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Short Communication

Biodiversity of *Streptomyces* of high-mountainous ecosystems of Kyrgyzstan and its biotechnological potential

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Abstract

The prevalence of actinomyces of *Streptomyces* class in various types of soils of Kyrghyzstan and the variety of its species have been investigated. It is shown that predominant members of *Streptomyces* complex are in the *Cinereus* section of *Chromogenus* series which are basically adapted to chestnut and black soil while species of the section *Roseus* of the *Fuscus* series are adapted in gray, brown, and chestnut soils. Their antibiotic and growth-stimulating effect and a great opportunity of use in biotechnological process have been determined.

Introduction

Streptomyces are one of the groups of microorganisms that are widely spread in soils and play an important role in the circulation of organic substances in nature.

Many representatives of this group have important practical interest as producers of antibiotics and other biologically active substances which have wide use in biotechnological production. *Streptomyces* have been found in all known soils of the world yet their number, role in biocenosis and biochemical activity vary depending on ecological and geographical conditions. Ecological and biotechnological features of the soil streptomyces in the natural ecosystems of Kyrgyzstan remain almost unexplored.

The present work aims to research *Streptomyces* complexes in various soil biotopes of Kyrgyzstan and to prospect their biological activity as producers of biofungicides and biological stimulators.

Materials and methods

During this work the following samples of soils have been analyzed: black soil, chestnut soil, and gray soil, taken from natural and managed ecosystems and agrobiocenosis of Kyrgyzstan (Mamytov).

The analysis of actinomyces was done using the sowing method from fluidized soil suspensions on agarized nutrition medium of Gauze 1. To isolate actinomyces into pure cultures and their further cultivation, oat agar has been used. The generic and specific identification was accomplished according to the determinant of Bergey's Manual (2000) and Gauze G.F. (1983).

The methods of strokes and agar blocks have been used in defining the antibiotic characteristics. Pathogens of agricultural and forest plants have been used as test cultures.

The sowing material of the *Streptomyces* strains has been cultivated in Amylum-ammoniac and oat agar. The obtained sowing material (5% of medium's size) was sowed in flasks with the sterilized fluid nutritious medium. The crops were grown in flasks on a shaker with a rotation speed of 200–220 rotations per minute at 28–30 °C during 72–96 h.

In order to study the growth-stimulating effect of the *Streptomyces* strains in laboratory and field conditions, we tested the suspension in doses of 50,100,500 mg/l. The seeds of Tiang-Shang fir were primarily steeped in 0.2–0.3% solution of $KMnO_4$ for decontamination. Slightly dried seeds were steeped in spore suspension of the strain cultures during 6, 12, 24, 48 h. We regularly dug out 25–30 healthy seedlings, measured their over ground length (stalk, fir needle), main root's length, the diameter of root's neck, and fixed their organic weight.

Results and discussion

The resulting data showed that in the examined types of soils, which differ from each other on their agrochemical properties and cultivation degree, various *Streptomyces* have been found, varying in diversity of their species and antagonistic ability. A rich diversity of *Streptomyces* was contained in the soils of mountainous ecosystems.

Ten cultures with antagonistic characteristics have been found in mountainous black soils, nine cultures in gray soils, and 16 cultures in chestnut soils (see Figure 1). Moreover, the majority of cultures of the last soils have shown a wide range of biological activity. In addition, our research has shown that soils of the reserved areas are rich in various species of *Streptomyces*. However, there are very few cultures having antagonistic characteristics among them.

By contrast, strains obtained from the soils of the technogenic ecosystems, namely on the territory of the Ak-Tuz ore dressing factory, which has been emitting heavy metals into soil during several years, had strong antagonistic characteristics.

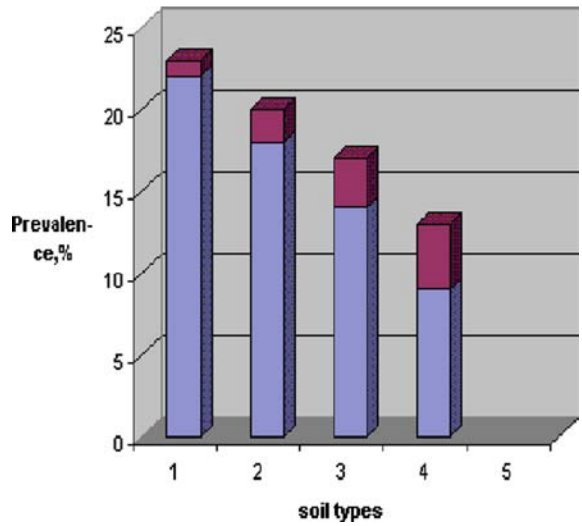

Figure 1. Prevalence of *Streptomyces* in various types of soil : 1 – black soil, 2 – chestnut soil, 3 – grey soil, 4 – brown soil.

The resulting data from this study show that the *Streptomyces* in various soils have different sets of groups and species as well as different quantitative properties. The representatives of the *Cinereus* section were prevailing in all of the examined types of soils. The *Roseus* group is less represented, and *Albus* and *Azureus* sections are fewer. The representatives of *Helvolo-Flavus* sections have been found in low quantity (see Figure 2). It is shown that the *Cinereus* section of *Chromogenus* series is basically adapted to mountainous chestnut and black soil (1900–2500 m high), the species of the section *Roseus* of the *Fuscus* series are adapted to gray, brown, and chestnut soils. The series of other sections did not show obvious adaptation to certain soil biotopes.

The total number of the prospected strains of *Streptomyces* reached 65, and 18 of them had evident antagonistic characteristics.

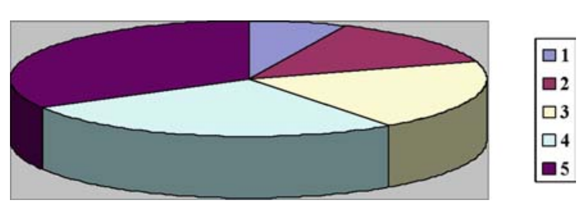

Figure 2. Taxonomic structure of *Streptomyces* and the quantity proportion of sections: 1 – *Helvolo-Flavus*, 2 – *Azureus*, 3 – *Albus*, 4 – *Roseus*, 5 – *Cinereus*.

The biotechnological potential of the strains obtained has been discovered during the research on their antibiotic activity. The results of the research on the biological activity of some *Streptomyces* strains are cited in Table 1.

Some of the tested *Streptomyces* cultures have shown a wide spectrum of the antagonistic characteristics, especially the strains of *S. bambergiensis*, *S. rubrogriseus* and *S. griseogromogenes*. They suppressed the growth and the development of phytopathogen not only of coniferous plants but also agricultural, whereas other species such as *S. noursei* and *S. fumanus* had a particular specificity and suppressed the development of only certain species of disease pathogen.

The growth-stimulating effect and increasing resistance of some *Streptomyces* strains to fungus diseases of coniferous arboreal species and agricultural crops were examined. The results of the research are given in the Table 2.

Almost all the tested strains with a concentration of 50 and 100 mg/l demonstrated a stronger growth-stimulating effect than strains with a dose of 500 mg/l. High germination capacity (86–93%) was demonstrated by the seeds steeped with the suspension of preparations of strains *S. rubrogriseus*, *S. bambergiensis*, *S. heliomycini*.

Thus, for the first time in the conditions of Kyrgyzstan, from various types of soils were isolated new species of *Streptomyces* class which had

Table 1. Biological activity of *Streptomyces* strains against diseases of coniferous species and agricultural plants.

No	Tested *Streptomyces* strains	Radius of zone lyses of phytopathogenic test-cultures, mm				
		Alternaria	*Fusarium*	*Sclerotinia graminearum Elen*	*Hypodermella sulsigena Tub*	*L. pinastri*
1.	*S. bambergiensis*	20.6	17.8	10.0	10.0	20.0
2.	*S. noursei*	15.0	14.3	8.2	15.2	10.0
3.	*S. griseogromogenes*	15.5	20.0	20.0	20.0	15.0
4.	*S. rubrogriseus*	18.0	21.0	12.3	21.0	12.5
5.	*S. fumanus*	2.5	16.0	1.2	14.8	1.5
6.	*S. wistariopsis*	3.4	16.3	11.2	20.0	4.0
7.	*S. albadancus*	5.0	15.8	12.5	15.6	0.5
8.	*S. heliomycini*	15,0	16,2	14,3	5,4	0
9.	Control	Growth is abundant	Growth is abundant	Growth is abundant	Growth is abundant	Growth is abundant

Table 2. Germination capacity and seed sprouting of the Tiang-Shang Fir after the treatment with suspension of the *Streptomyces* biological preparations (in 15 days).

Biopreparation sample	Concentration mg/l	Accretion Intensity, %	Germination in lab conditions, %	Stalk length days, mm	Root length, mm	Sprout weight, mg
S. bambergiensis	50	40	86	4.6	4.3	188
	100	42	92	4.2	3.8	112
	500	49	94	4.0	3.8	124
S. rubrogriseus	50	42	90	4.3	3.6	160
	100	36	86	4.0	3.0	166
	500	34	80	3.8	3.0	168
S. heliomycini	50	34	84	3.5	3.3	113
	100	36	86	3.6	3.2	121
	500	34	91	3.5	3.3	128
S. wistariopsis	50	53	93	5.2	4.5	192
	100	48	92	4.4	3.6	119
	500	48	90	4.3	3.6	124
S. fragilis	50	44	92	4.8	3.6	177
	100	42	86	4.7	3.8	126
	500	42	84	4.6	3.8	129
Control	Water	36	78	3.4	3.3	106

antagonistic characteristics towards phytopathogens of agricultural plants and coniferous trees and great growth-stimulating effect to their seeds.

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