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Research Article

Antioxidant and Anticancer Roles of a Novel Strain of *Bacillus anthracis* Isolated from Vermicompost Prepared from Paper Mill Sludge

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Mass production of vermicompost using suitable species of earthworms and selecting target organic waste materials has appeared to be a great development in the realm of biotechnological research for the sustainable eco-management. Although, for the bioconversion of organic wastes to vermicompost, suitable earthworm species play major roles, a hoard of bacterial assemblages by virtue of production of different enzymes facilitate the process of vermicomposting. The present study has documented the roles of vermicompost associated bacteria in combating, preventing, and controlling of cancer so as to open a new vista not only in the field of vermitechnology but also on biomedical research. Earthworms' associated bacterial metabolic products having their unique physicochemical excellence have gained importance due to their roles as a facilitator of apoptosis (programed cell death in a MCF-7 cell line). The antioxidant and anticancer activities of ethyl acetate extracts' of vermicompost associated bacterium *Bacillus anthracis* were undertaken by antioxidant assay which revealed maximum DPPH radical scavenging effect (75.79 ± 5.41%) of the extracts' at 900 μg ml-1. Furthermore, the crude extracts obtained from the same bacteria were found to decrease the activity of SOD (superoxide dismutase) with the increase in doses. MTT assay showed potent cytotoxic activity against human breast adenocarcinoma cells (MCF-7) with the IC50 value of 46.64 ± 0.79 μg ml-1. It was further confirmed through Hoechst 33258 staining of nuclear fragmentation assay and DNA fragmentation analysis. Western blotting test has confirmed a downregulation of Akt upon application of crude extracts. Increase of SOD activity along with decrease of Akt level reflects that the mode of action is entirely PI-3K dependent. This study tends to indicate that *B. anthracis* isolated from vermicompost could be potentially explored for the development of new therapeutic agents, especially against cancer.

1. Introduction

Vermitechnology involving vermiculture and vermicomposting process has emerged as a highly suitable, user-friendly, and cost-effective eco-technology for proper organic waste management [1]. During vermicomposting, nutrients such as nitrogen, carbon, potassium, phosphorus, zinc, and calcium of waste materials while passing through the earthworms gut are homogenized in bacterial rich environment into a highly mineralized chemical forms which are much more available to the plants when used as fertiliser [2]. It is a decomposition process in which biochemical degradation of the of organic waste materials as substrate occurs by the joint action of earthworms and microorganisms by way of fragmentation, conditioning, and stabilization [3]. Although the process involves microbial degradation, earthworms are the actual drivers of this technology [4, 5].

The present study has attempted to highlight a new vista on roles of these microbes in the context of health science. Microorganisms have so far established their importance in combating several medical problems through the production of several bioactive compounds for therapeutic purposes [6, 7]. Each year millions of people are diagnosed worldwide with cancer, and more than half of these patients eventually die from this disease. Based on global cancer statistics published in the year 2011, 12.7 million cases of cancer were detected and 7.6 million cancer deaths in a year were reported [8, 9]. Conventional cancer treatments

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Attachment and antimicrobial susceptibility of bacterial associates of zooplanktonic copepod: Lesson for environmental safety

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ABSTRACT

The present study emphasizes on the antimicrobial susceptibility of different bacterial strains isolated from the external body surface of a commonly found zooplanktonic copepod (*Heliodiaptomus viduus*, Gurney, 1916) inhabiting both in fresh and brackish water bodies of Midnapore (West and East) Districts, West Bengal, India. Out of 62 bacterial isolated strains, 38 isolates were identified as Gram-positive while the remaining 24 isolates were found to be Gram-negative. Antimicrobial properties of all those bacterial strains were determined by Vitek 2 compact system using minimum inhibitory concentration (MIC) values. All isolated bacterial strains had exhibited differential susceptibilities against some selected antibiotics. Field Emission Scanning Electron Microscope (FE-SEM) analysis revealed the considerable association of bacteria on the cuticular body parts of the studied zooplankton. The outcomes of the present research are expected to enable health professionals in identifying two major problems -1) bacterial association with zooplankton which is so far mostly considered as a novel source of food for fish in aquatic ecosystems. 2) Selection of antibiotics as treatment measure because of the pathogenic effects of zooplankton associated bacteria on human being. This unattended arena of research is also supposed to evoke a new dimension not only because of bacteria-zooplankton interactions but also on undertaking of judicious strategies to find out proper ways and means to make the surface water suitable for the utilization by the common peoples (minimising bacterial contamination) in the context of human health and environmental safety.

1. Introduction

Zooplankton and bacteria representing two significant structural biotic components in the pelagic food web of an aquatic ecosystem ensuring transfer of energy and materials among different trophic levels (Da Rosa et al., 2017).

Although there exists a complete niche differentiation between zooplankton and bacteria in the water bodies, they undergo mutual interactions in order to drive the ecological functioning of the ecosystem (De Souza Cardoso et al., 2019).

The bacterial population present in an aquatic ecosystem as planktonic form (free floating) and also as biofilm which remains associated with the body parts of zooplankton (Lawrene et al., 1987). Attachment of bacteria with body parts of zooplankton have not only observed in crustacean zooplankton but also in other zooplanktonic fauna such as appendicularians, rotifers, and jellyfish (Flood, 1991; Selmi, 2001; Schuett and Doepke, 2009). Such interactive associations are supposed to render benefits to bacteria in respect of shelter and protection in the assurance of obtaining organic carbon from the chitinous appendages of copepods (Verschuere et al., 2000a,b). The occurrence of reactive dissolved organic carbon (DOC) in a higher amount to different chitinous appendages of crustacean zooplankton is supposed to be due to the active discharge of organic matter (autochthonous and allochthonous) and sloppy feeding habits of the zooplankton (Berggren, 2015). Such condition attracts the free-living aquatic bacteria to develop zooplankton-bacterial association by attaching themselves on the bodies of zooplanktonic assemblages (Peduzzi and Herndl, 1992; Hansson and Norrman, 1995; Moller, 2005).

As the occurrence and distribution of zooplankton in spatial and temporal scale experience distinct seasonal oscillations after being determined by the combined effects of different water quality parameters, zooplankton-bacteria interaction in variable ecological conditions cannot be determined through any conventional techniques (Folt and Burns, 1999). Many studies have dealt on a per volume base with the abundance of aquatic microbes because of their free-living existence (Tang et al., 2011; Schmidt et al., 2016). In spite of complete ecological niche partitioning between these two groups (zooplankton and bacteria), culture dependent studies depict almost similar bacterial taxa

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