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EFFECT OF KITCHEN WASTES AND ANIMAL DUNG ON REPRODUCTIVE POTENTIAL OF *EUTYPHOEUS WALTONI*

Nazia Siddiqui and Keshav Singh*

Vermibiotechnology Laboratory, Department of Zoology
D.D.U. Gorakhpur University, Gorakhpur (U.P.), India

**Corresponding author:* keshav26singh@rediffmail.com

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Abstract: Earthworms are known to be an excellent biological source that recovers plant nutrients from the organic wastes. With the synergistic action of these earthworms along with bacteria, conversion of organic wastes into nutrient rich bio-fertilizer occurs through vermicomposting or vermistabilization, which is a cost efficient, eco-friendly and simple biotechnological process. During this process, important nutrients including nitrogen, potassium, phosphorus and calcium are released and converted into more soluble and easily available forms to plants by microbial action. The present review focuses on the effect of different combinations of animal dung with kitchen wastes on the reproductive potential of earthworm *Eutyphoeus waltoni* as well as bio-conversion of kitchen wastes mixed with animal wastes into humus rich manure.

Keywords: Bio-fertilizer, *Eutyphoeus*, Organic wastes, Reproductive potential.

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INTRODUCTION

Enormous mass of organic wastes are produced and released continuously in the environment. Animals produce enormous mass of organic wastes, which causes serious problem to the society. Simultaneously, such wastes also come into nature as a result of over anthropogenic activities (Prakash and Verma, 2022). Most of the bio-solid wastes are highly infectious as they hold an array of pathogenic micro-organisms. Due to the odour problem, wastes exert negative impact on the environment (Verma and Prakash, 2020a). Various harmful gases are produced due to the microbial decomposition of these wastes (Garg *et al.,* 2006). Disposal of these wastes into the environment without prior disinfection can cause hazardous risks to health and environment (Khaleel *et al.,* 1981). These wastes are considered as major resources that can enrich crop fields, supplement organic matters and improve soil conditions (Reinecke *et al.,* 1992).

Now it has become significant to develop a relevant technology to recover the energy from these organic wastes because these organic wastes act as a non-conventional sources and available at no or low cost. Vermicomposting technology has been developed to recycle the organic wastes in recent years. Vermicomposting technology constitutes one of the efficient tools for the management of organic waste (Manyuchi *et al.,* 2014). It is a type of composting in which some species of earthworms are used to enhance the process of organic waste conversion with the production as better end product called vermicompost.

The vermicomposting is a biotechnological, eco-friendly, aerobic and less expensive biological process of converting the wastes into stabilized vermicompost by earthworms (Gunadi *et al.,* 2002). It is an extremely valuable product and also known as black gold because it helps in the growth of plants when it is mixed with soil. The management of biological wastes is gaining great significance because it provides not only clean and healthy environment but also improves the quality of the soil and helps to make it fertile which in turn improves the productivity of the crops (Butler *et al.*, 2001).

A number of researchers such as Bisht *et al.* (2007) and Chauhan and Singh (2015) worked on various species of earthworms to utilize the wastes as feed materials for their growth but not much has been explored on anecic species. This review article focuses on the potential utilization of kitchen wastes with different combinations of animal dung as feed material for the growth and reproduction of anecic earthworm, *Eutyphoeus waltoni*.

EARTHWORMS

Earthworms are terrestrial invertebrates, belong to the class Oligochaeta of phylum Annelida (Verma and Prakash, 2020b). Earthworms act as soil engineers because they can manufacture energy and destroy soil pathogen (Deswal *et al.,* 2020). Earthworms in soil act as aerators, grinders, crushers, chemical degraders and biological stimulators (Edwards and Bohlen, 1996). Earthworms are great contributors to the recycling of carbon and nitrogen in the ecosystem and have the potential to break down the organic materials and excrete out the concentrated nutrients which makes them a functional contributor to the ecosystem. For monitoring soil pollution, earthworms act as a bio- indicator (Singh and Fatima, 2022a). Earthworms are also helpful in treating waste water by vermifiltration technology (Singh and Fatima, 2022b).

On the basis of morphology, ecology and vertical position in or above the soil, earthworms can be categorised into three groups i.e., Epigeic earthworms, Endogeic earthworms and Anecic earthworms (Bouche, 1972; Singh and Kumar, 2014). Anecic species inhabits near subsurface soil region. They have their own morphology and have their own feeding system. They make permanent vertical burrows in soil and feed on leaves on the soil and drag it into their burrows. They are of dark red or brown in colour at the head end and have paler tails. Anecic earthworms avoid cold temperature and migrate to soil layers which are more favourable. For conditioning the canteen waste, domestic waste, municipal waste, agricultural waste and other such type of wastes of organic nature, anecic species are found more suitable (Gergs *et al.*, 2022).

***Eutyphoeus waltoni* Michaelsen, 1907:**

Eutyphoeus waltoni Michaelsen, 1907 is an anecic earthworm species, belongs to the family Octochaetidae, found over a large part of India. *Eutyphoeus waltoni* is newly recorded in Amritsar, Punjab (Singh *et al.,* 2015). Its total length ranges from 9-23 cm with 190-210 segments. The colour of this species is brownish to violet grey.

The earthworm species are found abundantly in both cultivated and non-cultivated agro-ecosystems. In both the cases, *M. posthuma* was the most abundant species. But in the cultivated agro-ecosystem, *Eutyphoeus waltoni* was the second most abundant earthworm species while in the non- cultivated fields, *Eutyphoeus waltoni* is the fourth most abundant species (Singh *et al.,* 2020).The impact of the herbicide 2,4-D on earthworm *Eutyphoeus waltoni* in soil, has also been investigated as it has poor biodegradability. Its toxic effect was investigated in feed material in combination with the dung, agro waste and soil alone (Singh and Singh, 2015).

Kitchen wastes:

One of the major sources of municipal solid waste is household kitchen waste. Domestic waste is mainly of organic nature and contributes approximately 70% to 80% of urban solid wastes in India (Kale, 1998). Large quantity of kitchen wastes produced in India every year (Gupta, 2008). These kitchen wastes produce harmful effects on the health and environment, if they are not decomposed. In every home kitchen, large amount of food scraps are generated for disposal. These scraps create odour problem when they are thrown in the garbage and adds to the volume of waste going in the landfill. To dispose these kitchen wastes in a garbage disposal is very convenient, but it creates burden to the waste treatment system and throws away a potentially valuable resource (Chavan *et al.,* 2017).

About 320 million tonnes of agricultural wastes are generated annually in India (Suthar *et al.,* 2005), in which the vegetable waste is present in the major proportion. Vegetable scraps collected from the vegetable market and dumped into the municipal landfills, causes environmental issues because of high biodegradability (Bouallagui *et al.,* 2004). Vegetable waste is a good material for vermicomposting as it is a pure organic material so it can be easily decomposed in comparison of other wastes. Spinach, Chinese mustards, leaf mustards, cabbages, and other vegetables are the most common vegetable waste composition that can be found. Banana is the second largest fruit after citrus fruit which is produced and contributes about 16% of the world's total fruit production. The largest producer of banana fruit is India, which contributes to 27% of world's banana production. Banana is highly nutritious fruit rich in potassium and calcium. Components of banana plant is useful in food, feed, pharmaceutical, packaging, and many other industrial applications . The peel of banana is rich in vitamins, starch, crude protein, crude fat, total dietary fibre, and poly unsaturated fatty acids as well as micronutrients (K, P, Ca, Mg) (Debabandya *et al.,* 2010).

Animal wastes:

Million tons of animal wastes like cow, buffalo, goat dung etc are produced annually in India.These wastes create serious environmental and odour problems to the surrounding areas (Garg *et al.,* 2005). These animal wastes are powerful manures because they are rich in minerals like nitrogen, phosphorus, potassium etc so they can be positively used as a feed material for earthworms.

For the management of these wastes, organic farming through vermicomposting is a better option. Vermicomposting is the best option for better recycling of kitchen wastes and animal dung (Shrimal and Khwairakpam, 2010) and on the other hand utilization of these wastes reduces the pollution effect on the environment. Vermicomposting by the earthworms enhance the quality of feed material. Management of wastes through vermicomposting by using earthworms is one of the better options than microbes because it converts the waste into a valuable product which is used in agriculture to increase the production of food (Parr *et al.,* 2002).

Reproductive potential of various earthworms in different feed material:

Earthworm shows different patterns of cocoon production with different initial feed mixtures. The feed in the vermibed directly influence the pattern of reproduction in earthworms. Earthworms obtain their nutrition from organic wastes, living micro-organisms and by decomposing animals. The quality of organic wastes is one of the major factors which determine the onset and rate of reproduction (Dominguez *et al.,* 2000). The impact of vermibed substrate on reproductive potential of earthworms was also confirmed by Yadav and Garg (2011). The quantity of food taken by worms varies from 100 to 300 mg per g body weight per day.

Among the different variables the type of feed material seems to be most important for the production of earthworms (Fayolle *et al.,* 1997). Depending on the quality of the feed materials the reproduction pattern of earthworm shows variations in different feed materials. It has been reported by earlier studies that *Eisenia fetida* showed variation in reproduction pattern with respect to nature of the feed materials (Suthar *et al.,* 2005). The production of earthworm relies on the biochemical property of the feed material. Growth and reproduction of earthworms is favoured by the feed materials which provide enough amounts of easily metabolizable organic matter and non-assimilated carbohydrates. The doubling time of earthworm specifically depends upon the earthworm species, type of food, climatic conditions etc. The mean doubling time with reference to density and biomass of *Perionyx excavatus* is 11.72 and 16.14 days respectively (Ismail, 1997).

Suthar (2007a) reported that the decomposition of waste and production of earthworm was strongly associated with the quality of substrate mainly with their chemical and biological composition. Siddique *et al.* (2005) reported that cattle waste is one of the best food sources for earthworm. It has been observed by the researchers that, when earthworms were introduced into organic wastes, it showed increased growth rate and reproduction activity (Suthar and Singh, 2008). Earthworms which fed on any nitrogen-rich diet grow faster and produce more cocoons comparatively with little nitrogen available.

It has been reported that earthworm grow faster when provided with animal dung, leaf litter rich in protein, and soluble sugar (Edwards and Bohlen, 1996). Vermicomposting of cattle and goat manure by *Perionyx excavatus* and their growth and reproduction performance was studied. The cattle manure provided more nutritious and friendly environment to the earthworm than goat manure. Higher cocoon production and weight gain by *Eisenia fetida* in cattle waste than in goat waste has been reported by Loh *et al.* (2005). Kale *et al.* (1982) reported the potential of *Perionyx excavatus* for breaking down of organic waste. The highest rate of reproduction in *Perionyx excavatus* was noticed in the feed mixture of cow dung mixed with straw (Chaudhuri *et al.,* 2000). In the recent study it has been reported that *Perionyx excavatus* shows maximum growth and reproduction in the feed mixture of cow dung mixed with banana trunk and cow dung mixed with vegetable scraps (Sadia *et al.,* 2020).

Reproductive potential of *Eutyphoeus waltoni* in different feed material:

Highest increase in the number of earthworm *Eutyphoeus waltoni* was observed in the combination of buffalo dung mixed with gram bran than the dung alone. It has been observed that buffalo dung was found to be very potent for the growth and development of *Eutyphoeus waltoni* (Singh, 2020). Feeds that provide earthworms with a sufficient amount of easily available organic matter and non-assimilated carbohydrates promote earthworm growth and reproduction.

Different combinations of animal dungs (Cow, buffalo, goat) with kitchen wastes (vegetable waste, banana peels) mixed in different ratios had been used for earthworm *Eutyphoeus waltoni* as feed materials under identical laboratory conditions. Significant growth and development of earthworm *Eutyphoeus waltoni* was observed in the combination of wastes than in the control dung alone. Total biomass gain was highest in buffalo dung mixed with vegetable waste among all the feed mixtures. Significant growth was also observed in cow dung mixed with vegetable waste among all the combinations but less than the combination of buffalo dung and vegetable waste. It showed that buffalo dung mixed with vegetable waste is the better feed material for enhancing the population of earthworm, *Eutyphoeus waltoni*. Maximum significant gain in the weight and length of the earthworm, *Eutyphoeus waltoni* has been reported in the combination of gram bran and buffalo dung (Singh, 2020).

Change of physico-chemical properties in feed material by the processing of *Eutyphoeus waltoni*:

There was significant decrease in pH, Electrical Conductivity (EC), Total Organic Carbon (TOC) and Carbon to Nitrogen ratio while significant increase in Total Kjeldahl Nitrogen (TKN) and Total Available Phosphorus (TAP) in all the combinations of animal dungs with kitchen waste after the processing of earthworm *Eutyphoeus waltoni* when compared to the initial feed mixture. It was reported that pH declined due to the mineralization of nitrogen and phosphorus compounds and the production of humic acid during vermicomposting (Ndegwa *et al.,* 2000).

Micro-organisms which are found in the gut of earthworms produce organic acids which may decrease the pH in the feed mixtures by the activity of earthworms. The electrical conductivity of initial feed mixture decreased significantly after the processing of earthworm, which may occur due to the loss of high organic matter and consequent release of different mineral salts. It was observed that EC declined significantly (28.69%) in the final vermicompost during the management of bio sludge of the beverage industry (Singh *et al.,* 2010). Increased rate of loss of organic matter and consequent release of different mineral salts caused the reduction in EC (46% to 28.4%) in final vermicompost (Garg *et al.,* 2005).

The TOC content in all the feed mixture declined after the processing of earthworm *Eutyphoeus waltoni*. It may occur due to the loss of CO_2 by the activity of earthworms (Suthar and Singh, 2008). Decrease in the TOC content of a resultant product after vermicomposting was observed in the studies conducted by Contreras-Ramos *et al.* (2005). 24% to 60% reduction of TOC content during vermicomposting was observed in different combinations of vermibed in an earlier research (Yadav and Garg, 2010). TKN content was significantly increased in all the feed mixture after the processing of earthworm, *Eutyphoeus waltoni*. This may caused due to the mineralization of organic matter during the process and release of nitrogen rich excretory product, mucus enzymes and certain hormones by earthworms (Hobson, 2005). The availability of the nitrogen content in the vermicompost depends mainly on the combination of initial feed material.

It was reported by Chauhan and Singh (2013) that the final vermicompost of GWGr (goat dung + wheat straw + gram bran) showed the significant increase (53.80%) of TKN content. C/N ratio in all the feed mixture declined after the processing of earthworm *Eutyphoeus waltoni*. This may occur due to the loss of carbon by microbial respiration and mineralization as well as simultaneous addition of nitrogen by the earthworms in the form of mucus and nitrogenous excretory material (Suthar, 2007b). During the process of vermicomposting waste mineralization and stabilization was reflected by the C/N ratio of the substrate material. Higher C/N ratio indicates slow degradation of the substrate by the species and lower C/N ratio indicates the higher efficiency level of mineralization by the species (Haug, 1993). *Eudrilus eugeniae* lowers the C/N ratio in the final mixture after vermicomposting suggested that this species improved the mineralization of organic matter more efficiently (Pattnaik and Reddy, 2010). The total phosphorus content increased significantly after the processing of earthworm *Eutyphoeus waltoni*.

It has been reported that after vermicomposting total phosphorus content increased in the final feed mixture compared to the initial feed mixture (Suthar, 2007a). The increased phosphorus content in the final feed mixture has taken place due to the mineralization of phosphorus. During the process of vermicomposting, earthworms converted the insoluble P into soluble forms with the help of P solubilising microorganisms present in their gut (Padmavathiamma *et al.,* 2008).

CONCLUSION

Much work has not been reported in this area by using anecic species especially *Eutyphoeus waltoni*. This review article throws the light on identifying the suitable combination of animal wastes and kitchen wastes for better growth and development of earthworm *Eutyphoeus waltoni.* This species is the standard test organism used in terrestrial ecotoxicolgy because it can easily feed on a variety of organic wastes. As this species can easily feed on variety of organic wastes much work should be focused in this area by using anecic species to see whether they can contribute much or not. This study will also help to dispose the kitchen wastes which get generated extensively by every home kitchen on the daily basis in an efficient manner and can cause a positive impact on the environment. The wastes will not only be utilized efficiently but also help in making a value-added product called as compost. By using this compost in agricultural system the plant growth and productivity will increase significantly and it will be safe for soil, environment and human health.

CONFLICT OF INTEREST

The authors declare no conflict of interest regarding the publication.

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