



Actinomycetes benefaction role in soil and plant health



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ABSTRACT

Actinomycetes are aerobic, spore forming gram-positive bacteria, belonging to the order actinomycetales characterized with substrate and aerial mycelium growth. They are the most abundant organisms that form thread-like filaments in the soil and are responsible for characteristically “earthy” smell of freshly turned healthy soil. They play major roles in the cycling of organic matter; inhibit the growth of several plant pathogens in the rhizosphere and decompose complex mixtures of polymer in dead plant, animal and fungal material results in production of many extracellular enzymes which are conducive to crop production. The major contribution in biological buffering of soils, biological control of soil environments by nitrogen fixation and degradation of high molecular weight compounds like hydrocarbons in the polluted soils are remarkable characteristics of actinomycetes. Besides this, they are known to improve the availability of nutrients, minerals, enhance the production of metabolites and promote plant growth regulators. Furthermore, actinobacteria do not contaminate the environment instead, they help sustainably in improving soil health by formation and stabilization of compost piles, formation of stable humus and combine with other soil microorganisms in breaking down the tough plant residues such as cellulose and animal residues to maintain the biotic equilibrium of soil by cooperating with nutrient cycling.

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1. Introduction

The word “Actinomycetes” is derived from Greek word “atkis” (a ray) and “mykes” (fungus), having characteristics of both bacteria and fungi [18] but yet possess sufficient distinctive features to delimit them into kingdom bacteria. Actinomycetes are aerobic spore forming gram-positive bacteria; containing high guanine-cytosine (57–75%) in their genome, and belong to the order *Actinomycetales* characterized with substrate and aerial mycelium growth. They are filamentous like fungi and possess true aerial hyphae. Actinomycetes are ubiquitous and form a stable and persistent population in various ecosystems especially in soil, where they are predominant in dry alkaline soil. They unveil an array of life cycles which are unique among the prokaryotes and seem to play a vital role in the cycling of organic matter in the soil ecosystem [111]. Actinomycetes are economically and biotechnologically most worthwhile microorganisms. Actinomycetes are well known for the production of wide range of secondary metabolites of various medical values like antibiotics, antifungal, antiprotozoal, antiviral, anticholesterol, antihelminth, anticancer and immunosuppressant. Antibiotics such as streptomycin, gentamicin, rifamycin and erythromycin which are used presently are the product of actinomycetes only. They are important not just to the pharmaceutical industries but to the agriculture as well. Actinomycetes have the potential to inhibit the growth of several plant pathogens [44,98]. It also reported that the ability of actinomycetes the ability to inhibit *Erwinia amylovora* a bacteria that cause fire-blight to apple and *Agrobacterium tumefaciens* a causal agent of Crown Gall disease [80]. Most of the Actinomycetes feed on protein or non-protein organic matter. Some Actinomycetes are autotrophs as well while as some use waxes, resins, paraffins and petroleum as source of carbon. For them nitrates, ammonium salts, urea, amino acids and other substances can be used as the source of nitrogen. Actinomycetes live under the most diverse conditions, aerobic and anaerobic, at temperatures of 5–7 °C and 45–70 °C. They indulge in diverse soil processes (ammonium fixation, decomposition of cellular tissue and the synthesis and decomposition of humus). Many Actinomycetes are used to produce antibiotics, vitamins, amino acids and other biologically active substances.

2. Nature and habitat

Actinomycetes are predominantly found in soil, in the silt of water bodies, in the air and in plant remains. They are the most abundant organisms that form thread-like filaments in the soil. They grow as hyphae like fungi responsible for the characteristically “earthy” smell of freshly turned healthy soil [89]. The actinomycetes exist in various habitats in nature [30] and represent a ubiquitous group of microbes widely distributed in natural ecosystems around the world [99]. They are primarily soil inhabitants [55] but have been found widely distributed in a diverse range of aquatic ecosystem, including sediments obtained from deep sea [14,114] even from greatest depth Mariana Trench [84,106]. They may be present in extreme environments especially at cryophilic

region Antarctica [72,87] and even in desert soil [21].

2.1. Terrestrial habitat

Actinomycete population is largest in surface layer of soils and gradually decreases with the depth; individual actinomycete strains are present in all soil layers [104]. Actinomycetes are numerous and widely distributed in soil and are next to bacteria in abundance. They are widely distributed in the soil, compost etc with estimated values ranging from 10^4 to 10^8 per gram of soil. They are sensitive to acidity/low pH (optimum pH range 6.5–8.0) and waterlogged soil conditions. They are mesophilic (25–30 °C) organisms and some species commonly present in compost and manures are thermophilic growing at 55–65 °C temperature (e.g. *Thermoactinomyces*, *Streptomyces*).

2.2. Aquatic habitat

2.2.1. Fresh water habitat

Actinomycetes are abundant in fresh water lakes. They are also found in sewage and grew well at 60 °C. Various members of genera *Actinoplanes*, *Micromonospora*, *Rhodococcus*, *Streptomyces* and the endospore-forming *Thermoactinomyces* have been isolated from freshwater habitats [15]. Majority of these actinomycetes most probably are wash-in from land and accumulated in freshwater habitats [34]. Sporangia of *Actinoplanes* could withstand prolonged desiccation and release motile spores when rehydrated [63]. *Actinoplanes* are mainly discovered on allochthonous leaf litter washed to lake shore and twigs submerged in streams. Members of the genus *Micromonospora* represent a truly indigenous group of microbial inhabitants of waters and bottom deposits of inland lakes. *Micromonospora* spores can survive as dormant propagules as they washed into streams, rivers and lakes [89]. The presence of *Rhodococcus coprophilus* a coprophilic species in lakes is believed due to wash in of contaminated herbivore dung. The presence of *Streptomyces* in freshwater habitat is because of their spores being continuously washed into rivers and lakes [47]. *Streptomyces* are dominant in water samples while great numbers of *Micromonospora* were found in sediments [108].

2.2.2. Marine habitat

The existence of actinomycetes in marine environment was believed because of soil contamination, or to their presence on algal material floating on the surface of the sea, or to the fact that the samples of water were obtained near the docks. Based on absence of apparent morphological and biochemical differences between both marine and terrestrial isolates, actinomycetes might be originated from terrestrial but adapted to salinity level of sea water [37]. The spores of actinomycetes could be transferred from land to the sea by rain or river [78]. However, certain indigenous actinomycetes have been isolated from deep sediments [115]. Besides, a bimodal distribution in relation to depth had also been reported in maximum numbers of actinomycetes from near-shore sediments in both shallow and deep sampling sites showed [46]. It is therefore

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