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Editorial

Vermicompost Useful for Screening Mosquitocidal Bacteria-A Novel Approach

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Vermicomposting is a bio-oxidative process, non-thermophilic that involves earthworms and associated microbes (bacteria). As earthworms consume organic substances (cow dung), they excrete tiny pellets. Vermicompost is a nutrient-rich fertilizer as well as a soil conditioner. It has been shown to promote the plant growth and yield as well as suppressing key pests and diseases of horticultural plants in the greenhouse and in the field soils. Vermicompost enhances soil biodiversity by promoting the beneficial microbial organisms. The microbial population of the vermicompost is very diverse and the potential application of these microbes in control of the disease causing mosquitoes is not well explored. The recent activities develop a bioprocess technology from vermicompost for the identification of mosquitocidal bacteria to control mosquito vectors. The bioassay was carried out against mosquito species (*Culex quinquefasciatus*, *Anopheles stephensi*, *Aedes aegypti*) for confirmation toxicity against mosquito larvae. It is important to note that, the principal investigator has already identified successfully some novel bacteria from various environmental sources such as wild-bird excreta and marine soil (*Bacillus cereus*, *Bacillus sphaericus*, *Bacillus thuringiensis israelensis*). It has provided a unique opportunity utilizing natural resources for mosquito control and thereby mosquitoes borne diseases like dengue, malaria, chikungunya, filariasis and others. Further, this is a newer approach not done elsewhere in the field of applied research may bring out a cost-effective biological control agent for National Programs of disease control.

Bioactive natural products from environment have attracted the great interest of biologists and chemists the world over for the past five decades. As a result of the potential for new drug discovery, environmental natural products have attracted scientists from different disciplines, such as bioorganic chemistry, pharmacology, organic chemistry, biology and ecology. This interest has led to the discovery of thousands of natural products to date and many of the compounds have shown very promising biological activity. As earlier, numbers of microbial organisms have already been isolated from vermicomposting in the field of agriculture to promote plant growth, but no such studies have initiated in the field of medical research to control mosquito vectors. Therefore, the usage of newer biopesticides from vermicompost on public interest for the control of mosquito vectors.

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Work already done in this area in India/abroad

Soil, is the soul of infinite life that promotes diverse microflora. Soil bacteria viz., *Bacillus*, *Streptomyces* and *Pseudomonas* etc., are prolific producers of secondary metabolites which act against numerous co-existing human pathogenic bacteria and phytopathogeic fungi [1]. Earthworms are popularly known as the "nature's plowman" or "farmer's friend". Earth-worm play significance role for microbial community, chemical properties of soil and physical. They break down big soil particles and leaf litter and thereby increase the availability of organic matter for microbial degradation and transforms organic wastes into valuable vermicomposts by milling and digesting them with the help of aerobic and anaerobic microbes. Earthworm's activity is initiated to enhance the beneficial microflora and suppress harmful pathogenic microorganisms. Soil worm casts are wealthy source of micro and macro-nutrients, and microbial enzymes [2]. Vermicomposting is a resourceful nutrient recycling process that involves harnessing earthworms as flexible natural bioreactors for organic substance decomposition. Due to richness in nutrient availability and microbial activity vermicomposts enlarge the soil fertility, enhance plant growth and suppress the population of plant pathogens and pests. This review explains the bacterial biodiversity and nutrient condition of vermicomposts and their significance in agriculture and waste management.

Earthworms

Earthworms are able to transform waste into 'gold'. Charles Darwin explained earthworms as the 'unheralded soldiers of mankind' and Aristotle described them as the 'intestine of earth', as they could digest an extensive diversity of organic substances [3]. Soil volume, microflora and fauna influenced by earthworms have been named as "drilosphere" and the soil volume includes the external structures fashioned by earthworms such as surface and below soil casts, burrows, middens, diapause chambers as well as the earthworm's body outer surface and internal gut connected structures in contact with the soil [4]. Earthworms play a vital role in carbon turnover, soil formation, participates in cellulose degradation and humus accumulation. Earthworm activity intensely affects the physical, chemical and biological properties of soil. Earthworms are insatiable feeders of organic wastes and they use only a small portion of these wastes for their growth and excrete a large percentage of wastes used in a half digested form. Earthworms intestine have a wide range of microorganisms, enzymes and hormones which aid in rapid breakdown of half-digested material transforming them into vermicompost in a short time (nearby 4-8 weeks) compared to usual composting process which takes the advantage of microbes alone and thereby requires a extended time (nearly 20 weeks) for fertilizer production. As the organic matter passes during the gizzard of the earthworm it is grounded into a fine particles after which the digestive enzymes, microbes and other fermenting substances act on them further aiding their breakdown inside the gut and finally come out in the form of "casts" which are later acted upon by earthworm gut connected microbes converting them into mature product, the "vermicomposts" [5]. Earthworms, classified under phylum annelida are narrow, long, cylindrical, bilaterally symmetrical, segmented soil staying invertebrates with a glistening dark brown body enclosed with delicate cuticle. They are hermaphrodites and weigh above 1,400-1,500 mg after 8-10 weeks. Their body composed 65% protein (70-80% high value 'lysine rich protein' on a dry weight basis), 14% carbohydrates, 14% fats and 3% ash. Their life span varies between 3-7 years based upon the species and ecological circumstances. The intestine of earthworm is a straight tube opening from mouth followed by a muscular pharynx, esophagus, muscular gizzard, thin walled crop, foregut, midgut, hindgut, related digestive glands and ending with anus. The gut composed of mucus containing protein and polysaccharides, amino acids, organic and mineral matter and microbial symbionts viz., protozoa, bacteria and microfungi. The increased organic carbon, nitrogen, total organic carbon and moisture content in the earthworm gut provide a favorable environment for the creation of dormant microbes and germination of endospores etc. A broad group of digestive enzymes such as amylase, protease, lipase, cellulase, chitinase and urease were reported from earthworm's alimentary canal. The midgut microbes were found to be accountable for the cellulase and mannose activities. Earthworms comminutes the substrate, thereby increases the surface area for microbial degradation comprising to the active stage of vermicomposting. As this crushed organic substance passes through the gut it get mixed up with the midgut associated microbes and the digestive enzymes finally leaves the gut in partially digested form as "casts" after which the microbes gets up the process of decomposition contributing to the maturation phase. Relationship of earthworms with microbes is showed to be complex. Certain groups of microbes were found to be a part of earthworm's diet which is proofed by the destruction of certain microbes as they pass through the earthworm's digestive system. Few protozoa, yeasts and certain groups of fungi such as *Fusarium oxysporum*, *Alternaria solani* and microfungi were digested by the earthworms, *Lumbricus terrestris,* Drawida calebi and *Eisenia foetida*. *Bacillus cereus* and mycoides were accounted to decrease during gut channel while *Escherichia coli* and *Serratia marcessens* were completely removed during passage through earthworm gut [6].

Vermicomposting

Vermicomposting is a non-thermophilic bio-oxidation process in which organic material are transformed into vermicompost which is a peat such as material, exhibiting high porosity, aeration, drainage, water holding capacity and rich microbial behavior [7], through the interactions between earthworms and related microbes. Vermiculture is a cost-effective tool for environmentally sound waste administration. Earthworms are the fundamental drivers of the process, as they aerate condition and fragment the substrate and thereby considerably alter the microbial activity and their biodegradation potential. Numerous enzymes, intestinal mucus and antibiotics in earthworm's intestinal tract play an important role in the breakdown of organic matter. Biodegradable organic wastes such as crop residues, hospital, municipal and industrial wastes pose major difficulty in disposal and treatment. Release of untreated animal manures into agricultural fields pollutes ground water causing public health hazard. Vermicomposting is the best substitute to conventional composting and vary from it in several ways. Vermicomposting hastens the decay process by 2-5 times, thereby quickens the change of wastes into valuable bio-fertilizer and produces much more homogenous substances compared to thermophilic composting [8]. Distinct variations exist between the microbial populations found in vermicomposts and composts and hence the nature of the microbial processes is quite diverse in vermicomposting and composting [9]. The active stages of composting are the thermophilic stage described by thermophilic bacterial community where thorough decomposition takes place followed by a mesophilic maturation stage. Vermicomposting is an Eosinophilic process distinguished by fungi and mesophilic bacteria. Vermicomposting encompasses of an active stage during which earthworms and connected microbes jointly process the substrate and the maturation phase that involves the action of associated microorganisms and occurs once the worm's moves to the fresher layers of undigested waste or when the product is detached from the vermireactor. The duration of the active stage depends on the species and density of the earthworms involved. A wide range of oganic wastes viz., horticultural residues from practiced potatoes, mushroom wastes, horse wastes, pig wastes, brewery wastes; municipal sewage mud [5]; sericulture wastes, agricultural residues, weeds, cattle dung manufactured refuse such as paper wastes [10]; sludge from dairy plants and paper mills, urban residues, domestic kitchen wastes and animal wastes can be vermicomposted [11]. These bacteria can be accounted promising candidates for application in mosquito control.

The newer aspect of the present proposal is to identify novel bacteria from vermicompost for the control of mosquito vectors. It is important to note here that no study has been initiated in this area of applied research though number of microbial organisms was isolated from vermicomposts for agricultural purpose. Hence, there is an increasing curiosity in the potential of vermicomposts, as plant growth media and as soil amendments in recent years. Vermicompost is a sustainable resource of macro and micronutrients, which enlivens the soil through partial substitution of the horticultural container media. Research during the past few decades has led to the identification of some biological organisms and their products that could efficiently be used as fertilizer sources. This strategy of fertilizing the soil with biological sources has been widely acknowledged and recognized as a viable alternative to the application of chemical fertilizers. The principal objective of this study is to isolate, identify and characterize the potential mosquitocidal bacteria and these bacteria can be accounted promising candidates for application in biological research (Figure 1). Hence, the proposal is directly applicable in the field of mosquito control using the mosquitocidal bacteria isolated from vermicomposts collected from the Union Territory of Puducherry.

Figure 1: Vermicompost useful for screening mosquitocidal bacteria.

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