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VARIATION IN ORGANIC CARBON CONTENT AND CARBON NITROGEN RATIO IN VERMICOMPOST AS AFFECTED BY SUBSTRATE STRAW

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SUMMARY

The field experiment was carried out to study the variation in organic carbon content and carbon nitrogen (C/N) ratio in different crop straws used as substrate during the process of vermicomposting during 2011-12 in CCS Haryana Agricultural University, Hisar. In the present experiment, the agricultural wastes like wheat straw, millet straw, pulse brawn, mustard straw and cow dung were used as substrates for vermicomposting and the decrease in organic carbon (%) was observed for 90 days. Maximum reduction in organic carbon was found to be 25.6 to 5.7 per cent after 90 days in cow dung substrate during the composting process and maximum reduction in C/N ratio was found to be 40.12 to 6.55 after 90 days in mustard straw + cow dung. Thus, over the course of the composting and vermicomposting the concentration of organic carbon declined up to 90 days (after the release of earthworms).

Key words : Crop straw, organic carban, C/N ratio, vermicompost, earthworms

Green revolution with the use of chemical fertilizers came as a mixed blessing for mankind. It increased food productivity manifold, but at the cost of environment and society. The excessive use of nitrogenous fertilizers has also led to increase in the level of inorganic nitrogen content in groundwater (through leaching effects) and in the human food with grave consequences for the human health. Organic farming systems with the aid of various nutrients of biological origin such as compost are considered to be the answer for the food safety and environmental security in future. Hence, non-conventional sources of amending organic matter status of soil are acquiring much attention because of their easy availability, prompt response and feasibility in using over large area in less time (Moradi, 2014). This has led the way for using vermicompost, as organic fertilizer. India has estimated potential of producing about 4.3 million tonnes of compost each year. Organic matter constitutes 35-40 per cent of the municipal solid waste generated in India. Composting using worms known as vermicomposting gives a better product than composting due to enzymatic and microbial activity (Saikrithika *et al.*, 2015). Vermicomposting is a waste management practice and directly impacts on human health (Giusti, 2009) and it results in a better quality product in terms of nutrient availability than traditional composting system (Suthar, 2009). Variation in nutrient composition of vermicompost prepared from different types of straw wastes has been reported by Kumar *et al.* (2017). It has also been reported that the digestion of carbohydrates and other polysaccharides from the substrates by inoculated worms may cause carbon reduction during vermicomposting of organic wastes (Suthar, 2010). Some part of organic carbon may be converted to worm biomass through the assimilation process, which consequently reduces the carbon budget of waste substrate used. Furthermore, losses in organic carbon decrease in pH (Yadav and Garg, 2011), mineralization of the organic matter containing proteins (Garg and Gupta, 2011) and conversation of ammonium nitrogen into nitrate (Atiyeh *et al.*, 2000) may be responsible for increasing nitrogen fraction in vermicompost. The C/N ratio is one of the most widely used indices for maturity of organic wastes and it decreases in the substrate with time (Esaivanic *et al.*, 2015). The loss of carbon as carbon dioxide in the process of respiration and production of mucus and nitrogenous excrements enhance the level of nitrogen, which lower the C/N

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ratio. The type of substrate and species used for vermicomposting plays a significant role in plant growth and yield. Most commonly used substrates are cowdung, industrial wastes, agricultural residues, etc. In view of the above, the variation in organic carbon content and the C/N ratio was studied in different crop straws viz., wheat straw, millet straw, pulse brawn and mustard straw along with cow dung which were used as substrates for vermicomposting.

MATERIALS AND METHODS

The present studies were carried out at the Research Farm of Department of Zoology and Aquaculture, CCS Haryana Agricultural University, Hisar during 2011-12. The agricultural wastes like wheat straw, millet straw, pulse brawn, mustard straw and cow dung were used as substrates for vermicomposting. The earthworm *Eisenia fetida* was used for preparation of vermicompost as it is most promising for the preparation of vermicompost (Figs. 1 and 2).

Fig. 1. Prepared vermicompost with dark colour.

The dry weight of all the five wastes was calculated by ovendrying overnight at 60^0C. The wastes were then mixed up separately with the fresh cow dung in a ratio of 1 : 5 (substrate : cow dung) and filled @ 80 kg dry weight in the pits measuring 2 in x 0.5 m x 0.6 in made in open field under a temporary shed of straws. Each mixture was having six pits. The pits having the organic waste mixtures were covered with gunny bags and were watered daily.

The earthworms were released in the pits after 15 days (after surpassing the thermogenic stage of microbial decomposition). One hundred healthy adult earthworms, having almost same weight, were randomly selected, and released in each pit. The earthworms were released in three pits only and the remaining three were kept as control for comparison

Fig. 2. Earthworm *Eisenia fetida.*

of changes in chemical composition with the vermicompost prepared by the earthworms.

The experiment was conducted for 90 days (after the release of earthworms). The samples for chemical analysis were collected on 0, 30, 60 and 90 days of the release of earthworms. These were analyzed for carbon by Nelson and Sommers (1982), and nitrogen by Kjeldhal method (Brenner and Mulvancey, 1982).

RESULTS AND DISCUSSION

Organic Carbon (OC)

In vermicomposting process several physical, chemical and the biological reactions take place, thereby resulting changes in the organic matter in a certain period of time. In the present studies, the OC (%) decreased during vermicomposting. It was found maximum in wheat straw + cow dung mixture i. e. 36.0, 31.0, 22.6 and 15.1 per cent at 0, 30, 60 and 90 days, respectively, and minimum in pulse brawn + cow dung, which was 28.2, 22.3, 17.7 and 10.7 per cent at respective intervals. In mustard straw + cow dung mixture, OC was observed 32.1, 26.5, 19.9 and 11.7 per cent, while that in millet straw+ cow dung, it was found 31.4, 25.4, 21.9 and 12.5 per cent at respective intervals during vermicomposting. In sole cow dung, OC was found to be 25.6, 20.3, 14.6 and 5.7 per cent after 0, 30, 60 and 90 days. (Table 1 Fig. 3). The digestion of carbohydrates and other polysaccharides from the substrates by inoculated worms may cause carbon reduction during vermicomposting of organic wastes (Suthar, 2010). Some part of OC may be converted to worm biomass through the assimilation process, which consequently reduces the carbon budget of waste substrate in the treatments. A part of the carbon in the decomposing residues evolved as CO_2 and a part

TABLE 1
Change in organic carban per cent in different agricultural wastes during vermicomposting

Waste mixture in ratio (1 : 5)	Time days			
	0	30	60	90
	O. C. (%)			
Wheat straw : cow dung	36.8b	31.7	22.8b	15.2b
Mustard straw : cow dung	32.5a, b	26.3b	19.5a, b	11.8a
Pulse brawn : cow dung	28.6a	22.8a, b	17.6a, b	10.7a
Millet straw : cow dung	31.4a	25.4b	21.9b	12.5a, b
Cow dung	25.6	20.3a	14.6 a	5.7
C. D. (P=0.05)	4.56	4.66	5.24	3.19

Value denoted by similar letter in each column do not differ significantly.

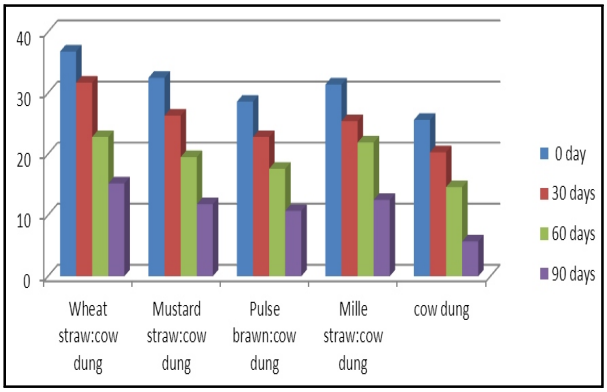

Fig. 3. Change in Organic Carban % in different agricultural waste during vermicomposting.

was assimilated by the microbial biomass (Cabrera *et al*., 2005). The decrease in carbon concentration during the composting process was also observed by Chhotu and Fulekar (2008).

Carbon/Nitrogen (C/N) Ratio

Plant roots in general cannot assimilate the mineral nitrogen unless the carbon/nitrogen (C/N) ratio is in the order of 20 : 1 or lower. In the present experiment, C/N ratio of the mixtures reduced with time during vermicomposting (Table 2 and Fig. 4). The C/N ratio was found maximum in wheat + cow dung which was 43.80, 30.48, 17.01 and 15.20 after 0, 30, 60, and 90 days and minimum in pulse brawn + cow dung being 32.50, 18.84, 11.65 and 5.60 at respective intervals. In mustard straw + cow dung, C/N ratio was found to be 40.12, 22.86, 13.44 and 6.55, respectively, and it was 38.29, 21.34, 14.69 and 6.79 at respective intervals of vermicomposting with millet straw + cow dung substrate. In sole cow dung substrate, the C/N ratio was found to be 35.6, 22.71, 12.37 and 4.38 at respective intervals. The reduction in carbon and lowering of C/N ratio in the vermicomposting could be achieved either by the respiratory activity of the earthworms and microorganisms or by an increase in the nitrogen by microbial mineralization of organic matter and also by the addition of the worm's nitrogenous wastes through their excretion (Kaushik and Garg, 2003). Similar reduction in the C/N ratio during composting process was reported by Garg and Kaushik (2005). The vermicomposting resulted in faster reduction of C/N ratio as compared to composts without earthworms (Chhotu and Fulekar 2008). Hand *et al.* (1988) reported that nitrogen mineralization would be greater in the presence of earthworms and this mineral nitrogen was retained in nitrate form. According to Levi-Minzi *et al*. (1986) the C : N ratio of the farm yard manure decreased after storing it for a period of three months.

TABLE 2
Change in C : N ratio in different agricultural waste during vermicomposting

Waste mixture in ratio (1 : 5)	Time days			
	0	30	60	90
	C : N ratio			
Wheat straw : cow dung	43.80c	30.48	17.01	15.2
Mustard straw : cow dung	40.12b, c	22.86a	13.44a, b	6.55a
Pulse brawn : cow dung	32.50a	18.84a	11.65a	5.60a
Millet straw : cow dung	38.29b	21.34a	14.69b	6.79a
Cow dung	35.06a	22.71a	12.37a	4.38a
C. D. (P = 0.05)	4.63	5.70	2.53	3.26

Value denoted by similar letter in each column do not differ significantly.

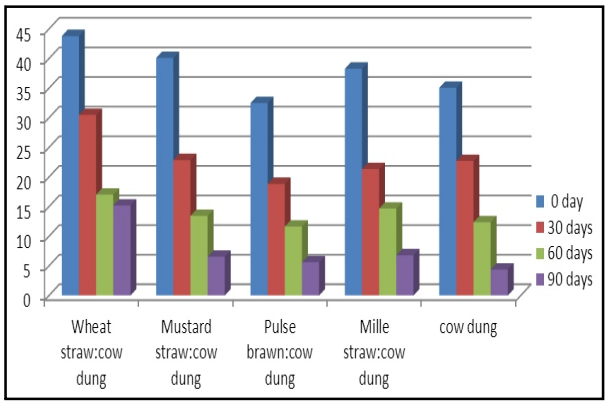

Fig. 4. Change in C : N ratio in different agricultural wastes during vermicomposting.

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