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Effect of storage on quality of vermicompost

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Abstract
Properties of vermicompost vary during storage with variation in moisture content, storage conditions and time duration. Therefore, the study was undertaken to observe the changes in characteristics and quality of vermicompost when stored for two months at normal room conditions. The moisture content reduced from 38.87% to 28.94% after two months of storage. Total N, P, K and S content of vermicompost after two months of storage at normal room temperature was recorded as 1.15%, 0.37%, 0.93% and 0.52%, respectively. Microbial population and their enzymatic activity was high in the fresh vermicompost sample which gradually decreased with decreasing moisture content on storage of vermicompost. Dehydrogenase activity, acid phosphatase activity and alkaline phosphatase activity recorded after storage was 71.18µg TPF/g of vermicompost/hr, 64.18µg p-nitrophenol /g /hr and 90.66µg p-nitrophenol/g/hr respectively after 60 days of storage. Considering all the changes in physico-chemical, biological and biochemical properties of the vermicompost is best to be used after harvesting, when the composting period is over and it is ready for use. If stored, there is gradual deterioration in its fertilizer value which unables its full utilization.

Keywords: vermicompost, moisture content, dehydrogenase activity

Introduction
Vermicompost is an organic source of soil amendment and has beneficial effects on soil fertility. Application of vermicompost in the growing media ensures food safety and environmental well being, an important aspect for sustainable organic farming systems. It also has additional benefits such as organic waste recycling, environmental protection and food security (Sinha *et al.*, 2010) [16]. In order to achieve good productivity with minimal environmental impact, sustainable management of physical, chemical and biological properties of the growing media is very important (Abbey *et al.*, 2013) [2]. The vermicast deposited by earthworms is known to fertilize the soil and improve its physicochemical and biological properties which is beneficial for plant growth as well as soil environment (Karthikeyan *et al.*, 2014) [6]. It helps improving soil aeration, water holding capacity and cation exchange capacity of soil (Nada *et al.*, 2011; Wang *et al.*, 2017) [14, 21]. In vermicomposting process, nutrients present in the organic matter is converted to bioavailable forms (Harit *et al.*, 2014) [5]. Vermicompost supplies sufficient amount of macronutrients and micronutrients required to support plant growth and its development (Pattnaik and Reddy, 2010; Abbey *et al.*, 2012) [14, 1]. Thus, it is widely used as an organic source of carbon and nutrients (Pankaj *et al.*, 2020). It contain higher numbers of beneficial microorganisms including bacteria, actinomycetes, fungi, rhizobium, PSB, azotobacter etc. along with important enzymes (Varsha *et al.*, 2020). Availability of vermicompost is variable in respect to time and area of application. Sometimes its directly applied to farmers field as fresh vermicompost and sometimes even after storage. This study explores the changes in moisture content, nutrient content and microbial activity of vermicompost during storage at normal room conditions.

Materials and Methods
The present study was conducted to study the changes occurring in vermicompost quality on storage by analyzing various physiochemical and biological parameters. Vermicompost was generated from crop residue biomass and cow dung using *Eisenia foetida*, an epigeic species. Vermicompost samples were collected from various production units of vermicompost at Bihar Agricultural University Farm, Sabour. Three representative vermicompost samples bag of 25 kg were put it in the store room at normal room conditions. Samples were drawn at 0 day, after 30 days, after 60 days and stored in refrigerator for laboratory analysis of quality

parameters of vermicompost according to the objective under investigation. Moisture content of vermicompost was determined by oven drying the vermicompost sample up to constant mass as described by Baruah and Barthakur (1997) [4]. Total nitrogen content of vermicompost was determined by method given by Piper (1966) [15]. Vermicompost samples were firstly digested by using diacid digestion then total P, K and was determined. Total phosphorus in the digest was estimated by the vanado-molybdate yellow colour method described by Page *et al.*, (1982) [12]. Total potassium was determined by using a known volume of digest (prepared as in total phosphorus) and estimated by flame photometer as described by Page *et al.*, (1982) [12]. Total sulphur in the digest was estimated with the help of the method given by Tabatabai *et al.*, (1982) [17] using $BaCl_2$ crystal and spectrophotometer (420 nm). Population of bacteria, fungi, actinomycetes, rhizobium, azotobacter, and phosphate solubilising bacteria (PSB) were also taken into account by serial dilution plate technique for estimation of microbial population. Dehydrogenase activity in vermicompost was determined by method given by Klein *et al.*, (1971) [10] using spectrophotometer. Acid and alkaline phosphatase was determined by the colorimetric method given by Tabatabai and Bremner (1969) [18] using spectrophotometer at wavelength 440 nm (blue filter).

Results and Discussion

Effect of storage on physicochemical characteristics of vermicompost

The change of physicochemical characteristics of vermicompost during storage upto 60 days are presented in the table 1. The initial moisture content of collected fresh vermicompost i.e. zero (0) day sample under study was 38.87%. During storage gradual decrease in its moisture content was recorded. It reduced to 30.04% after 30 days and 28.94% after 60 days of storage period. According to Kiefer and Rivin (2012) [8] there was drying of vermicompost during storage without humidity control, the moisture content reduced from initial moisture range of 55-63% to 7-11% after storage in room conditions. Total N content recorded for fresh vermicompost as on 0^{th} day sample was 1.41%. After 30 days of storage, total N content of vermicompost was analyzed as 1.24% and after 60 days of storage total N recorded was 1.15%. Harit *et al*., (2014) [5] reported there was 31% reduction in total N in 14 days stored vermicompost followed by slight decrease during the storage process of 120 days. According to Kharin and Kukarov (2009) [7], upto 30% N loss from fresh castings occurs due to denitrification. A constant decrease in the nutrient content of vermicompost was recorded throughout the storage period which combined to reduction in its moisture content. Total P content was recorded as 0.42% on 0 day whereas 0.39% and 0.37% after 30 and 60 days, respectively after storage. Harit *et al*., (2014) [5] reported loss of 73% of total P was observed in the first two weeks of storage followed by gradual decrease. This reduction may be due to nutrient assimilation carried out by bacterial and fungal grazing macroinvertebrates present in the castings. Total K content also followed a declining trend in its concentration in vermicompost on storage. Total K in 0 day sample was recorded as 1.02% whereas 0.99% and 0.93% after 30 and 60 days, respectively. According to Kleawklaharn and Iwai (2014) [9] without any humidity control on storage, total K in vermicompost decreased in the first month from 0.97 to 0.63%. Similarly, there was decrease in concentration of total S at the end of study. Total S observed on 0 day was 0.61% whereas 0.54% and 0.52% after 30 and 60 days, respectively. Harit *et al*., (2014) [5] reported decrease in total S content because of the similar reasons as for reduction in total P and K content during the storage.

Table 1: Change of physicochemical characteristics of vermicompost during storage

Properties	0 Day	30 Day	60 Day
Moisture (%)	38.87±1.46	30.04±1.72	28.94±2.34
Total N(%)	1.41±0.17	1.24±0.12	1.15±0.09
Total P(%)	0.42±0.03	0.39±0.02	0.37±0.01
Total K(%)	1.02±0.06	0.99±0.05	0.93±0.06
Total S(%)	0.61±0.05	0.54±0.03	0.52±0.04

Effect of storage on microbial population of vermicompost

There was decrease in microbial population with decreasing moisture during the storage period of 60 days and results are presented in the table 2. Bacterial population in 0^{th} day fresh vermicompost sample was recorded as 6.22 x 10^7cfu/g which declined to 5.59 x 10^7cfu/g and 4.5 x 10^7cfu/g at the end of 30 and 60 days, respectively. Population of actinomycetes in vermicompost sample for 0^{th} day was recorded as 2.11 x 10^7cfu/g whereas 2.01 x 10^7cfu/g and 1.72 x 10^7cfu/g at the end of 30 and 60 days, respectively. Fungal population in 0^{th} day fresh vermicompost was observed as 17.78 x 10^4cfu/g which reduced with time of storage and was recorded further as 14.79 x 10^4cfu/g and 11.67 x 10^4cfu/g after 30 and 60 days, respectively. Population of phosphate solubilizing bacteria (PSB) for 0^{th} day sample was observed 13.89 x 10^6cfu/g which decreased further on storage i.e., 12.27 x 10^6cfu/g and 9.97 x 10^6cfu/g at the end of 30 and 60 days, respectively. Population of rhizobium in 0^{th} day was 4.33 x 10^7cfu/g whereas at the end of 30 and 60 days it was recorded 3.58 x 10^7cfu/g and 1.92 x 10^7cfu/g. Azotobacter population for fresh vermicompost i.e., for 0^{th} day sample was 13.11 x 10^6cfu/g which decreased on further storage and was observed as 10.86 x 10^6cfu/g and 8.67 x 10^6cfu/g at the end of 30 and 60 days of storage, respectively. Decrease in microbial population was may be due to absence of earthworm as it provides congenial conditions for growth of microbes in its digestive tract and also by ingestion of organic wastes which not only provides energy but also acts as substrate for their growth as reported by Tiwari *et al*. (1989) [19].

Table 2: Change in microbial population of vermicompost during storage

Properties	0 Day	30 Day	60 Day
Bacteria (x 10^7)	6.22±0.77	5.59±0.80	4.5±0.93
Actinomycetes (x 10^7)	2.11±0.38	2.01±0.45	1.72±0.40
Fungi (x 10^4)	17.78±5.17	14.79±4.63	11.67±2.90
PSB (x 10^6)	13.89±1.95	12.27±1.06	9.97±1.40
Rhizobium (x 10^7)	4.33±1.33	3.58±0.79	1.92±0.54
Azotobacter (x 10^6)	13.11±2.55	10.86±2.42	8.67±2.40

Effect of storage on microbial enzymatic activities of vermicompost

There was reduction in enzymatic activity during the storage period and laboratory analyzed data are presented in the table 3. Dehydrogenase activity recorded in fresh vermicompost taken as 0^{th} day sample was 83.06 µg TPF/g of vermicompost/hr which showed a decline in trend with time on further storage. It was observed as 78.28µg TPF/g of vermicompost/hr and 71.18µg TPF/g of vermicompost/hr at the end of 30 and 60 days, respectively. Acid phosphatase activity observed in 0th day vermicompost was 82.17 µg p-nitrophenol /g /hr which reduced to 71.72µg p-nitrophenol /g /hr and 64.18µg p-nitrophenol /g /hr at the end of 30 and 60 days, respectively. Alkaline phosphatase activity recorded in fresh vermicompost taken as 0th day sample was 103.67µg p-nitrophenol /g /hr which followed the similar decline in trend as dehydrogenase activity and acid phosphatase activity. Its value recorded at the end of 30 and 60 days were 99.45µg p-nitrophenol /g /hr and 90.66µg p-nitrophenol /g /hr, respectively. Aira *et al*. (2006) [3] suggested that the decreased enzyme synthesis was may be due to absence of degradable organic compounds (available substrate) in vermicompost.

Table 3: Change in microbial enzymatic activities of vermicompost during storage

Properties	0 Day	30 Day	60 Day
DHA (µg TPF/g of vermicompost/hr)	83.06±22.31	78.28±21.28	71.18±20.92
Acid phosphatase (µg p-nitrophenol /g /hr)	82.17±1.83	71.72±4.41	64.18±5.40
Alkaline phosphatase (µg p-nitrophenol /g /hr)	103.67±8.86	99.45±8.45	90.66±10.46

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