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Changes in Activities of Various Enzymes During Vermicomposting

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Vermicomposting is a well known technology to convert various types of wastes into nutrient rich fertilizer. Enzymes play key role in transformation of nutrients during vermicomposting. Present study is an attempt to find out activities of β- glucosidase, amylase, acid and alkaline phosphatase and urease at 0, 30, 60 and 90 days of vermicomposting of *Brassica juncea* cake and buffalo dung. Four treatments were used in the experiment with three replications in Completely Randomized Block Design. Treatments were- Buffalo dung + *Eisenia foetida* (Control); Buffalo dung + *Brassica juncea* cake (T_1); Buffalo dung + *Brassica juncea* cake + *Eisenia foetida* (T_2) and *Brassica juncea* cake + *Eisenia foetida* (T_3). Results show that activities of all the enzymes increases with time except urease activity which decreases with composting time. Effect of treatments was found significant at 5% level of significance for all the enzymes.

Key words: β- glucosidase, amylase, acid and alkaline phosphatase and urease

On an estimate India produces approximately 620 million tons of crop residues and its half comes from rice, wheat and oilseed crops[1]. Farmer has no idea to utilize these wastes hence he adopts the cheap method of waste management i.e. burning which causes many health and environmental pollution problems [2, 3]. The burning of rice straw alone emits approximately 144719 Mg of total particulate matter annually[4]. Besides this, processing of agricultural products also produces a large amount of waste. Rapeseed-mustard is an important oil seed crop of India. After oil extraction the left over cake remains unused because it contains toxic compounds glucosinolates and their harmful effects on health are reported by many workers[5,6,7,8], hence it is difficult to manage this waste. Vermicomposting is a proven technology to convert wastes into nutrient rich compost by the activities of earthworms. Chemical properties of vermicompost are been studied in great deal compared to enzymatic parameters which are highly important to study because enzymes play important role in decomposition of composting material[9,10]. Vermicomposting is a combined action of microorganism and earthworms. Microorganisms degrades waste by secreting various enzymes so present study deals with study of microbial and enzymatic changes during vermicomposting of mustard cake using *Eisenia foetida* species of earthworms.

MATERIALS AND METHODS

Mustard (*Brassica juncea*) cake, *Eisenia foetida* and buffalo dung, used in the experiment were collected locally. To increase the microbial activity mustard cake was cut into small pieces of about 1" length. Four treatments with three replications were used in the experiment.

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Treatments comprises- Buffalo dung + *Eisenia foetida* (Control); Buffalo dung + *Brassica juncea* cake (T_1); Buffalo dung + *Brassica juncea* cake + *Eisenia foetida* (T_2) and *Brassica juncea* cake + *Eisenia foetida* (T_3). Twelve number of above ground pits of size (45×45×21 cm) (l×b×h) were prepared using bricks on cemented floor and 6 kg material was added in each pit. In control and T_3 treatments 6kg each of buffalo dung and *Brassica juncea* cake were filled whereas in treatments T_1 and T_2 the 3kg buffalo dung was kept as bottom layer followed by one layer of small pieces of mustard cake (1kg) and top layer of buffalo dung (2kg). The material was mixed properly and watered to the amount that no portion of material should remain dry and also no free flow of water will be there. Now the pits were left as such for next seven days and at seventh day first turning was given. After second turning 18g of *Eisenia foetida* were added in each pit except T_1. At 30, 60 and 90 days a sample of vermicomposting material was collected and analyzed in laboratory for activities of β-glucosidase, amylase, acidic and alkaline phosphatase, urease[11] and obtained results were analyzed statistically following Completely Randomized Block Design and significance of data was calculated at 5% level of significance [12].

Table 1. Activities of β- glucosidase (IU/mL) at different days of vermicomposting

Treatments	Composting time (Days) 0	30	60	90
Control	4.01^a	6.62^a	7.25^a	8.23^a
T_1	5.00^{a,b}	8.36^a	9.36^b	9.74^a
T_2	5.90^b	9.36^a	11.33^c	12.25^b
T_3	9.36^c	14.25^b	16.39^d	19.23^c
SEM (±)	0.81	1.19	0.49	0.91
CD5%	1.88	2.74	1.13	2.10

Control: Buffalo dung + *Eisenia foetida*; T_1: Buffalo dung + *Brassica juncea* cake; T_2: Buffalo dung + *Brassica juncea* cake + *Eisenia foetida*; and T_3: *Brassica juncea* cake + *Eisenia foetida*
Alphabet ^{a,b,c,d} shows significance and non-significance of treatments at 5% level of significance. Treatments with same alphabet are non-significant and with different alphabet are significant.

RESULTS AND DISCUSSION

Vermicomposting is a process in which complex molecules are converted into simpler one. Most significant complex molecule in plant wastes is cellulose. Breakdown of cellulose occurs due to many enzymes but the final step of conversion of cellobiose to glucose happens in presence of β-glucosidase. Data presented in Table 1 show that content of β-glucosidase increases with time of composting process in all the treatments. Effect of treatments on content of ²-glucosidase was found significant at all the stages of analysis. Among treatments T_3 produces highest amount of β-glucosidase and the lowest amount was recorded

Table 2. Activities of Amylase (IU/mL) at different days of vermicomposting

Treatments	Composting time (Days) 0	30	60	90
Control	1.10^a	1.84^a	2.01^a	2.22^a
T_1	3.03^c	4.85^c	5.12^c	6.13^b
T_2	1.96^b	3.25^b	3.66^b	4.01^c
T_3	2.20^{b,c}	3.11^b	3.99^b	4.66^d
SEM (±)	0.36	0.48	0.43	0.20
CD5%	0.84	1.09	1.00	0.46

Control: Buffalo dung + *Eisenia foetida*; T_1: Buffalo dung + *Brassica juncea* cake; T_2: Buffalo dung + *Brassica juncea* cake + *Eisenia foetida*; and T_3: *Brassica juncea* cake + *Eisenia foetida*
Alphabet ^{a,b,c,d} shows significance and non-significance of treatments at 5% level of significance. Treatments with same alphabet are non-significant and with different alphabet are significant.

Table 3. Activities of Acid Phosphatase (µg/g) at different days of vermicomposting

Treatments	Composting time (Days) 0	30	60	90
Control	17.86^a	22.22^a	26.25^a	31.70^a
T_1	15.60^b	18.25^b	21.24^b	26.38^b
T_2	12.10^c	15.60^c	18.25^c	22.26^c
T_3	27.34^d	31.25^d	36.47^d	49.65^d
SEM (±)	0.35	0.56	1.08	0.73
CD5%	0.80	1.30	2.49	1.69

Control: Buffalo dung + *Eisenia foetida*; T_1: Buffalo dung + *Brassica juncea* cake; T_2: Buffalo dung + *Brassica juncea* cake + *Eisenia foetida*; and T_3: *Brassica juncea* cake + *Eisenia foetida*
Alphabet ^{a,b,c,d} shows significance and non-significance of treatments at 5% level of significance. Treatments with same alphabet are non-significant and with different alphabet are significant.

in control at 0, 30, 60 and 90 DOC (Days of composting). At 60 DOC all the experimental treatments differs significantly from each other for β-glucosidase content whereas at 0, 30 and 90 days control was at par with T_1; at 0 days T_1 was at par with T_2; at 30 days control was also at par with T_2 (Table 1).

Starch is another important constituent of plant wastes. Its conversion into simpler molecules is governed by amylase. Amylase converts starch to maltose[13]. During vermicomposting process its content also varies significantly with time (Table 2). A close examination of data presented in Table-2 reveals that with composting time amount of amylase production increased in all the treatments. At 90 days this amount was found significantly different in all the treatments whereas at 30 and 60 DOC treatments T_2 was found at par with T_3; and at 0 days T_3 was also at par with T_1.

We know that phosphorus is an essential plant nutrient required by plant in significantly greater amount thatswhy it is a major nutrient. It is non-mobile nutrient and gets adsorbed on soil particles almost immediately after its addition to soil if not used by plant roots. For this reason although soil has tremendous amount of phosphorus but farmer has to add it every time due to its non-availability to crop. Phosphatic fertilizers are very costly so scientists tried to find out a way to solubilize this adsorbed phosphate by any means and isolated many microorganisms causing phosphate solubilization by secreting enzyme phosphatase. Since, soil reaction is of two type- acidic and alkaline, so we studied both acid and alkaline phosphatase activities during vermicomposting. Data presented in Table 3 & 4 show that activities of acid and alkaline phosphatase increased with composting time and all the treatments differs significantly from each other at 0, 30, 60 and 90 DOC. Activities of acid phosphatase were found maximum under T_3 whereas alkaline phosphatase activities were found maximum in T_2 closely followed by T_3 at 0, 30, 60 and 90 DOC (Table 3 &4).

Another important primary plant nutrient is nitrogen which is supplied through addition of urea in soil. Nitrogen is highly mobile nutrient so if not utilized by plant roots then lost either through leaching or evaporation. Added urea in soil is rapidly converted into ammonia by urease that can be absorbed by plants quickly so its loss can be prevented. Higher the urease activity lower will be the loss of urea and higher will be its absorption by plant roots. Data presented in Table 5 reveals that urease activities decreased continuously with increased composting time and all the treatments differ significantly from each other at 0, 30, 60 and 90 DOC. Decreased activities of urease with time can be explained by the fact that accumulation of

Table 4. Activities of Alkaline Phosphatase (µg/g) at different days of vermicomposting

Treatments	Composting time (Days)			
	0	30	60	90
Control	14.36[a]	16.81[a]	20.31[a]	26.00[a]
T_1	11.54[b]	13.26[b]	16.49[b]	21.50[b]
T_2	20.99[c]	26.36[c]	31.25[c]	36.25[c]
T_3	17.86[d]	22.64[d]	27.25[d]	33.67[d]
SEM (±)	0.42	0.63	0.58	0.99
CD5%	0.97	1.44	1.35	2.29

Control: Buffalo dung + *Eisenia foetida*; T_1: Buffalo dung + *Brassica juncea* cake; T_2: Buffalo dung + *Brassica juncea* cake + *Eisenia foetida*; and T_3: *Brassica juncea* cake + *Eisenia foetida*
Alphabet [a,b,c,d] shows significance and non-significance of treatments at 5% level of significance. Treatments with same alphabet are non-significant and with different alphabet are significant.

Table 5. Activities of Urease (µg/g) at different days of vermicomposting

Treatments	Composting time (Days)			
	0	30	60	90
Control	90.63[a]	61.72[a]	46.27[a]	20.56[a]
T_1	69.39[b]	49.42[b]	32.05[b]	13.87[b]
T_2	84.26[c]	58.32[c]	39.63[c]	15.03[c]
T_3	84.94[c]	56.84[d]	38.11[d]	15.13[c]
SEM (±)	0.70	0.56	0.37	0.18
CD5%	1.62	1.29	0.85	0.42

Control: Buffalo dung + *Eisenia foetida*; T_1: Buffalo dung + *Brassica juncea* cake; T_2: Buffalo dung + *Brassica juncea* cake + *Eisenia foetida*; and T_3: *Brassica juncea* cake + *Eisenia foetida*
Alphabet [a,b,c,d] shows significance and non-significance of treatments at 5% level of significance. Treatments with same alphabet are non-significant and with different alphabet are significant.

heavy metals and production of proteolytic enzymes degrade urease [14,15,16,17].

Higher activities of cellulase, amylase, invertase, protease, peroxidase, urease, phosphatase and dehydrogenase in the worm casts[18,19,20].

CONCLUSION

On the basis of results of this study we can conclude that during vermicomposting of *Brassica juncea* cake and buffalo dung activities of important enzymes changes continuously with time of composting and increases except that of urease.

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