Influence of particle size and extraction time on soil pH analysis based on SPSS software

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Abstract. Soil pH is an important index of the basic physicochemical properties of soil. In this paper, the effects of different soil particle size (0.9 mm and 2.0 mm) and extraction time (10 min, 30 min and 60 min) on the soil pH analysis were analyzed. SPSS software was used to analyze the data for significance analysis. The results showed that the particle size and extraction time had little effect on the pH value during the process of soil pH determination.

1. Introduction
Soil is a crucial medium for crop growth, which maintains the crop productivity and affects the quality of the environment and the health of animals, plants and human beings. Soil acidity and alkalinity is a comprehensive reflection of many chemical properties of soil. It is closely related to the formation process of soil and the effectiveness of various nutrients in the soil. Soil pH plays an essential role in a series of processes including dissolution, precipitation, oxidation, absorption, re-absorption and coordination reaction in the soil. The appropriate pH value can provide a good external environment for the growth of plants and microorganisms.

With the development of social economy and the improvement of industrial productivity, the problems faced by the soil environment are getting worse, such as the salinization, the erosion, the desertification, the degradation and the pollution of soil. These problems lead to the extreme decline of soil quality in agricultural arable land and the serious shortage of comprehensive agricultural production capacity. This directly threatens and affects the safe production of grain in China, which also severely hinders the sustainable development of our agricultural economy [1-2]. Therefore, the quality improvement of land has become an urgent problem to be solved in land use.

Soil pH is one of the most important physical and chemical indicators of soil. The research on soil pH will help to achieve land use and management, and to change the focus on the quantity to the combination of quantities, qualities, protection and ecological management. It can also improve the comprehensive benefits of land use and effectively promote the development of land use work [3-4].

In this study, a number of alkaline and acidic soil samples were selected, and the effects of soil particle size (0.9 mm and 2.0 mm) and extraction time (10 min, 30 min and 60 min) on pH determination were studied based on SPSS software.
2. Materials and Methods

2.1. Preparation of soil samples
The acidic (pH about 6.5) and alkaline soil (pH about 8) samples were collected. The soil was naturally air-dried and grinded, and then passed through the 0.9 mm and 2.0 mm sieves. A number of soil samples required for the subsequent experiments were obtained, and were then stored in the plastic bags.

2.2. Effect of particle size on pH measurement
4 g of 0.9 mm and 2.0 mm of alkaline and acidic soil samples were weighed by electronic balance. The soil samples were placed in a 50 mL beaker and added 10 mL de monized water, according to the soil and water ratio of 2.5:1. The mixture was evenly stirred by glass rod and was allowed to stand for 30 min. The soil pH was measured by a pH meter. Each sample was repeated 3 times to record the results.

2.3. Effect of extraction time on pH measurement
4 g of 0.9 mm and 2.0 mm of alkaline and acidic soil samples were weighed by electronic balance. The soil samples were placed in a 50 mL beaker and added 10 mL de monized water (the soil and water ratio was 2.5:1). The mixture was evenly stirred by glass rod and was allowed to stand for 10 min, 30 min, and 60 min, respectively. The soil pH was measured by pH meter. Each sample was repeated 3 times to record the results.

2.4. Statistical analysis
One-way ANOVA analysis and t-test analysis based on the p-value was performed to evaluate the significance of the difference among different samples, using SPSS software (version 19.0).

3. Results and Discussions

3.1. Effect of soil particle size and extraction time on pH measurement in alkaline soil
Figure 1 is a comparison of pH measured in alkaline soil of different particle sizes at different extraction time. It can be seen that for soil of the same particle size, the average value of soil pH increased slightly with the increase of lixiviating time, with a value-added range of 0.03 units.

According to the statistical results obtained from SPSS software (Figure 2), for the soil samples with similar particle size, the influence of extraction time on soil pH measurement was not significant. In addition, under the same extraction time, the pH determination average of 0.9 mm particle size of alkaline soil was slightly higher than the pH value of 2.0 mm particle size soil, regardless of the extraction time length. However, there was no significant difference between the different particle size treatment, according to the statistical results (Figure 2).

![Alkaline soil (water-to-soil ratio 2.5:1)](image)

Figure 1. Effect of particle size on the pH determination of alkaline soil (water-to-soil ratio 2.5:1)
Figure 2. The results of t test in alkaline soil (Note: 1, 2, 3 groups are 0.9 mm alkaline soil with extraction time of 10 min, 30 min and 60 min; 4, 5, 6 groups are 2.0 mm alkaline soil with extraction time of 10 min, 30 min and 60 min).

3.2. Effect of soil particle size and extraction time on pH measurement in acidic soil

Figure 3 is a comparison of the pH measured in acidic soil of different particle sizes at different extraction time. For soil samples with the same particle size, the average value of soil pH showed a tendency of decrease, and then increased with the rise of lixiviating time. The fluctuation ranges in soil pH for 0.9 mm soil and 2.0 mm were about 0.09 and 0.05 units, respectively.

According to the statistical results obtained from SPSS software (Figure 4), the impact of extraction time on soil pH determination was not significant for the soil samples with the same particle size. Under the conditions of the same extraction time, the average pH value of 0.9 mm acid soil was slightly lower than that of 2.0 mm acid soil. But within the same extraction time, there was no significant difference between the different particle size treatments (Figure 4).
Figure 3. Effect of particle size on the pH determination of acidic soil (water-to-soil ratio 2.5:1)

![Acid soil graph](image)

**Multiple Comparisons**

| d | VAR900001 | (d) VAR900001 | Mean Difference d- d |
|---|------------|----------------|----------------------|
| 7.00 | 8.00 | .05000 | 0.2611 | .104 | .0139 | .1138 |
| 9.00 | 7.00 | -.03333 | 0.2611 | .248 | .0805 | .0372 |
| 9.00 | 8.00 | -.03333 | 0.2611 | .288 | .0872 | .0305 |

**Multiple Comparisons**

| d | VAR900001 | (d) VAR900001 | Mean Difference d- d |
|---|------------|----------------|----------------------|
| 10.00 | 11.00 | .09333 | 0.04579 | .086 | .0167 | .2054 |
| 12.00 | 11.00 | .09333 | 0.04579 | .086 | .0167 | .2054 |
| 12.00 | 10.00 | .09333 | 0.04579 | .086 | .0167 | .2054 |
| 12.00 | 11.00 | .09333 | 0.04579 | .086 | .0167 | .2054 |

Figure 4. The results of t test in acidic soil (Note: 7, 8, 9 groups are 0.9 mm acidic soil with extraction time of 10 min, 30 min and 60 min; 10, 11, 12 groups are 2.0 mm acidic soil with extraction time of 10 min, 30 min and 60 min).
In this study, the effects of particle size and extraction time on soil pH determination were not significant. This indicated that the particle size and extraction time had little effect on soil pH in the determining process. The same conclusion has been reported in another study using extreme difference methods [5].

4. Conclusion

In summary, for both alkaline and acidic soils, soil particle size (0.9 mm and 2.0 mm) and extraction time (10 min, 30 min and 60 min) had little effects on the soil pH determination. According to the general experimental requirements of precision and from the aspects of simple experimental operation and data error considerations, it is recommend to choose the appropriate particle size and extraction time for soil pH analysis.

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