



Microbial Analysis of the Gut of *Perionyx excavatus*

¹Vishnu Ganesh

²Ismail M. Ali

³Ayana S Y

¹M.Sc. in Microbiology Scott Christian College

²M.Sc in Microbiology Ramnarain Ruia College

³M.Sc in Biotechnology Sree Narayana College

ABSTRACT

Perionyx excavatus possesses an immense bacterial diversity within their digestive tracts and is very little explored mainly because of the non-cultivable character of a large quantity of microorganisms which mainly come from soil. All these organisms establish relationships among themselves in highly varied and complex ways which contribute to soil characteristics because of their role in the modification of solid, liquid and gaseous stages.

The aim of this study was, therefore, to screen the microbiology in the gut of *Perionyx excavatus* which are used in management of biowaste

It can be concluded from this study that the composting ability of *Perionyx excavatus* is enhanced by the microbial activities in the gut and can be used in the management of number of organic waste generated in agriculture, horticulture, rural industries including household section creating environmental population and problem.



Corresponding author:

Vishnug619@gmail.com

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INTRODUCTION

The transmission power system blackout in Nigeria has hampered certain firms that rely completely on electricity to maintain their operations. One of the main causes of the country's intermittent power supply is when the per-unit voltages of some malfunctioning buses do not fall within the range of 0.95 to 1.05, which is intended for stability. Because of the country's electricity



unreliability, innovative solutions for enhancing voltage stability in Nigeria's 132kv transmission network are needed. As demonstrated in this work, an intelligent Line Reactor would be used to alleviate this situation. The ability of a power system's network to withstand disturbances and return to its normal stable state without breaking down is referred to as its security [1]. The transient stability of a power system, which is one of the key

performance indices, can be used to assess the system's security. [2] Stated that, it has to do with a power system's ability to maintain Vermicomposting is the process by which earthworms are used to convert organic materials, usually wastes, into a vermicompost. Vermicomposting is a non-thermophilic biological oxidation process in which organic materials are converted into vermicompost which is a peat like material, exhibiting high porosity, aeration, drainage, water holding capacity and rich microbial activities, through the interactions between earthworms and associated microbes [1]. Vermiculture is a cost-effective tool for environmentally sound waste management [3]. Earthworms such as *Perionyx excavatus* play an important role in carbon turnover, soil formation, participates in cellulose degradation and humus accumulation. They actively profoundly affect the physical, chemical and biological properties of soil. Earthworms (such as *Perionyx excavatus*) intestine's contains a wide range of microorganisms, enzymes and hormones which aid in rapid decomposition of half-digested material transforming them into vermicompost in a short time (nearly 4-8 weeks) [22] compared to traditional composting process which takes the advantage of microbes alone and thereby requires a prolonged period (nearly 20 weeks) for compost production. [20] Earthworms are classified into epigeic, anecic and endogeic species based on definite ecological and trophic functions. Epigeic earthworms are smaller in size, with uniformly pigmented body, short life cycle, high reproduction rate and regeneration. They dwell in superficial soil surface within litters, feeds on surface litter and mineralize them. They contain an active gizzard which aids in rapid conversion of organic matter into vermicompost's. Epigeic earthworm includes *Perionyx excavatus*, *Lumbricus rubellus*, *Bimastus minusculus*, *Dendrodrilus rubidus*, etc. Endogeic earthworms are small to large sized worms, with weakly pigmented body, life cycle of medium duration, moderately tolerant to disturbance, forms extensive horizontal burrows and they are geophagous feeding on particulate organic matter and soil. They can efficiently utilize energy from poor soils, hence can be used for soil improvements. Endogeics include *Aporrectodea caliginosa*, *Octolasion cyaneum*, *Dontoscolex corethrurus*, etc. Anecic earthworms are larger dorsally pigmented worms with low reproductive rate, sensitive to



disturbance, nocturnal, phytogeophagous, bury the surface litter, forms middens and extensive deep, permanent vertical burrows and live in them. *Lumbricus terrestris*, *Lumbricus polyphemus* and *Aporrectodea longa* are examples of aneiceic earthworms.^[16] Epigeics and aneiceics are harnessed largely for vermicomposting^[3]. Epigeics have been used in converting organic wastes into vermicompost. Earthworms thus act as natural bioreactors, altering the nature of the organic waste by fragmenting them.^{[21][24]}

Earthworm's gut is a straight tube starting from mouth followed by a muscular pharynx, oesophagus, thin walled crop, muscular gizzard, foregut, midgut, hindgut, associated digestive glands and ending with anus. The gut is an effective tubular bioreactor, which maintains a stable temperature regulatory mechanism, thus accelerating the rates of the bioprocess and preventing enzyme inactivation caused by high temperatures. The gut consisted of mucus containing protein and polysaccharides, organic and mineral matters, amino acids and microbial symbionts viz., bacteria, protozoa and micro-fungi. The increased organic carbon, total organic carbon and nitrogen moisture content in the earthworm gut provide an optimal environment for the activation of dormant microbes and germination of endospores, etc. A wide array of digestive enzymes such as amylase, cellulase, protease, lipase, chitinase and urease were reported from earthworm's alimentary canal.

Enzyme activity in earthworms is regionally specialized and influenced by physiological state, age and microorganisms. Digestive enzymes like cellulase, xylanase, acid phosphatase and alkaline phosphates were found to be more in the gut of *Perionyx excavatus* as compared to other earthworms. Amylase, cellulose, acid phosphatase, alkaline phosphates and nitrate reductase were secreted in the gut of the earthworms due to increase in presence of microorganisms in it. Amylase, cellulase, xylanase, endoglucanase, cellobiase, acid phosphatase, alkaline phosphate and nitrate reductase produced jointly by earthworms and gut microflora are supposed to play a central role in the process of digestion and humification of soil organic matter. Amylase, cellulase, xylanase, endoglucanase and cellobiase act upon the complex biomolecules such as starch, cellulose, xylan and cellooligosaccharides. Acid phosphatase and alkaline phosphates and nitrate reductase are involved in the metabolism of phosphates and nitrogen. The gut microbes were found to be responsible for cellulose and mannose activities.^[21] As the organic matter passes through the gizzard of the earthworm it is ground into a fine powder after which the digestive enzymes, microorganisms and other fermenting substances act on them further aiding their breakdown within the gut, and finally passes out in the form of "casts" which are later acted upon by earthworm gut associated microbes converting them into manure product, the "vermicompost".^[11] When the organic matter passes through the gut of the earthworm, it gets mixed up with the digestive enzymes and finally leaves the gut in partially digested form as "casts" after which the microbes take up the process of decomposition contributing to the maturation phase.^[17] The gut of the earthworm constitutes a unique microenvironment in soils. The selective digestion of microbes in the gut influences the type of nutrients that are available for subsequent assimilation by both the earthworm and members of the gut microflora. The variation in the microbial population in the earthworm's gut maybe because of their nutritional needs and digesting ability of the earthworms. The bacteria in the foregut helps to digest the food particles, actinomycetes in the midgut helps to

destroy the pathogens by antagonistic activity and the fungi helps to bind the waste particles as casting in the hindgut. We look forward to work on the types of microbes present in the gut and the enzymes produced by them extracellularly that in turn helps in the digestion of the waste products into valuable castings or vermicompost.

EXPERIMENTAL METHODS

Collection of Earthworms:

The specimens selected for the present investigation were the adult earthworms namely *Perionyx excavatus*. The worms were collected from Koonpura- The house of mushrooms, Trivandrum and from Vivekananda centre, Kanyakumari. Species identification was confirmed using the general characters of the worms presented in Result section 3.1, table 1 and the taxonomical classification is presented in Results section 3.1 table 2.

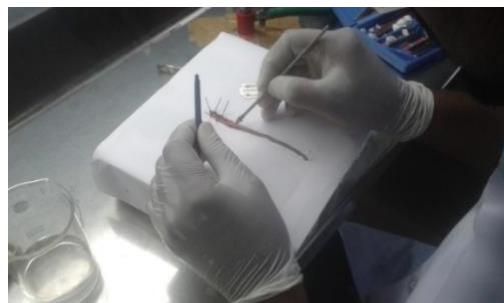
Figure 1 – *Perionyx excavatus*



Dissection of *Perionyx excavatus*.

Healthy adults from each type were collected and allowed to starve for 24 hours. They were then disinfected with 50% ethanol. A sterile surgical blade was used for dissection. Bell pins was inserted into the ventral surface of the clitellar region and with the body slightly raised up. With the sterile surgical blade an incision was made longitudinally along the worm. The gut was then freed from the surrounding blood vessels. With a flamed forceps the gut section was removed. This was then transferred to saline solution (0.85% NaCl solution) and homogenized for 5 minutes in a vortex. This serves as the samples for further analysis.

Figure 2 – Dissecting of earthworm





Microbial analysis of the gut of *Perionyx excavatus*

The gut isolated from *Perionyx excavatus* was further tested for the number of total heterotrophic and fungi. The biochemical identification of the microbes observed during the enumeration of heterotrophic counts were also performed.

RESULTS

Physical and Taxonomical classification of *Perionyx excavatus*

Table 1- General Characteristic's

Features	<i>Perionyx excavatus</i>
Size	23-120 mm × 2.5-5 mm
Segments	Around 75 to 165
Colour	Deep purple to reddish brown dorsally; pale ventrally
Behaviour	Very active; moves rapidly when distributed
Prostomium	Open epilobous
Setae	Perichaetine
Clitellum	Annular; usually in segments 14-17
Spermathecal pores	Two pairs in intersegmental grooves, 7/8 and 8/9
Intersegmental septa	Septa 7/8 and 8/9 somewhat thick; others weak
Male pores	Situated in pigment 18; closely paired
Female pores	Single and median; situated in segment 14
Genital markings	None
Spermathecae	Paired in segments 8 and 9
Nephridia	Holoic
Cocoons	Spindle-shaped

Table 2. Taxonomical classification of *Perionyx excavatus*

Kingdom	Animalia
Phylum	Annelida
Class	Oligochaeta
Subclass	Clitella
Order	Haplotaxia
Family	Megascolecidae
Genus	Perionyx
Species	<i>P. excavatus</i>

Results for the number of heterotrophic bacteria.

In nutrient agar plates colony count was determined and the colony count (CFU/ml) found is tabulated in Table 3 below.

Table 3 – Heterotrophic plate counts

Dilution Factor	Number of Colonies (CFU/ml)		
	Original	Duplicate	Average
10^{-4}	256	239	247.5
10^{-5}	222	201	211.5
10^{-6}	156	130	143

Results for the number of fungi.

The fungal count was determined by spread plate technique onto Rose Bengal agar plates. The colony count is tabulated in the table 4 below.

Table 4 – Fungi Counts

Dilution Factor	Number of Colonies (CFU/ml)		
	Original	Duplicate	Average
10^{-4}	156	144	150
10^{-5}	55	43	49
10^{-6}	24	32	28

Identification of heterotrophic bacteria.

The bacterial isolates were identified by various morphological and biochemical characterizations and the results are presented in Table 5.

Table 5 - Results for biochemical identification

Identification tests	FB ₁	FB ₂
Gram staining	Gram +ve cocci	Gram +ve cocci
Motility	Non motile	Non motile
Indole test	negative	negative
Methyl red test	positive	positive
Voges proskauer test	negative	negative
Citrate utilization test	positive	positive
Triple Sugar Iron agar test	Acid slant acid butt	Acid slant acid butt
Catalase test	positive	positive
Oxidase test	negative	negative
Starch hydrolysis test	negative	negative

Identification of fungi

The fungal isolates were identified by microscopic examination by LCB mounting technique and by colony morphology and results are presented in table 6

Table 6 – Results for fungi isolates

Isolate	Colony morphology	Microscopic examination by LCB mounting technique
FF ₁	Black color colony	

DISCUSSION

In the present study, the microbial analysis of the gut of *Perionyx excavatus*, was studied. The worms' gut was dissected and screened for the microbial analysis. The vermicomposting ability of the worm is enhanced by the gut microbes.

Earthworms possesses an immense bacterial diversity within their digestive tracts and is very little explored mainly because of the non-cultivable character of a large quantity of microorganisms which



mainly come from soil. Earthworms activity engineers the soil by forming extensive burrows which loosen the soil and makes it porous. Earthworm feeding reduces the survival of plant pathogens such as *Fusarium* sp. and *Verticillium dahliae* and increases the densities of antagonistic fluorescent pseudomonads and filamentous actinomycetes while population density of *Bacilli* and *Trichoderma* spp. remains unaltered.^[14] The gut microbes of earthworm were found to be responsible for the cellulase and mannosidase activities.^[21]

In the present study Heterotrophic bacteria namely *Staphylococcus* sp were identified in the gut of *Perionyx excavatus* by Morphological and biochemical characterizations. Among the two isolates all showed same biochemical results and was found to be *Staphylococcus* sp. The bacteria namely *Staphylococcus* sp, *Enterococci* sp, *Bacillus* sp, *Micrococcus* sp, and *Citrobacter* sp were found significantly in the gut of earthworm *Perionyx excavatus*.^[30] In the present study fungal isolate obtained from the gut of *Perionyx excavatus* was identified by morphological examination. It was identified as *Aspergillus niger*.

Thus the microorganisms present in the gut of earthworms are the major cause for casting. These organisms produce enzymes which are responsible for the breakdown of the waste products into valuable casting or vermicompost.

CONCLUSION

In the present study *Perionyx excavatus* was collected for the microbial analysis of their gut microflora. It was concluded that the earthworm composting ability is enhanced by the microbial activities in the gut. The earthworms can be used in the management of number of organic waste generated in agriculture, horticulture, rural industries including household section creating environmental population and problem.

Vermicomposting seems to be a natural tool for waste management since it converts the waste into wealth in form of compost and the environmental population will be mitigated. Thus the way of management of organic waste seems to be vermicomposting technique. Vermicomposting is an efficient eco-friendly method of waste management.

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