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Distribution of Actinobacteria in different soils of Kalaburagi region, Karnataka, India

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Abstract

This study investigates the distribution of actinobacteria in different soil samples from the Kalaburagi region, focusing on the relationship between their prevalence and the physicochemical and elemental properties of the soil. Soil samples were analyzed for key parameters, including pH, moisture content, inorganic carbon, nitrogen and elemental composition to understand the factor influencing microbial diversity. The results revealed significant variations in soil physicochemical properties across different locations, with high levels of inorganic carbon and nitrogen correlating with increased actinobacteria presence. Additionally, 48 actinomycetes were isolated based on their morphological characteristics, demonstrating the adaptability of these microorganisms to diverse soil conditions. The findings highlight the role of soil physicochemical properties in shaping microbial communities and emphasize the kalaburgi region potential as a rich reservoir of actinobacteria. These microorganisms hold promise for applications in biotechnological and agriculture.

Key words : Actinomycetes, Elemental analysis, Physicochemical, Soil samples.

Soil microorganism are vital for sustaining a balanced ecosystem. They contribute significantly to biogeochemical cycles, detoxification and elimination of pollutants, facilitate the transformation of minerals and metals, and play a crucial role in breaking down organic matters[1]. Actinomycetes, a prominent group of Gram-positive filamentous bacteria,

are known for their ability to synthesize bioactive secondary metabolites and enzymes[3,5]. These microorganisms are ubiquitous in soil ecosystems and are essential for nutrient cycling, organic matter decomposition, and sustaining soil health[10]. The soil of Kalaburgi, located in the northern region of Karnataka, India, presents a unique environment for the growth of actinomycetes due to semi-arid climate and agricultural activities. The exploration of actinomycetes diversity from such regions holds discovering novel bioactive compounds with industrial, agricultural and pharmaceutical applications[11]. The diversity of actinomycetes in soil is influenced by various physicochemical parameters. These properties influence soil fertility and impact the growth and diversity of microorganisms, including actinomycetes. Key factor such as pH, moisture content, organic carbon, and nitrogen availability, as well as elemental composition provide a comprehensive understanding of soil health[6]. Assessing these parameters provide valuable insights into the environmental factors that govern the occurrence and distribution of actinomycetes and soil functionality.

The soil in Kalaburagi is primarily black soil, known for its rich mineral content and high water retention capacity. The semi-arid climate, coupled with agricultural practices, creates a dynamic soil environment with varying physicochemical properties. By analyzing these parameters, this study aims to correlating the soils physicochemical and elemental properties with actinomycetes occurrence, this study aims to provide a deeper understanding of their ecological adaptions and explore how these environmental factors approach offers a foundation for identifying and utilizing soil microorganisms from kalaburgi in various applications, ranging from agriculture to pharmaceuticals.

Collection of soil samples :

Soil samples were collected from different locations of Kalaburagi region, India. The collected soil samples were transferred to research laboratory of microbiology, Department of Botany GUK.

Physicochemical analysis of soil sample:

Physicochemical parameters include pH, moisture content, percent organic carbon/ nitrogen were determined following standard procedure[2].

pH *of soil sample :*

Soil samples were dried at 60ºC for 24h, then powdered in pestle and mortar and sieved. The resulting fine particles were dissolved in distilled water (2.5w/v) and vortexed for 5 min at 120 rpm. The soil suspension was filtered and determine its pH using digital meter[7].

Moisture content :

10 g of soil samples was weighted both before and after oven drying at 60ºC for 24h and the moisture content was calculated using the following formula[7].

$$\text{Moisture \%} = \frac{W_{1(\text{weight of soil before drying})} - W_{2\ (\text{weight of soil after drying})}}{100} \times 100$$

Percent organic Carbon and Nitrogen :

One gram soil sample was combined with 10 ml of 1N potassium dichromate ($K_2Cr_2O_7$) and 20 ml conc. sulphuric acid (H_2SO_4). Then 25 ml of 0.5 M ferrous sulphate ($FeSO_4$) and 150 ml of deionized water were added and the solution was titrated with 0.1 N potassium permanganate ($KMnO_4$) solution, observed for the formation of pink colour at the end point[8,14].

$$\text{Percentage of organic carbon} = \frac{\text{Volume of } K_2Cr_2O_7 - \text{Volume of } KMnO_4}{\text{Weight of soil sample}} \times 0.3 \times 1.33$$

Percentage of organic nitrogen = 0.862 × % organic carbon.

Elemental analysis of soil samples by Atomic absorption spectrophotometer method (AAS) :

The soil elements were estimated using GBC 932 AA Unicom Flam Atomic Absorption Spectrometer (AAS), at USIC, GUK, Karnataka, India. 1g of soil sample was dissolved in 20ml of deionized water in 100ml of the conical flask and added 10ml of each of nitric and hydrochloric acid. Then, allowed the mixture to stand until the sample gets dissolved and the final volume was made up to one litter using deionized water. The 10mg/l of content was equivalent to 0.1% (m/m) of the element in the original sample[13].

Isolation of Actinomycetes :

Isolation of actinomycetes was carried out using serial dilution. One gram soil sample was suspended in 9 ml of distilled water and the dilution was performed up to 10^{-8} dilutions. From each dilution 0.1ml was placed on the starch casein agar plates supplemented with 10mg/100ml nystatin to inhibit fungal and bacterial contamination. The plates were incubated at 30 °C for 7days. Distinct colonies exhibiting actinomycetes-like morphology were selected and subsequently purified on ISP medium.

Collection of soil samples from different habitats :

Based on the color and nature of soil, nine distinct soil samples were collected from Farthabad agriculture field soil, Firozabad agriculture field soil, tomato cultivated soil, brinjal cultivated soil, groundnut cultivated soil, pigeon pea cultivated soil, rivers bank, compost and garden soil (Table-1).

Physicochemical analysis of soil sample :

Physicochemical analysis of soil pH, moisture, % organic carbon and % nitrogen was carried out in detail. The pH of collected soil samples was determined and revealed a varied range from 5.8 in firozabad agriculture field soil to 8 in garden soil, indicate that the garden soil exhibited higher alkalinity than the firozabad agriculture field. This increased may be due to the accumulation of alkaline materials in the garden soil, leading to elevated pH levels. (Table-2). Zakalyukina *et al.,*[15] reported that microbiological analysis with the use of neutral pH revealed the maximum number of actinomycetes[15]. However, the current study revealed that the neutral to alkalinity pH is favourable for the actinomycetes growth.

Moisture content is an important key factor and it promotes the microbial growth. The investigated soil samples showed moisture content ranged from 2% in firozabad agriculture field soil to 11% in garden soil (Table-2). Higher moisture content in garden soil is due to its ability to retain water. Actinomycetes are aerobic bacteria that depend on sufficient oxygen for growth and activity. The moisture content of the soil impacts the oxygen availability, thereby affecting the growth and activity of actinobacteria[6]. The % carbon and nitrogen were estimated and found highest of 1.236 percent carbon and 1.065 percent nitrogen in garden soil and minimum in tomato cultivated soil (0.239 & 0.206) (Table-2). It was found that there was positive correlation between organic carbon, nitrogen content and load of actinomycetes in garden soil. Key ecological factor such as pH, temperature, moisture and organic carbon and nitrogen content greatly affect the propagation of actinomycetes in soil and may play a role in the identification of new drugs[4,9].

Table-2. Physicochemical analysis of soil sample

Sl. No	Name of the soil	pH	% Moisture	% Carbon	% Nitrogen
1	Farthabad agriculture field soil	6.5	3	0.398	0.343
2	Firozabad agriculture field soil	5.8	2	0.359	0.309
3	Tomato cultivated soil	7	4	0.239	0.206
4	Brinjal cultivated soil	7.1	5	0.319	0.274
5	Groundnut cultivated soil	6.2	10	0.478	0.412
6	Pigeon pea cultivated soil	6.5	8	0.518	0.446
7	Rivers bank soil	6.8	6	0.399	0.343
8	Compost soil	6	8	0.718	0.618
9	Garden soil	8	11	1.236	1.065

Elemental analysis of different soil samples

The elemental analysis (magnesium (Mg), potassium (K), iron (Fe), zinc (Zn), lead (Pb) and copper (Cu) were carried out in detail. The brinjal cultivated soil showed the highest available soil magnesium concentration (2.249mg/L), while the pigeon pea soil had the lowest (0.502mg/L). In term of available soil potassium, the ranged from 0.052mg/L in the river bank soil to 1.524mg/L in the tomato cultivated soil. The available soil iron ranged from 0.018mg/L in the pigeon pea cultivated soil to 0.228mg/L in the brinjal cultivated soil. Zinc ranged from 0.015mg/L in the river bank to 0.097mg/L in the garden soil. Lead ranged from 0.032mg/L in the river bank soil to 0.281mg/L in the pigeon pea cultivated soil. Copper ranged from 0.009mg/L in pigeon pea and river bank soil to 0.112mg/L in the garden soil (Fig 1, Table-3). Actinomycetes are essential for nutrient cycling, including the decomposition of organic matter and mineralization of nutrients[12]. Consequently, variations in soil mineral content of the soil are major factors that impact the diversity and population of Actinomycetes.

Table-3. Elemental analysis of soil sample by ASS method

Sl.No	Soil samples	Mineral elements (mg/L)					
		Mg	K	Fe	Zn	Pb	Cu
1	Farthabad agriculture field soil	1.500	0.103	0.057	0.039	0.077	0.053
2	Firozabad agriculture field soil	1.853	0.182	0.020	0.038	0.188	0.060
3	Tomato cultivated soil	1.505	1.524	0.037	0.031	0.093	0.049
4	Brinjal cultivated soil	2.249	0.242	0.228	0.065	0.071	0.062
5	Groundnut cultivated soil	1.660	0.207	0.060	0.038	0.067	0.073
6	Pigeon pea cultivated soil	0.502	0.128	0.018	0.021	0.281	0.001
7	Rivers bank	0.791	0.052	0.121	0.015	0.032	0.001
8	Compost	1.490	0.613	0.088	0.037	0.035	0.059
9	Garden soil	2.190	0.375	0.058	0.097	0.100	0.112

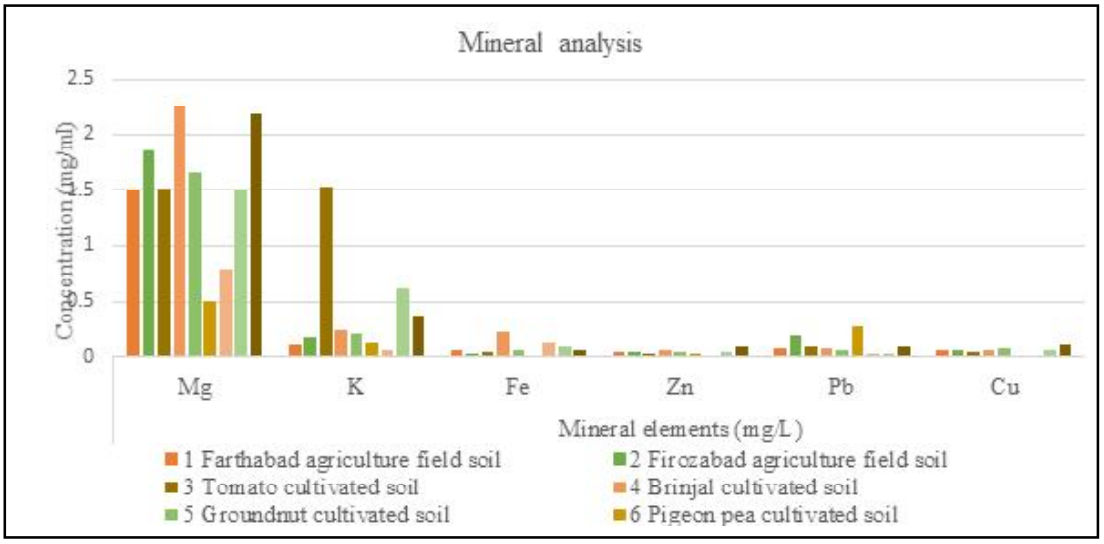

Fig. 1. Different elemental composition of different soil samples by ASS method

Isolation of Actinomycetes :

A total 48 actinomycetes isolates were extracted from the analyses of 9 different soil samples. All the actinomycetes isolates were pure cultured by using standard techniques. The morphological and cultural characteristics of these isolates revealed they belongs to *Streptomyces*, *Micromonospora*, *Nocardia*, *Rhodococus*, *Nocardiopsis*, *Streptosporangium*, *Saccharopolyspora* sp. The actinomycetes species that appeared simultaneously will be selected for further studies.

Isolation, physicochemical and elemental

analysis of soil samples from the kalaburgi region revealed significant variability in soil composition and microbial diversity. A total of 48 actinomycetes isolates were successfully obtained based on their morphological characteristics, indicating the regions potential as a reservoir for diverse microbial strains. Physicochemical analysis demonstrated distinct soil properties, including pH, moisture content, organic carbon, nitrogen levels and elemental analysis influence on soil quality and microbial ecology. In addition to providing a baseline for the soils agricultural potential and identification of novel bioactive compounds from the isolated actinomycetes, supporting their future application in medicine, agriculture and industry.

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Conflicts of Interest

Nill

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