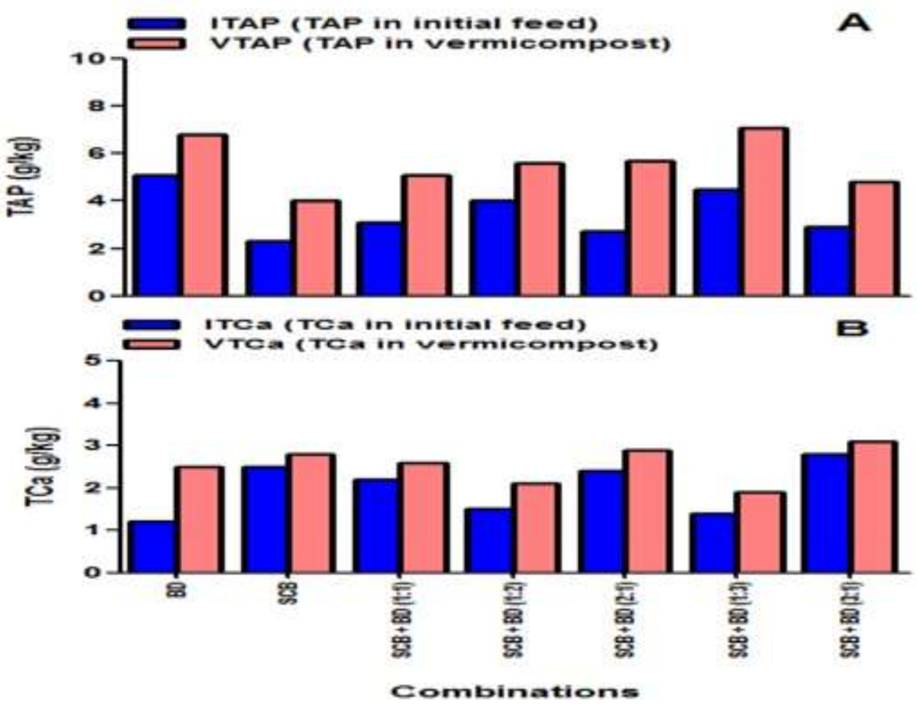

Figure 4: Concentration of TAP (A) and TCa (B) in initial feed material and the vermicompost of different combinations of buffalo dung with sugarcane bagasse by *Lampito mauritii.* ITAP= total available phosphorus in initial feed material, VTAP= total available phosphorus in vermicompost, ITCa= total calcium in initial feed material, VTCa= total calcium in vermicompost, BD= buffalo dung, SCB= sugarcane bagasse.

CONCLUSION

Earthworms have the ability to transform a variety of wastes into viable plant-nutrient-rich products, which can help farmers, succeed economically and lessen the burden of organic waste. After processing the earthworm *Lampito mauritii*, the physico-chemical properties of buffalo dung combined with sugarcane bagasse in various ratios underwent considerable modifications, as shown by this study. Vermicomposting could be used as an effective process to turn bagasse waste into nutrient-rich manure.

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