Using Soil Microorganism to Construct a New Index of Soil Quality Evaluation

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Abstract. As an important resource for human survival, soil plays an important role in maintaining productivity, environmental quality, animal and plant health, etc. Unreasonable use of land resources and large-scale soil degradation has brought serious threat to human beings. At present, the evaluation of soil quality focuses on the physical and chemical properties of soil, and the study of soil microorganisms has little impact on soil quality. This paper attempts to construct a new soil quality evaluation system from the perspective of soil microorganisms, highlighting the important role of soil microorganisms, and providing new ideas for the rational construction of soil quality evaluation system.

1. Introduction

With the increasing pressure of population on land and the over exploitation of land resources, soil degradation is gradually caused. In China, soil degradation is very serious. At present, 1/4 of the total area are difficult to use due to the poor ecological environment or low soil fertility. Only 35.8% of the total area has soil organic matter content higher than 2%, and 37% of the total area has low yield. The area of soil erosion, soil desertification, salinization and acidification is still increasing. The area of soil erosion in China is 3.67 million square kilometers, an average annual increase of 10000 square kilometers, and the area of desertification is 2.674 million square kilometers, and the development speed is amazing [1].

Soil is an important resource for human survival and development. It plays an important role in maintaining crop productivity, environmental quality, animal and plant health in the ecosystem [2-3]. The most fundamental role of soil is to provide nutrients and water for crops, but also as a medium for the extension and fixation of crop roots. The soil not only stores and supplies nutrients, but also performs a series of biological, chemical and physical transformation of various nutrients in the soil. Therefore, it is urgent to strengthen and continue to pay attention to the research of soil, to help the restoration of damaged soil, and to build a powerful soil ecosystem.
2. Current situation of soil quality evaluation

Soil quality is the embodiment of a series of comprehensive processes including soil physical, chemical and biological properties [4]. Sparling and Schipper describe soil quality as the function of "maintaining ecological balance, maintaining biological productivity, maintaining environmental quality and maintaining plant, animal and human health" carried by soil, which is different from a single physical, chemical and biological index. It is necessary to evaluate these attributes on a time scale or a space scale [5].

Soil quality, as a comprehensive index to evaluate soil restoration status, can effectively indicate soil status. Improving soil quality is the ultimate goal of sustainable land use and management. Reliable and accurate soil quality evaluation is helpful to strengthen the correct understanding of soil quality. It is a decision-making method for quantitative and comprehensive expression of known soil attributes, in which soil quality index method benefits from its high flexibility and easy implementation [6], making it the most commonly used method for evaluating soil quality. The soil quality index usually consists of three steps: (1) select the appropriate index, (2) grade the index, and (3) combine the index scores into a comprehensive index. Single soil index can not accurately evaluate the difference of soil quality [7]. In the evaluation of soil quality, soil physical, chemical and biological characteristics that can affect soil function and are sensitive to environmental change are selected as soil quality indicators [8], especially biological indicators. Because they are used to evaluate the short-term impact of environmental change on soil function, more attention has been paid recently [9].

The index system of soil quality evaluation should be considered comprehensively from the aspects of soil system components, state, structure, physical and chemical properties, biological properties, functions and time and space. In the early stage of soil quality evaluation, the relationship between individual soil properties and soil quality was discussed by simple correlation analysis. In recent years, with the application of statistical methods in related fields, more and more researchers use multivariate analysis method to integrate a large number of soil property indicators into comprehensive indicators, functional relationships or graphs to evaluate soil quality. At present, principal component analysis is widely used in soil quality evaluation. It is generally believed that principal component analysis can weaken the error caused by the autocorrelation among variables, form the uncorrelated principal components, obtain the scores of each principal component, and obtain the comprehensive evaluation scores through calculation, so as to achieve the accurate evaluation of soil quality [10].

3. Interaction between soil microorganism and soil

Soil microorganisms obtain nutrients and habitats from the soil, directly participate in the soil material circulation and energy flow, and play an important role in maintaining the stability of the ecosystem and regulating the soil ecosystem, which directly affects the soil condition [11], and has an impact on the soil quality [12]. Soil microorganism plays an important role in the process of ecosystem, which is the main driving force and influencing factor of biochemical process. Due to the important regulatory role of soil microorganisms in the ecosystem, the restoration of soil microbial community is the key process of soil restoration, which has a positive effect on the realization of soil health and sustainable utilization [11]. Research shows that soil microorganisms play an important role in regulating various ecological functions [13]. Soil microorganisms obtain nutrients and habitats from the soil and have an impact on soil quality. Soil microorganisms improve the vitality of soil, which are closely related to the quality and health of soil, and are important driving forces of material circulation and energy flow in soil ecosystem [14]. Therefore, soil microbial diversity is an important indicator of soil quality. Conversely, soil quality can also affect soil microbial diversity.

Soil is a very complex organic-inorganic complex. Its physical, chemical and biological properties determine the characteristics of soil. Soil quality is the basis of the healthy and sustainable development of agricultural ecosystem. Soil microorganism is an important part of soil quality evaluation. Once the soil quality is destroyed or lost, the soil microbial ecosystem will be destroyed and the diversity of soil microbial will be reduced.
4. Constructing a new index of soil quality evaluation with soil microorganism
Soil microorganism is one of the most potential sensitive indicators to characterize soil quality. The relationship between soil microorganism and environment is reflected by the number and diversity of microorganism, microbial biomass, biological activity of microorganism and the correlation between soil enzyme and environmental factors [15]. Soil microorganisms and their biological activities are often used as early sensitive indicators of soil stress process or ecological restoration process in natural and agricultural ecosystems. Soil microorganism is the most active part in the soil. It not only participates in almost all life processes in the soil, including nutrient decomposition, transformation and circulation, energy flow, etc., but also reserves the effective nutrients of plants, and enriches the organic part of the soil through the life active products [16]. Soil microorganism is very sensitive to the change of micro environment, and can react rapidly according to the change of environment [17]. Therefore, the sensitivity of soil microorganism to the change of micro ecology makes it as a biological index to make up for the defects of physical and chemical indexes and become a more direct and effective quality evaluation index.

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