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Development and Imitation of Eudrilus Eugenae in Diverse Mammal Wastes through Vermicomposting

KEYWORDS: Eudrilus eugenae, vermicompost, growth, mortality.

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ABSTRACT *Vermicomposting is the process by which worms are used to convert organic materials into a humus like material known as vermicompost,& the goal is to process the material as quickly & efficiently as possible. The vermicompost has more available nutrients per kg weight than the organic substrate from which it is produced. The biological activity of earthworms provides nutrients rich vermicompost for plant growth thus facilitating the transfer of nutrients to plants. The earthworm species most commonly utilized for the breakdown of organic wastes are Eudrilus eugenae. The growth and mortality of an epigeic earthworm Eudrilus eugenae was studied under laboratory conditions from five wastes, i. e. cow, buffalo, goat, sheep and pig. Five hatchlings per 100 g of waste were used to study mortality and growth rate. No mortality was observed in any waste. The earthworms grew rapidly in cow, goat and sheep waste. The growth observed during present study exhibited in the order cow>goat> Sheep>buffalo>donkey in Eudrilus eugenae.*

Introduction:-

Vermicomposting is the process by which worms are used to convert organic materials into a humus like material known as vermicompost & the goal is to process the material as quickly & efficiently as possible. The vermicompost has more available nutrients per kg weight than the organic substrate from which it is produced. The biological activity of earthworms provides nutrients rich vermicompost for plant growth thus facilitating the transfer of nutrients to plants. The earthworm species most commonly utilized for the breakdown of organic wastes are Eudrilus eugenae & its related species. Their biological requirements have been studied extensively.

Earthworms are the soil dwelling invertebrates, which have great agricultural importance. They influence the soil structure by ingestion, which leads to the break down of organic matter and its ejection as a surface or subsurface cast (Nijhawan and Kanwar, 1952; Edwards and Lofty, 1977). The most effective use of earthworms in organic waste management requires a detailed understanding of the biology of all potentially useful species (Edwards and Bohlen 1996). One of the most promising worms for vermicomposting is Eudrilus eugenae. This is an epigeic species which lives in organic wastes, and high moisture contents and adequate amounts of suitable organic material are required for populations to become fully established and for them to process organic wastes efficiently. This paper evaluates the detailed growth and reproduction of Eudrilus eugenae in different animal wastes (cow, buffalo, donkey, sheep and goat). It was hypothesized that waste of different animals would affect the life cycle of Eudrilus eugenae due to differences in physico-chemical characteristics.

Materials and methods:-

Young clitellated specimens of Eudrilus eugenae, weighing 150–250 mg live weight were randomly picked from several stock cultures containing 500–1500 earthworms in each, maintained in the laboratory with cow dung as culturing material. Fresh waste of five different mammalian animals, viz., cow, sheep, goat, buffalo and donkey were collected from different animal farms of Rahuri taluka. The dung consisted of a mixture of faces and urine without any bedding material. The main characteristics of animal wastes are given in Table 1. All the samples were used on dry weight basis for biological studies and chemical analysis that was obtained by oven drying the known quantities of material at 110 °C. All the samples were analyzed in triplicate and results were averaged.

Five circular 05 plastic containers (diameter 14 cm, depth 12 cm) were filled with 100 g (DW) of each dung material. The moisture content of wastes was adjusted to 70– 80% during the study period by spraying adequate quantities of water. The wastes were turned over manually everyday for 15 days in order to eliminate volatile toxic gases. After 15 days, 5 clitellated hatchlings, each weighing 150–250 mg (live weight), were introduced in each container. Three replicates for each waste were maintained. All containers were kept in dark at temperature 25±1 °C. Biomass gain, clitellum development and cocoon production were recorded weekly for 15 weeks. The feed in the container was turned out, and earthworms and cocoons were separated from the feed by hand sorting, after which they were counted, examined for clitellum development and weighed after washing with water and drying them by paper towels. The worms were weighed without voiding their gut content. Corrections for gut content were not applied to any data in this study. Then all earthworms and feed (but no cocoons) were returned to the respective container. No additional feed was added at any stage during the study period. All experiments were carried out in twice and results were averaged. The pH and electrical conductivity (EC) were determined using a water suspension of each waste in the ratio of 1:10 (w/v) that had been agitated mechanically for 30 min and filtered through What man No. 1 filter paper. Total organic carbon (TOC) was measured using the method of Nelson & Somers.

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Table 1. Initial physico-chemical characteristics of various animal wastes.

Animal waste	Moisture content (%)	pH (1 : 10)	EC (dS/m)	C : N ratio	TK(%)	TAP(%)
Cow	56.0±2.24	8.2±0.78	2.10±0.24	89.4±3.57	0.48±0.12	0.33±0.09
Buffalo	72.3±3.16	8.4±1.03	2.60±0.35	93.0±4.72	1.07±0.21	0.50±0.11
Donkey	54.0±2.95	8.1±0.83	3.91±0.40	97.1±4.19	1.31±0.37	0.50±0.07
Sheep	73.4±4.37	8.2±1.07	0.90±0.12	88.9±3.32	0.70±0.19	0.31±0.08
Goat	21.8±1.39	7.6±0.63	2.56±0.42	93.5±2.85	0.72±0.21	0.37±0.05

Total available phosphorus (TAP) was analyzed using the colorimetric method with molybdenum in sulphuric acid. Total K (TK) was determined after digesting the sample in diacid mixture (cc HNO3 : cc HClO4 = 4 : 1, v/v), by flame photometer (Elico, CL 22 D, Hyderabad, India) .

Results and discussion:-

a) Physico- chemical characteristics of the animal wastes:-

The initial physico-chemical characteristics of animal wastes before use are summarized in table 1. The different physico-chemical parameters showed the range 21%-73% for moisture, 7.6- 8.4 for pH, 0.90-3.91 for Electrical conductivity, 0.89 dS/m -0.97 dS/m for C:N ratio, 0.70 % -1.31 % for TK and 0.31 % -0.50 % for TAP.

b) Growth of Eudrilus eugenae in various animal wastes:-

No mortality was observed in any animal waste during the study period. Gunadi and Edwards reported the death of Eudrilus eugenae after 2 weeks in the fresh cattle solids although all other growth parameters such as moisture content, pH, electrical conductivity, C:N ratio, NH4+ and NO3- contents were suitable for the growth of the earthworms. They attributed the deaths of earthworms to the anaerobic conditions which developed after 2 weeks in fresh cattle solids. In our experiments, all the wastes were pre-composted for 2 weeks and during this period all the toxic gases produced might have been eliminated. It is established that pre-composting is very essential to avoid the mortality of worms. The growth rate of Eudrilus eugenae in studied animal wastes over the observation period are given in table 2. Maximum worm biomass was attained in sheep waste (1294±245mg/earthworm) and minimum in sheep waste (800±137 mg/earthworm).

Table 2: Growth of Eudrilus eugenae in different animal wastes:-

Animal waste	Mean initial weight/ earthworm (mg)	Maximum Weight achieved /worm (mg)	Maximum weight achieved on	Net weight gain / worm (mg)	Growth rate/ Worm / day(mg)	Worm weight-gained per unit dry animal waste(mg/g)
Cow	196±69	889±90	6th week	686±22	16.3±0.52	34.0±1.9
Buffalo	190±30	1026±210	13th week	836±186	9.2±2.04	41.9±2.6
Donkey	182±40	1116±208	9th week	930±169	14.±2.71	46.6±1.1
Sheep	192±67	1294±245	6th week	1102±197	26.2±4.70	55.3±1.9
Goat	210±29	904±174	6th week	694±148	16.5±3.54	33.5±1.7

The maximum weight by earthworms was attained in the 6th week in cow, sheep, goat wastes, where as it took 9, 10 and 13 weeks in donkey and buffalo wastes respectively. Initially worms gained biomass but later after few weeks, weight loss by earthworms was observed in all the tested animal wastes. The loss in worm biomass can be attributed to the exhaustion of food. When Eudrilus eugenae received food below a maintenance level, it lost weight at a rate which depended upon the quantity and nature of its ingestible substrates. The biomass gain for Eudrilus eugenae per g dry weight of feed (DW) was highest in sheep Waste (55.3±1.9 mg/g) and smallest in goat waste (33.5±1.7 mg/g). Edwards et al. have reported a biomass gain of 292 mg/g cattle waste by P. excavatus at 25 °C. However, in our experiments, the biomass gain was only 34.0±1.90 mg/g by Eudrilus eugenae species in cow dung at 27 °C. In donkey waste, biomass gain by P. excavatus species was about 2 times higher than Eudrilus eugenae. This difference could be due to the difference in species morphology and initial characteristics of the feed waste. Nauhauser et al. reported that rate of biomass gain by Eudrilus eugenae was dependent on population density and food type. Net biomass gain/earthworm per unit feed material in different feeds followed the order: sheep > donkey > buffalo > goat ≈ cow. Net biomass gain by earthworms in sheep waste was 1.92 times higher than in goat waste (Table 2). The growth rate (mg weight gained/ day/earthworm) has been considered a good comparative index to compare the growth of earthworms in different wastes. The buffalo (9.2± 2.04 mg/day/earthworm) and horse wastes (9.5± 1.28 mg/day/earthworm) supported the least growth of Eudrilus eugenae; goat and donkey wastes were marginally better than buffalo and sheep wastes (Table 2). Lower growth rate in buffalo waste, in spite of attainment of more body weight than cow waste, was due to the fact that the time taken to achieve the maximum biomass was longer for buffalo waste than cow waste. Similar observations have been reported by Chaudhuri & Bhattacharjee for vermicomposting of cow dung and kitchen waste by Perionyx excavatus. The worm growth rate was highest in sheep waste which was about twice than in goat waste. Earthworms grew at relatively similar rates in cow and goat wastes (Table 2).

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c) Sexual development and cocoon production:-

The sexual development and cocoon production by Eudrilus eugenae indifferent feeds. All individuals in all the feeds developed clitellum before day 21 except donkey waste (day 28) after the start of the experiment. Cocoon production by earthworms was started by day 28 in donkey, sheep and goat wastes; and by day 35 in cow, buffalo wastes. Table 2 shows the cumulative cocoon production by earthworm in different feeds. After 15 weeks maximum cocoons were counted in sheep waste and minimum in buffalo waste. The mean number of cocoons produced per worm per day of in sheep waste was 231% greater than cocoons produced per day in buffalo waste. The number of cocoons produced per earthworm per day in different wastes was in the order: sheep > cow ≈ goat > donkey > buffalo. The difference between rates of cocoon production could be related to the biochemical quality of the feeds, which is an important factor in determining the time taken to reach sexual maturity and onset of reproduction. Feeds which provide earthworms with sufficient amount of easily metabolizable organic matter and non-assimilated carbohydrates, favor growth and reproduction of earthworms. But in our experiments, buffalo and donkey wastes were in contrast to this observation. The weight gain by earthworms was more in these feeds but cocoon production was lower than other feeds tested. It indicates that buffalo and donkey wastes are a good biomass supporting medium but not good for reproduction. A large proportion of the energy of mature worms is used in cocoon production. When cocoons are not produced the energy is utilized for tissue growth, the cocoon production was ceased by day 84 in cow feed wastes; by day 91 in buffalo, donkey, sheep and goat wastes.

Conclusions:-

Disposal of animal dung materials is a serious problem. Currently the fertilizer values of animal dung are not being fully utilized in India resulting in loss of potential nutrients. Our trials demonstrated vermicomposting as an alternate technology for the recycling of different animal dung materials using an epigeic earthworm Eudrilus eugenae under laboratory conditions. The dung materials strongly influenced the biology of Eudrilus eugenae The growth observed during present study exhibited in the order cow>goat> Sheep>buffalo>donkey in Eudrilus eugenae. Finally, cow, sheep and goat wastes supported the growth and reproduction of Eudrilus eugenae, hence it can be used as feed materials in large scale vermicomposting facilities. Further studies are required to explore the potential of utilization of buffalo, donkey and wastes in mixture with cow or sheep or goat wastes.

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