BR03 - Study on Restoration of Bauxite Residue by Salt-Alkali Tolerant Bacteria

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Abstract

Two salt-alkali tolerant bacteria (ZH-1 and ZH-22) were successfully isolated from bauxite residue disposal site. Both strains were identified by 16S rRNA genes as *Bacillus sp.* The restoration effect of salt-alkali tolerant bacteria on bauxite residue was studied to provide technical support for ecological restoration of bauxite residue disposal site. Bauxite residue was treated with the culture medium of ZH-1 and ZH-22, and the pH value of bauxite residue decreased from 11.57 to about 9 within 45 days and remained basically stable. The addition of ZH-1 and ZH-22 strains increased the organic matter and microbial biomass carbon content in bauxite residue as well as increased the catalase and dehydrogenase activities. The stability of bauxite residue aggregates was significantly improved after the treatment within 30 days, and the improvement was more obvious for the treatment of ZH-22. The analysis of bacterial community showed that the relative abundance of ZH-1 and ZH-22 in bauxite residue increased from 5.06 % and 2.71 % to 23.5 2% and 12.03 %, respectively, during the 30 days incubation. After that, additional carbon and energy source were supplied, and the relative abundance of ZH-1 and ZH-22 further increased, and with ZH-22 more significant. This result indicates that additional supply of carbon source can induce the resurrection of the salt-alkali tolerant bacteria.

Keywords：Bauxite residue, salt-alkali tolerant bacteria, microbial biomass carbon, aggregates.

1. Introduction

The reduction and comprehensive utilization of bauxite residue in alumina industry has become a worldwide problem, so far there is no feasible method for large-scale utilization in the world. A large amount of bauxite residue is disposed by storage, its pollutant migration risk is large, the natural weathering process is slow, and the ecological reconstruction of the yard is difficult. The environmental safety problem of bauxite residue storage is seriously threatening the sustainable development of alumina industry [1]. At the same time, the vegetation reconstruction of bauxite residue disposal site is the most promising method ecological disposal of bauxite residue [2]. However, due to the strong salinization and special physical structure of bauxite residue, it is difficult to plant common plants [3-5]. Therefore, reducing the pH value of bauxite residue and improving the physical structure of bauxite residue are the premise of vegetation reconstruction. At home and abroad, a series of research and practice work have been carried out for bauxite residue soil improvement, such as using foreign soil cover [6], adding modifier [7-9], leaching neutralization [11-13], etc. Although these methods have certain effect, but their efficiencies are not high, there are the problems of secondary pollution or high economic cost.

Microorganisms play an important role in bauxite residue improvement. Soil microorganism is the key driving force of nutrient transformation and circulation of organic matter in soil ecosystem [14]. Microorganism is closely related to many biochemical processes in soil and is sensitive index to characterize soil quality [15]. It can be used as an index of soil ecosystem stability and has environmental remediation function. The metabolic acidogenesis of microorganisms can neutralize the alkalinity of bauxite residue and promote the improvement of lateritic soil, which has great potential in realizing large-scale ecological restoration of bauxite residue [16-21]. Screening suitable strains and providing suitable growth environment to improve microbial activity are the research focus of current microbial methods [22].

Two saline-alkali tolerant bacterial strains (ZH-1 and ZH-22) with high organic acid yield have been screened from bauxite residue yard. Both strains belong to Bacillus (Bacillus sp.). ZH-1 and ZH-22 have strong metabolic acid production ability in alkaline environment, and the organic acids produced (such as citric acid, butyric acid and tartaric acid) are the key factors to reduce the alkalinity of bauxite residue and improve the structure of aggregates. This paper will study the effect of ZH-1 and ZH-22 saline-alkali tolerant bacteria strains on bauxite residue, analyze the effect of their metabolites on bauxite residue pH value, aggregates and their stability, characteristic enzyme activity and microbial carbon, study the changes of community structure during bauxite residue restoration, explore the survival state of saline-alkali tolerant bacteria in bauxite residue, and provide technical support for microbial remediation application in bauxite residue disposal site.

2. Experiment

2.1 Materials and Experimental Methods

The bauxite residue samples were taken from the bauxite residue disposal site of Henan Branch of CHALCO. Table 1 showed the main chemical composition of the bauxite residue. The main chemical composition of the bauxite residue is Al_2O_3, Fe_2O_3, SiO_2, CaO and Na_2O, among which Na_2O is 6.55%.

Table 1. The main chemical composition of the bauxite residue.

Element	Al_2O_3	SiO_2	Fe_2O_3	Na_2O	CaO	MgO	K_2O	TiO_2
Content (%)	25.48	20.58	11.77	6.55	13.97	1.54	2.07	4.14

The collected bauxite residue samples were put into sample bags and stored in 4 °C refrigerator for standby. The liquid medium was prepared according to yeast extract 3.0 g/L, glucose 5.0 g/L, sodium chloride 50.0 g/L. the strain ZH-1 and ZH-22 cultured to logarithmic phase were inoculated into the optimal medium, and then mixed with high-purity water and added into 2 kg bauxite residue, and cultured in biochemical incubator at 30 °C for 4 d, 7 d, 14 d, 21 d, 30 d and 45 d, and then added carbon source at 30 d After the last sampling, part of the bauxite residue was stored in the refrigerator at -20 °C for standby, and the other part was dried in the oven at 50 °C.

2.2 Analysis

2.2.1 Determination of pH Value of Bauxite Residue

The dried samples of raw bauxite residue, 4 d, 7 d, 14 d, 21 d, 30 d and 45 d were taken. Determine the pH of bauxite residue solution according to the ratio of liquid to solid 5:1, weigh 5.0 ± 0.1 g bauxite residue, put it into a 50 ml beaker, add 25 ml high pure water, stir it violently with glass rod for 5 min, then stand for 30–60 min, measure the pH of the supernatant with a calibrated pH meter, and calculate the average value of five parallel tests.

5. References

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