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Research Article

Alteration of Physical and Chemical Properties of Livestock Manures by *Eisenia fetida* (Savigny, 1926) and Developing Valuable Organic Fertilizer

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Abstract | The end product of the aerobic composting process is vermicompost which is prepared by the use of earthworms. Vermicompost contains sophisticated and more soluble major and minor nutrients. The objective of this experiment was the chemical and physical analysis of raw material of goat manure, cow dung, sheep manure and their vermicompost products. The earthworms for vermicomposting, *Eisenia fetida* (an epigeic species), were used as the test species. The samples were collected from prepared vermicompost and raw material for chemical and physical examination. For these samples, the pH, EC, organic matter, C:N ratio, phosphorus, potassium, calcium, magnesium, iron, nitrogen, sulfur and heavy metals i.e. tin, cadmium, nickel, lead, mercury and chromium parameters were evaluated. The experimental design was Complete Randomized Design (CRD). The data obtained was investigated at 1% probability and Least Significant Difference (LSD) test was used to segregate the significant means. The outcomes showed that percentages of EC, C:N ratio, heavy metals and organic matter decreased in vermicompost as compared to raw material while the proportion of pH, Ca, Mg, Fe, S, N, P, K increased in vermicompost as compared to livestock manures. Based on obtained results, it could be determined that the vermicompost had an outstanding nutrients availability, established by chemical studies, and confined all the vital macro, micronutrients and less heavy metals. This analysis will also support to select the best option for future use of these materials in the fields.

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1. Introduction

The intensive application of chemical fertilizers in field crops to get higher yields depreciates the environment through exhaustion of fossil fuels which releases CO_2 and performs as a major hazard to the world. Chemical Fertilizers make the soil either unfertile or decrease the fertility nature that triggered in soil deprivation (Chen, 2006). Implementing appropriate environmental and sustainable farming practices can create the environment more prolific (Bokhtiar et al., 2005). Earthworm works as decomposers and improves the decomposition of deceased and rotten organic materials and performs a key role in the soil ecosystem by enhancing the fertility of soil (Vasanthi et al., 2013).

Cattle manure is one of the main underutilized resources in most of the countries. Cattle manure mostly describes dung and urine along with the bedding material. Cattle waste is available both in dairies and slaughterhouses and at the decks of the houses.

Links Researchers

Cattle dung generating problems in an environment such as the supply of vulgar smells, causing surface and underground water pollution along with other wastes of animals and agro-industry. This excessive animal waste is getting a matter of consideration in the quality area of water. Assumption of improved waste management of animal practices can decrease the transfer of pathogens and nutrients from animal farms to surface and groundwater that could enhance the quality of water. However, the production of food has been increased expressively from 1900 to 1960 by application of high yielded variety seeds, pesticides, fertilizers and farm machinery. The traditional growers are facing the problem of quiet efficiency due to declined soil organic carbon. To recover the organic level qof soil the growers are currently rotating traditional practices of organic farming i.e. handling the agriculture with deprived of the use of synthetic or inorganic fertilizers and pesticides.

Mostly cattle dung is the excreta called crap or feces, of fodder or forages consumption animals called herbivores and poultry mixed with bedding material and thus is severely polluted with their excreta and urine. Animal feaces vary conferring to species, food, productivity and environment of the animal. The type of feaces formed by diverse species of animal varieties from 0.12-1.9 tons per year per animal.

Earthworms are invertebrates and almost 3600 kinds of earthworms in the globe. Earthworms are mostly distributed into burrowing and non-burrowing types. The non-burrowing type earthworm eats soil (10%) and organic constituents (90%) and transforms the organic discarded into vermicompost earlier than the rummaging earthworms (Nagavallemma et al., 2004). The method of vermicomposting is an easy biotechnological technique and used to improve the method of waste renovation. Vermicomposting is another form of composting in various ways (Gandhi et al., 1997) where earthworms work as biotic experimentation and proficient in altering gold from waste (Vermi, 2001).

Earthworms contain biomass more than eighty out of a hundred of soil invertebrate. They eat on a diversity of organic wastes ingredient and yield vermicast. It contains more microbes, inorganic minerals, organic matter in plant uptake form. Around 10-15% of production is channelized by earthworms. In completely best circumstances of luxury and crushed up, saturated food, the herd will reprocess their peculiar mass in litters all twenty-four hours (Gupta, 2003).

Vermicompost increases the development and production of cereals, flowers vegetables, and fruits in crops (Tara, 2003). Earthworms discharge lubricant which keeps pH at 6.5-7.5 to courtesy the microflora of soil (Kadam, 2004) and moldings called vermicompost which is rich in calcium, magnesium, potassium, nitrogen, enzymes, hormones, vitamins and some minor elements necessary for the growth of plant (Bansal and Kapoor, 2000) and enhance the movement of various vital microorganisms like phosphate solubilizes and nitrogen fixers (Shoji, 2005; Hazra et al., 2014). It also can control some plant diseases (Litterick and Wood, 2009). Sujatha et al. (2003) described that the earthworm substances in the home-garden frequently contain 5-11% additional N, P_2O_5 and K_2O than the adjacent soil. The feaces of earthworms also comprise rich sources of enzymes, vitamins and antibiotics such as chitinases, proteases, lipases, amylases and cellulases.

Keeping in view the above literature, the current research was focused to regulate chemical and physical analysis of livestock manures and their vermicompost obtained from *Eisenia fetida*, epigeic earthworm species. The analysis i.e. pH, EC, organic matter, C:N ratio, nitrogen, iron, phosphorus, potassium, calcium, magnesium, sulfur and heavy metals i.e. nickel, cadmium, plubum, mercury, chromium and tin of cow manure, goat manure, sheep manure and their vermicompost were determined.

2. Materials and Methods

The study was directed at the Soil Science Laboratory No.1, Department of Soil Science and Plant Nutrition, Faculty of Agriculture, Tekirdag Namık Kemal University, Suleymanpasa, Tekirdag, Turkey. An epigeic species of earthworms for vermicomposting, "*Eisenia fetida*" (Savigny, 1926), was used as the test species. For conducting this study, vermicompost and its raw material of cow dung, manure of goat and manure of sheep samples consist of cattle manure in Tekirdag. The material was pre-composted for 20 days to remove all toxic gasses and favorable for earthworm's food. Jute bags were used to cover the wooden boxes to keep them wet during hot summer weather. Moisture contents were kept in range of 60-

70% by watering every 2 or 3 days during hot days and every week during cold weather. The material in wooden boxes was turned every 1-3 days intervals depending on the season to offer the aeration and to prevent it from anaerobic conditions.

The water was stopped formerly one week of vermicompost harvesting. The worms were blowout crosswise the pit come in adjacent and penetrated each other in the arrangement of sphere in 2 or 3 places. The compost was heaped by eliminating the globules and placed them in a container. After assembly of compost from top films, the food factual was again restocked and the composting procedure was reorganized. The material was filtered in 2 mm sieve, the material approved through the sieve called as vermicompost was stockpiled in polythene sacks.

The pH, EC, organic matter, C:N ratio, iron, nitrogen, phosphorus, potassium, calcium, magnesium, sulfur and heavy metals i.e. tin, cadmium, nickel, lead, mercury and chromium parameters were evaluated.

Preparation of Samples: The vermicompost and raw material used for the studies were collected and dried. After drying, the material was ground into a fine powder using a mortar and pestle, filtered and deposited in air-tight vessels beneath chilled temperature prior examination.

The EC and pH of tasters were noted by a digital conductivity meter and pH meter, respectively. The N was assessed by method of Kjeldahl, and P and K fillings of tasters were examined by a calorimetric way and flame photometric process, respectively. The Ca and Mg fillings of the tasters were also examined using the atomic absorption spectrophotometer. The C: N percentage was intended from restrained values of C:N. The micronutrients of raw material and vermicompost were determined rendering to the approaches designated by Achikanu et al. (2013).

The total contents of the heavy metals Cr, Cd, Sn, Ni, Hg and Pb were measured by atomic absorption spectrophotometer (Agilent Technologies two hundred Series AA) afterward assimilation of 0.25 g of sample with 2mL HNO_3, two milliliter HF and two milliliter H_2O_2 in a warm oven (Milestone-Ethos1), heated to 200 °C for ten minutes and preserved at 1200 watts for twenty minutes. To examine the excellence and heavy metals bioavailability existing within the compost, a serial abstraction was achieved in 3 phases, in triplicate, custom-made from Egreja et al. (1999) within the commencement, the transferrable portion (F1) was removed by the accumulation of potassium nitrate one mol L^{-1}, with pH scale attuned to seven, to roughly one g of the crushed sample. The suspension was unendingly stimulated for 60 minutes, centrifuged for fifteen minutes at 3000 revolutions per minute (fifteen hundred nine g) and sieved over filter-paper for fast purification. Targeted HNO_3 was adjacent to the extract, that was heated, cool and transported to a 10.00 metric capacity unit meter flask. The spontaneously certain portion (F_2) was removed from the coating of the primary step by nonstop vibrating for 120 minutes within the existence of EDTA 0.05 mol L^{-1}, attuned to pH scale 7. Once centrifuging for 15 minutes at 3000 revolutions per minute (fifteen hundred nine g) and purification over paper for fast purification, the extract was pickled with targeted HNO_3, heated, cool and transported to a 25.0 metric capacity unit meter flask. The residual fraction (F_3) was gained from residue of the subsequent phase, which was quantitatively transported to a PTFE bottle, to that four metric capacity unit HNO_3, a pair of metric capacity unit HF and a couple of metric capacity unit H_2O_2 were side. The flasks were wrapped and transported to microwave oven, wherever temperature was enhanced to two hundred degrees Celsius in ten min. and preserved for twenty min at twelve hundred watts. Once heating, the bottles were cooled and therefore the digestible material was transported to twenty-five metric capacity unit meter bottle and therefore the volume accomplished with deionized water. At every phase, the absorptions of atomic number twenty nine Pb, Zn atomic number twenty eight and atomic number fifty were resolute by AAS for every compost sample. Seeing metal quality declines from transferrable portion (F_1) to remaining portion (F_3), bioavailability issue (BF) was intended for every metal because of the quantitative relation of the total of the portions F_1 and F_2 by full total of portions $F_1 + F_2 + F_3$ (Singh and Kalamdhad, 2012).

2.1 Statistical analysis

The recorded data were statistically investigated via Fisher's analysis of variance (ANOVA) technique. LSD test was used ($p \leq 0.01$) to compare significant treatments means using Statistic version 8.1(Analytical Software ©, 1985-2005). and according to (Steel et al., 1997).

3. Results and Discussion

The pH was somewhat acidic in vermicompost, shadowed by raw substantial i.e. 6.67, 7.00, 6.80 for cow dung, goat manure and sheep manure respectively and 7.12, 7.35 and 7.08 for vermicompost all this material correspondingly. The answerable salt attentions (measured as electric conductivity) was less in vermicompost, followed by the raw material i.e. 4.43 dSm^{-1}, 3.00 dSm^{-1}, 3.50 dSm^{-1} for cow dung, goat manure and sheep manure, respectively and 3.19 dSm^{-1}, 2.50 dSm^{-1} and 2.50 dSm^{-1} for vermicompost of above materials, respectively. Similar to other researchers, the results of our experiment also disclosed that pH of vermicompost slightly increased as equated to raw material and EC of vermicompost reduced (Rehman et al., 2017) as equated to raw factual. The rise in pH may happen due to the production of organic acids and CO_2 fashioned throughout the metabolism of microbes. Several investigators have stated that most earthworms favor a pH of about 7.0 (Singh, 1997; Pagaria and Totwat, 2007; Narayan, 2000).

The Organic matter was less in the vermicompost, followed by raw material i.e. 75%, 68%, 68% for cow dung, goat manure and sheep manure respectively and 48%, 45% and 41% for vermicompost of respective materials. The C: N ratio was reduced in vermicompost, followed by the raw material i.e. 9.2%, 10.20% and 12.20% for cow dung, goat manure and sheep manure respectively and 10.3%, 10.20% and 10.20% for vermicompost of respective materials (Figure 1). The reduction of carbon/ nitrogen proportion is result of quick breakdown of organic waste, and mineralization and maintenance during progression of vermicomposting (Domínguez and Edwards, 2011).

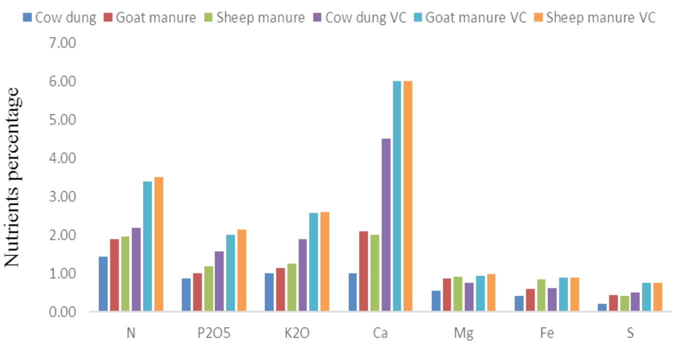

Figure 1: Chemical analysis of livestock manures and their vermicompost.

Goat and sheep manure are known for its high nutrient composition. Regardless of the feed type goat and sheep excreta contain more Iron, nitrogen, phosphorous, potassium, Calcium, Magnesium and Sulfur than cattle manure. It is also known vermicompost supply more nutrients to the plants (Balasubramanian et al., 2009). Results shown in Table 1 indicated that the concentrations of total N, P_2O_5, K_2O, Ca, Mg, Fe, and S in goat and sheep manure vermicompost are higher than those in cattle manure vermicompost (Figure 2). Karmegam and Daniel (2009) findings are similar to our study that showed that the vermicompost has high levels of total and available macro and micronutrients as compared to its respective source.

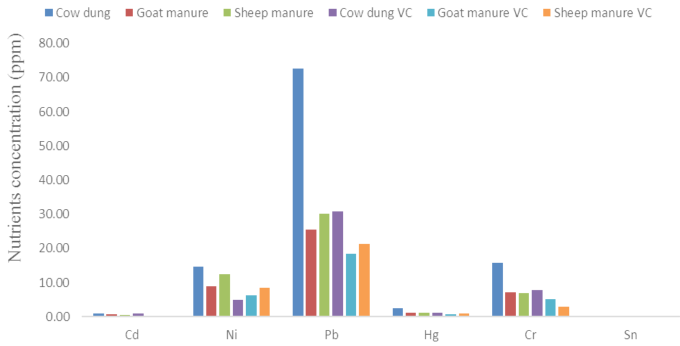

Figure 2: Chemical analysis for heavy metals of livestock manures and their vermicompost.

During the chemical analysis of vermicompost and its raw material, it was detected that heavy metals i.e. chromium, cadmium, nickel, lead, mercury and tin were less in the vermicompost, followed by the raw material showed in Table 2. The minimum heavy metals were observed in the vermicompost of goat and sheep respectively and their manure contained fewer heavy metal compared with cow dung and its vermicompost.

Similar to other investigators, the results of our investigation also presented that the vermicomposting technique uses earthworm's environmental purposes in mixture with the microbial variety to alleviate, decrease and reuse efficiently heavy metals existing in wilds (Singh et al., 2011). Throughout vermicomposting process, organic litters are humified and mineralized with the support of enzymes to make humbler or small chain organic acids. Additionally, the freshly shaped organic acids called humic bind to metals existing to making steady metal multiplexes and silicate portions (Wang et al., 2013; Hait and Tare, 2012). Temporarily, convinced portions of metals get simply bioaccumulated in the earthworm tissues triggering a

Table 1: Chemical analysis of livestock manures and their vermicompost (VC).

Treatments	pH	EC (dS/m)	OM (%)	C/N (%)	N (%)	P_2O_5(%)	K_2O (%)	Ca (%)	Mg (%)	Fe (%)	S (%)
Cow dung	6.68F	4.44A	76.00 A	11.30 B	1.44D	0.88F	1.02E	1.00E	0.55A	0.41D	0.22E
Goat manure	7.01D	3.01D	69.00B	10.20C	1.90C	1.01E	1.15D	2.10C	0.88A	0.60C	0.44C
Sheep manure	6.81E	3.51B	69.00B	12.20A	1.97C	1.20D	1.27C	2.00D	0.91A	0.86B	0.41D
Cow dung VC	7.13B	3.20C	49.00 C	10.30C	2.20B	1.57C	1.90B	4.50B	0.77A	0.62C	0.51B
Goat manure VC	7.36A	2.51E	46.00 D	9.20D	3.40A	2.01B	2.58A	6.00A	0.95A	0.90A	0.76A
Sheep manure VC	7.09C	2.51E	42.00 E	10.20 C	3.50A	2.15A	2.60A	6.00A	0.98A	0.90A	0.75A

Table 2: Chemical analysis for heavy metals of livestock manures and their vermicompost (VC).

Treatments	Cd (mg/kg)	Ni (mg/kg)	Pb (mg/kg)	Hg (mg/kg)	Cr (mg/kg)	Sn (mg/kg)
Cow dung	0.93 A	14.7 A	72.70 A	2.43 A	15.70 A	0.30 A
Goat manure	0.67 C	9.00 AB	25.50 D	1.23 B	7.10 B	0.02 BC
Sheep manure	0.41 D	12.40 C	30.17 C	1.12 C	7.0 D	0.02 BC
Cow dung VC	0.88 B	5.00 C	30.85 B	1.11 C	7.77 C	0.04 B
Goat manure VC	0.31 F	6.30 C	18.50 F	0.60 E	5.10 E	0.01 C
Sheep manure VC	0.34 F	8.40 BC	21.17 E	0.87 D	3.0 F	0.01 C

complete reduction in metal contents. Numerous investigators have deliberated the immobilizing and bio gathering capacity of earthworms liable for a substantial reduction in contents of many heavy metals (Kaushik and Garg, 2003; Gupta et al., 2007).

Conclusions and Recommendations

It can be concluded that the percentages of EC, organic matter, C:N ratio, and heavy metals decrease in vermicompost as compared to raw material while the amount of pH, N, P, K, Ca, Mg, Fe, S increased in vermicompost as compared to livestock manures. Based on the obtained results, it could be concluded that the vermicompost had an outstanding nutrient status, established by the chemical examines, and contained all the vital macro, micronutrients and less heavy metals.

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Authors' Contributions

Conceived and designed the experiment: Ali Ahmad and Korkmaz Bellitürk, Performed the experiment: Ali Ahmad and Zubair Aslam, Analyzed the data: Korkmaz Bellitürk, contributed reagents/ materials/ analysis tools: Zubair Aslam and Ali Ahmad, Wrote the paper: Ali Ahmad and Zubair Aslam and Sami ur Rehman.

Conflict of interest

The authors have declared no conflict of interest.

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