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Vermicomposting of Flower Waste Generated from APMC Market Yard, Solapur using *Eudrilus eugeniae*: Physico-chemical Analysis

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Abstract: Vermicomposting is a biological process by using earthworm species converting organic waste into enriched compost. The worm cast also known as a vermicast is improved with the nutrient growth promoting substances and useful soil microbial flora. Vermicompost is becoming popular for converting solid waste in major metropolitan cities as well as from various municipal corporation and municipalities. APMC (Agricultural Produce Market Committee) Market yard in Solapur was established in 1959. Solapur market is considered as one of the biggest wholesale markets especially from western Maharashtra. The advantage of Solapur being connected with both road and railways to the adjoining district as well as to the two neighbouring states Karnataka and Telangana. After collection, segregation of the huge waste generated from APMC, Solapur dumped at specified location. This generates soil and air pollution, aesthetically nuisance and unhygienic conditions. The present investigation mainly focussed on conversion of flower waste generated from APMC into vermicompost using earthworm *Eudrilus eugeniae*.

Keywords: Flower waste, *Eudrilus eugeniae*, Vermicompost, Physico-chemical

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Introduction

Solapur is located in Maharashtra state of India, considered to be one of the oldest city of India and one of the most diverse cities of India. The city is spread over an area of 19.67 Km^2 with population density of 290 people per square kilometre as per 2011 census. The Solpaur city's population was 951558. Approximately 300 to 350 tons per day solid waste is generated. The waste generated is processed at SMC processing plant located at Tuljapur road in 55 acres land (Chavan and Zambare, 2013).

In India various religious festivals are frequently celebrated which use flowers, fruits and different variety of items, which leads to generation of variety of flower waste. Dumping of floral waste in the aquatic ecosystem or in open landfills create hazard to the environment (Singh *et al.*, 2013). Vermicomposting involves joint interaction between earthworms and microorganisms to generate a homogeneous, stable and nutrient rich product called as vermicompost (Crawford, 1983; Bhole, 1992).

Earthworms are considered to be the friends of farmers. They are the invertebrates of agro ecosystem and predominantly found in temperate and tropical soils. Earthworms are the voracious feeders;feed on all biodegradable organic refuses. Vermicomposting and composting are more or less similar but distinct techniques are used to exploit bio-organic waste as a fertilizer for betterment and to increase soil fertility (Nagar *et al.*, 2018).

Solapur city is observing rapid increase in population, economic growth, development and industrialization. All these factors lead to solid waste generation at an accelerated rate in Solapur. The waste generated such as biodegradable, non-biodegradable, construction, metal, plastic and other kinds of waste is posing an ecological threat to this region. Vermicomposting is sustainable, cost effective and green technology for efficient management of biodegradable or recyclable waste and conversion into harmless and valuable product. The main objective of the study was to convert flower waste into a nutrient rich vermicompost and study the physico-chemical properties.

Materials and Methods

Floral waste of APMC market yard was allowed to decompose for a period of 10 days at 23°C. After decomposition process, the decomposed material was used for vermicomposting by raised bed method using the earthworm species *Eudrilus eugeniae*.

Collection and Segregation of floral waste:

APMC is located on the national highway NH 65 at the entrance of Solapur city, is the main connecting site for transport vehicles from different location nearby Solapur. Flower wastes generated from APMC Market yard, Solapur comprised of large quantities of marigold, rose and lily flowers. After collection of flower waste from APMC Market yard, Solapur non-biodegradable part like plastic, thermocol etc. was removed by hand and sorting the biodegradable waste for further process.

Site Selection for vermicomposting:

The present investigation was carried out at vermicomposting unit D.B.F. Dayanand College of Arts and Science, Solapur, Maharashtra, India.

Air drying and partially decomposition of flower waste:

The segregated floral waste was air dried by spreading on the top of roof. The air-dried samples were subjected to partially decomposition for 10 to 15 days using DC (Decomposing Culture). Partial decomposition of flower waste was carried out in a pit (4x6x5' size) to make flower waste appropriate for the process of vermicomposting.

Selection of earthworm species:

For vermicomposting the *Eudrilus eugeniae* species (Fig. 1) of earthworm was selected. The earthworms were procured from Krishi Vigyan Kendra, Solapur and were reared and cultured in the Institute. Only cultured live earthworm were used for vermicomposting and no harm or injury done to earthworm during the vermicompost process.

Vermicomposting Raised bed method:

After 10 days of decomposition in compost pit, partially decomposed organic waste of flower waste whose C:N ratio <20 was obtained. This decomposed flower waste Organic Raw Material (ORM) was used for vermicompost production using earthworm species, *Eudrilus eugeniae.* Vermicomposting is done on the rough floor by making bed (6x2x2' size) of organic mixture (Fig. 2). This method is easy to maintain and to practice. 100 kg partially decomposed flower waste was given as feed to earthworms. Thousands of earthworms were released on the bed for further multiplication. After one month many adult earthworms were obtained because of

Fig. 1: Earthworms *Eudrilus eugeniae* used for Vermicomposting

Fig. 2: Raised bed

Table 1: Physico-chemical analysis of flower waste vermicompost processed by *Eudrilus eugeniae* by raised bed method

	Moisture	pH	Organic Carbon (OC)	C: N	N	P	K
Flower waste	68.00±0.02	07.04±0.01	29.00±0.01	29.00±0.3	01.01±0.09	0.20±0.01	0.56±0.01
Decomposed flower waste	70.00±0.02*** (02.90%)	06.90±0.03 (01.98%)	27.70±0.02* (4.48%)	18.00±0.1* (37.90%)	01.54±0.10** (52.47%)	0.31±0.03 (55.00%)	0.87±0.01** (55.35%)
Vermicompost flower waste	78.00±0.04*** (14.70%)	06.29±0.02 (10.65%)	18.00±0.01* (37.90%)	17.00±0.1* (41.37%)	01.90±0.23** (88.11%)	0.62±0.05 (210.00%)	0.98±0.05** (75.00%)

Values in the bracket includes percentage variation; *Value significant at $p<0.01$, ** value significant at $p<0.02$, ***Value significant at $p<0.001$

natural rearing. The beds were protected from predators like ants, lizards, birds etc. Bed temperature was maintained at 25 ± 1 °C by sprinkling water on the bed and covered with gunny bag. The vermicompost thus obtained was analysed for macro nutrients.

Physico-chemical (Macro nutrient) analysis of vermicompost:

pH, moisture and temperature were determined by using Supremo soil tester kit. Organic carbon (OC) was determined by Walkley and Black (1934) rapid titration method. Nitrogen (N) was measured by using Kjeldhal method (Jackson, 1962). Phosphorus (P) was determined by Vanamolybdate method described by Anderson and Ingram (Olsen *et al.*, 1954). Potassium (K) was determined by flame photometry method (Flame photometer Elico made with Cl361 flame). Data were statistically analysed by t-test using PAST software (Hammer *et al.*, 2001).

Results and Discussion

Market waste management: Agricultural product selling and distribution is major event in any given market yards from different places including Solapur. The ideal waste management is to minimize the waste production and the prime strategy to protect the environment and to take care of harmful waste isolation and reduce properly the organic waste generated from market yard, APMC which is a vital center in Solapur which integrates various agricultural products- vegetables, flowers, fruits, pulses, millets by selling and distribution to the farmers and wholesalers.

In the present investigation physico-chemical parameters such as moisture, pH, OC, C: N, N, P, K of flower waste, decomposed flower waste and flower waste vermicompost were studied. Flower waste taken as control is compared with decomposed flower waste and flower waste vermicompost for the physico-chemical parameters.

Moisture: Moisture is an important factor for vermicomposting process. Earthworm contains 75-90% of water by its body weight. Optimal moisture also increases beneficial microbes (Parthasarathi *et al.*, 2008). The high content of moisture and microbes in vermicompost may be due to higher degradation rate of flower waste by earthworm and its microbial flora (Venkatramlingam and Saravanan, 2021). The moisture content increased from 68.00±0.02% in flower waste to 70.00±0.02% (Table 1; Fig. 3) in decomposed flower waste. There is 14% moisture increase in the flower waste vermicompost (78.00±0.04%) as compared to control (Table 1). All the values are significant at ($p<0.001$). The 70 - 80% moisture content in the vermicompost may be due to decrease of granular structure of earthworm casts (Hassan *et al*., 2022). Our results are in accordance with Mulla and Pathade (2020). They found that the incubation period of 6 weeks, pH 7.0 and moisture content of 70 to 80% are the optimum conditions for the vermicomposting process by *Eudrilus eugeniae.*

pH: In decomposed flower waste and vermicompost pH was 6.90±0.03 and in vermicompost the pH was 06.29 ± 0.02 (Table 1,Fig. 3), pH range 6 to 7 of vermicompost helps growth of plant by enrichment of macronutrient like N, P, K (Edwards and Bohlen, 1996). In the present investigation the findings of pH are similar with studies of Yadav and Garg (2016). Microbial decomposition of flower waste (Organic matter) during vermicomposting shifts the pH to neutral (Garg and Kaushik, 2004; Nath *et al.*, 2009; Das *et al.*, 2012). Ndegwa *et al.* (2000) accredited pH shift as to nitrogen and phosphorous mineralization and bioconversion of ORM.

Organic carbon (*OC*): In fresh flower waste the organic carbon was high 29±0.2%. After 15 days the decomposed flower waste was 26±0.2% and in vermicomposting flower wastes it was 18±0.1% (Table 1, Fig. 3). As compared to vermicompost the organic carbon content of fresh flower was high and all the values are significant at $p<0.01$. Organic Carbons (OC) are involved in building blocks of all living organisms. It is a measure source of energy for composting process (Ismail, 2007).

Sharma and Yadav (2017) studied the vermicompost product of flower waste from Surat, India. They have observed organic carbon in the vermicompost and compared it with cow dung. They suggested that flower waste composting is an ideal method of recycling the waste and converting it into useful product. From our investigation it is evident that the original flower waste showed more carbon content in all comparing floral waste which was decomposed by using decomposing culture for further vermicomposting. Flower waste showed maximum carbon content when compared at the percentage variation between flower waste and vermicompost. It is evident from our result that during vermicomposting process the earthworm consumed predecomposed organic matter along with microbial decomposition. The Organic Carbon (OC) was reduced due to the earthworms. Earthworm converted organic matter into useful product by decomposition (Suthar, 2007, 2009; Kaushik and Garg, 2003).

C:N ratio: The C:N ratio showed decrease in all experimental groups when compared with fresh flower waste. In fresh flower waste the C:N ratio was 29±0.3%, in decomposed flower waste the C:N ratio decreased up to 18±0.1%. After 30 days of experimentation by using earthworm species, *Eudrilus eugeniae* the C:N content decreased significantly in flower waste vermicompost to 17±0.1% (Table 1, Fig. 3).

The decrease of C:N ratio is due to rapid decomposition of organic floral waste and mineralization and stabilization process of vermicomposting (Kaushik and Garg, 2003). In the organic waste the advanced degree of maturity indicates C:N value less than 20. Senesi (1989) reported that microbial respiration and nitrogenous excretion reduces the C:N ratio during decomposing process. When the organic material is added to the soil it will increase the Carbon content and also stimulate the microorganism growth. The C: N ratio is indicated to evaluate the crop growth and microbial composition of the soil. The C: N ratio also signifies the composting nature

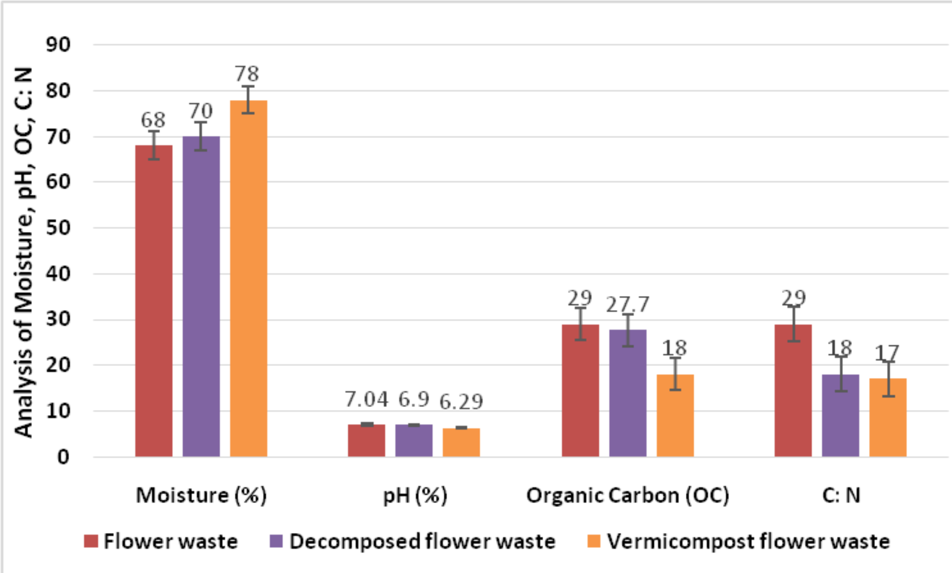

Fig. 3: Analysis of Moisture, pH, OC and C: N in flower waste; Decomposed flower waste and vermicompost flower waste.

of organic matter because the microbes require the steady balance of carbon and nitrogen in order to maintain activity. High C: N ratio prolongs the time duration of composting. If the C: N ratio is decreased, it will increase the Nitrogen loss from the organic matter.

In our present investigation the C:N ratio was found to be more in flower waste which was 29±0.3, however, in decomposed flower waste material the C:N ratio reduced to 38% (18±0.1) which was significant at $p<0.01$. In the third experimental group the vermicompost produced from Flower waste showed further decrease in C:N ratio that is up to 48% (17± 0.01) which was also significant ($p< 0.01$). This clearly indicates that C: N ratio is optimum in both vermicompost as well as decomposed flower waste and it is good for the microbial population having enhanced Organic matter recycled by earthworms and decomposition culture (DC culture). Therefore C:N ratio is considered as the most important indicator of organic waste maturity which might be due to the decomposition process enhanced by microorganism of flower waste organic matter which later stabilized in vermicomposting process. Similar results are also reported by Kaushik and Garg (2003) while studying vermicomposting process of textile mill sludge mixed with cow dung with the help of earthworm *Eisenia foetida.*

Shrimal and Khwairakpam (2010) studied effect of C:N ratio of vermicomposting vegetable waste. They selected earthworm *Eiseniafoetida* for vermicomposting of vegetable waste obtained from Malviya Institute, Jaipur, India. They have observed decline of C:N ratio in experimental groups and stated that the C:N ratio after 30 days was found to be best ratio of vermicomposting because all the earthworms were active at the end of experimentation.

Nitrogen (*N*): Nitrogen in fresh flower waste was high (1.01±0.09%). After 15 days in decomposed flower waste it increased to 1.54±0.10% and in vermicomposting flower waste it further increased to 1.90±0.23% (Table 1, Fig. 4). Earthworms enhance the nitrogen levels in the vermicomposting substrate by adding their excretory products, mucus, body fluids, and enzymes. In the present study, nitrogen level was highest in the flower waste vermicompost.

Nitrogen content in compost and vermicompost depends on raw material and the extent of decomposition process by earthworms

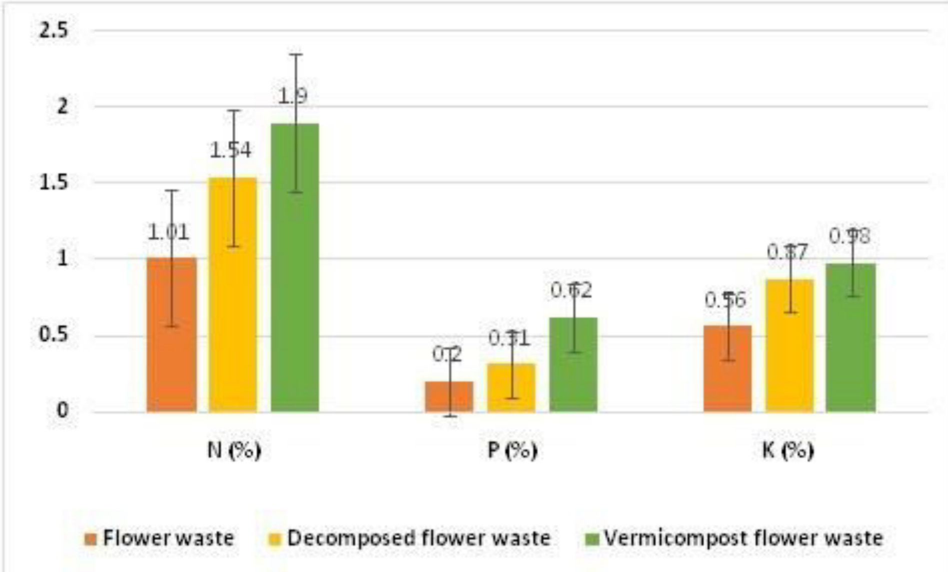

Fig. 4: Analysis of N, P, K flower waste; decomposed flower waste and vermicompost flower waste.

even by the saprophytic microorganism (Crawford, 1983). Nature of food influence worm activity and variation in the acceptability of organic waste by earthworms depending on the chemical nature and texture of particular waste (Kale *et al.*, 1982). Decomposition activities by earthworm might enhance the bacteriological population and increased mineralization method eventually enhance plant nutrient. Total nitrogen was relatively higher in the second than in the first harvest of vermicompost. Out of the total nitrogen is excreted by earthworm, some amount of nitrogen is reduced as mucoproteins by gland cells present in epidermis, certain amount of nitrogen is the form of ammonia, urea and uric acid as allantoin in a fluid excreted from the nephridiopores (Edwards and Lofty, 1977). Earthworms increase excretable Nitrogen by feeding on microbial biomass thus mineralization of nitrogen activity was increased (Bhole, 1992).

Phosphorus (*P*): In the present study, phosphorus content in the flower waste was 0.02±0.01%. After 15 days the phosphorus content of decomposed flower waste increased to 0.31±0.03% and in vermicomposting flower waste it further increased up to 0.62±0.05% (Table 1, Fig. 4). The higher phosphorus content in the vermicompost showed that the compost produced was of good quality and highly nutritious.

Phosphorus solubilising microorganism present in worm casting causes conversion of Phosphorus to make it bioavailable to plants (Suthar, 2009). Phosphorus is an important component found in vermicompost. Generally, in the range of 1.55% to 2.25% it is an important macro-nutrient needed for the formal growth and wellbeing of the plant. The phosphate stabilising bacteria are very important. The agricultural soil contains large quantity of inorganic and organic phosphorus but they are immobile and unavailable hence, microorganism plays important role for the utilization of phosphorus. Parastesh *et al.* (2019) studied the role of phosphate solubilizing bacteria during vermicompost and concluded that the phosphate stabilising bacteria enriched vermicompost which is beneficiary component for good management of phosphorus fertilization. Mousavi *et al.* (2019) also found significant increase in phosphorous content in the vermicompost. Few studies revealed phosphorous raw material consumption by earthworm and processing time (Hartenstein and Hartenstein, 1981; Ndegwa *et al.*, 2000). Satchell and Martein (1984) found an increase of 25% in phosphorus content in paper waste vermicompost, which is in accordance with the present study.

Potassium (K): In the present study, the Potassium content in the flower waste was 0.56±0.01%. After 15 days in the decomposed flower waste it was 0.87±0.01% and in vermicomposting flower waste it was 0.98±0.05% (Table 1, Fig. 4). The higher Potassium content in the vermicompost may be due to enhanced microbial activity during vermi-composting process, which consequently enhance rate of mineralization (Suthar, 2007).

Generally, in vermicompost potassium content may be in the range between 1.85 to 2.25%. Potassium is considered to be the most important in compost which is readily available for the plant uptake. It can be taken from the compost and made available to the plant as it is water soluble. Biswash *et al.* (2014) studied the effect of potassium and vermicompost on growth of mung bean. They concluded that inorganic potassium fertiliser and vermicompost have contributed significant growth and yield parameter of mung bean.

Conclusion

From our study it is clearly indicated that all essential macro nutrients which are necessary for plant growth are significantly increased in decomposed flower waste and vermicompost flower waste. It is also evident that the recycling of flower waste has higher nutrient value because the earthworm derives nutrients from decomposed flower waste and with the help of gut microflora the final product of vermicompost enriched microbial content which help in fertility of soil. Vermicompost of flower waste provide an ideal solution for its waste management and in maintaining soil health useful for sustainable agriculture.

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