Physical and Chemical Properties and Nutrient Composition of Pisha Sandstone Under Different Temperature and Ph Value

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Abstract. The Pisha sandstone is widely distributed and rich in mineral elements. It has caused widespread concern about how to turn the rich mineral elements contained in Pisha sandstone into an activation state that can be absorbed and utilized by plants. Meanwhile, it will be the focus of this paper that the effect of physical and chemical properties and nutrients of the Pisha sandstone under the various activation conditions, such as pH, temperature and salt solution. We take pH and temperature as examples, the changes of physical and chemical properties, the main nutrients and nutritional level evaluation of the treated Pisha sandstone were studied. The results show that the conductivity of the Pisha sandstone can be improved under acidic or alkaline conditions. The temperature is one of the main factors affecting the content of available phosphorus, organic matter and available potassium of the Pisha sandstone, while the total nitrogen content is little affected by pH and temperature. And the nutrient grade of the Pisha sandstone increases from very low to low Only at 50°C.

1. Introduction
The Pisha sandstone is a general appellation in China for some type of fluvial clastic deposition sandstone formed in the Jurassic, Triassic and Cretaceous period [1]. It is mainly distributed in the Inner Mongolia Autonomous Region and parts of its neighboring Shaanxi Province and Shanxi Province in northwestern China. The total area is about 5.44104 km², and the soil type is mainly aeolian sandy soil and loess, about one-third of which is loose rock [2]. The Pisha sandstone has the characteristics of becoming sand after encountering the wind and becoming mud after encountering water. It is prone to weathering and erosion, and the water and soil loss in its distribution area is very serious. Therefore, China attaches great importance to the control of the Pisha sandstone and has carried out a number of research and governance projects. At present, the domestic and international
sandstones are concentrated in the following aspects: The basic lithologic characteristics of the Pisha sandstone, including basic physical and chemical properties, particle composition, mechanical strength; sediment yield and its laws in the sandstone area; Physical and chemical properties and crop growth after the Pisha sandstone and sand compounding improvement; Adsorption characteristics of heavy metal ions in strontium sandstone [2-6]. In addition, through the analysis of the composition of the sandstone composition, it is found that the main chemical components in the sandstone include quartz, potassium feldspar, plagioclase, montmorillonite, kaolin, calcite, etc. Different colors of strontium sandstone vary in composition ratio [7, 8]. Mean, the rich elements such as Ca, Mg, K, Na, P, S, and various trace elements contained in the Pisha sandstone can be transformed into a state that can be absorbed and utilized by plants and microorganisms through weathering. Then, through the artificially simulated weathering, for example, through the activation of mineral elements in the sandstone by temperature, pH, salt ions, etc., whether it will affect the physical and chemical properties of the sandstone and the composition of nutrients, and the degree of impact, further research is needed. In this research, the changes of physicochemical properties and nutrient composition including available potassium, organic matter, total phosphorus of the Pisha sandstone, then analyzing through nutrient evaluation to provide a theoretical basis for the impact of the activation process of the Pisha sandstone on its lithology.

2. Materials and Methods

2.1. Materials

The tested Pisha sandstone was from Yulin, Shaanxi Province, China. The gravel and plant residues are removed, passed through a 2mm standard sieve for use after natural air drying. The reagents such as HCl and NaOH used in this research were all of analytical grade.

2.2. Batch test of the change of Pisha sandstone physical and chemical properties and nutritional Composition

Accurately weigh 18 pieces of 50g Pisha sandstone that has passed the 2mm standard sieve, and add 50 mL of solution with pH 2, 4, 6, 8, 10, 12 respectively. The pH value of the solution was adjusted with 0.1 mol/L NaOH and 0.1 mol/L HCl. After stir well and seal, standing at 25 ° C, 50 ° C, 100 ° C for 24 h, and then drying in an oven at 105 ° C, then the obtained strontium sandstone samples were reground through a 2mm standard sieve. Finally, the conductivity, available potassium, available phosphorus, total nitrogen, organic matter and other indicators of these samples were tested. Another 50 g of 2 m standard sieve of Pisha sandstone was added to 50 mL of pH 7 solution, the temperature was set to 25 ° C, and the corresponding indicators were tested according to the above steps, as a control, recorded as CK. A total of 18 treatments were tested, and each treatment was set to repeat 1 time.

2.3. Analytical method

The conductivity of strontium sandstone was determined by soil colloid Zeta potential meter (Brookhaven Zeta PALS). The determination of available potassium was carried out by ammonium acetate extraction-flame photometer. The determination of available phosphorus was carried out by sodium bicarbonate extraction-molybdenum antimony Spectrophotometry (HJ 704-2014), the determination of total nitrogen using the acid digestion-flow analyzer method, and the determination of organic matter using the potassium dichromate method. Data foundation processing, chart production, variance and correlation analysis were performed using Excel 2010 and SPSS 10.0, respectively.
3. Results and discussion

3.1. The changes of physical and chemical properties of Pisha sandstone

Conductivity and CEC (cation exchange capacity) are the main physical and chemical properties of sandstone. As shown in Figure 1, the conductivity and CEC of the CK Pisha sandstone in the control group were 9.7 ms/m and 10.69 cmol/kg, respectively. The conductivity of strontium sandstone is improved under acidic or alkaline conditions, and it tends to increase with acid/alkaline enhancement. Analysis of variance showed that there was no significant difference between the three temperatures (F=0.442, P>0.5). Therefore, under different pH conditions, the conductivity of the Pisha sandstone is not affected by temperature. However, it can be seen from the figure that the electrical conductivity of the Pisha sandstone is affected by temperature. The rate is affected by temperature. Overall, the higher the temperature, the higher the conductivity of the sandstone. Among them, when the temperature is 100 °C and the pH is 2, the conductivity of the Pisha sandstone is the highest, which is 21.3 ms/m. For CEC, the CEC content in the Pisha sandstone is basically larger than CK after being treated by different pH and temperature, but it has little relationship with temperature. When the temperature is 50 °C, pH=8, the Pisha sandstone CEC is the largest, equal to 15.56 cmol/kg.

![Fig. 1 Variation of Pisha sandstone conductivity and CEC under different pH and temperature conditions](image)

3.2. The changes of nutrient in the Pisha sandstone

Table 1 shows the main nutrients of the Pisha sandstone after treatment with different pH values and temperature, including organic matter available phosphorus available potassium. Among the 18 treatments, 77.8% of the sandstone organic matter content was lower than CK, which was reduced by 0.85%~59.60%. The available phosphorus content in the sandstone varies with pH to varying degrees. When the temperature is 50 °C, under the acidic condition (pH<7), the effective phosphorus content of the Pisha sandstone is lower than the CK; and when the temperature is 25 °C, it’s lower than the CK value when the pH value is 2. The effective phosphorus content of the treated Pisha sandstone in both 25 °C and 50 °C groups increases with the increase of pH value under acidic conditions, and it almost never changes when the pH≥7. The available potassium content of the Pisha sandstone increased only 0.88~1.03 times at 50°C, and reached the maximum at pH 4, which was 156 mg/kg. The available potassium content of the Pisha sandstone in this treatment group did not fluctuate much. When the temperature is 25 °C and 100 °C, the available potassium content in the Pisha sandstone fluctuates above and below the CK value, and it tends to increase first and then decrease, and also reaches the maximum at pH 4, respectively, and increased by 0.17 times and 0.09 times.
Table. 1 The nutrients of the Pisha sandstone after treatment with different pH values and temperature

| T/℃ | pH  | Organic matter(g/kg) | Total nitrogen(g/kg) | Available phosphorus(mg/kg) | Available potassium (mg/kg) |
|------|-----|----------------------|----------------------|-----------------------------|-----------------------------|
|      | 2   | 2.84                 | 0.10                 | 4.8                         | 110                         |
| 25   | 4   | 3.17                 | 0.15                 | 5.3                         | 124                         |
|      | 6   | 2.75                 | 0.11                 | 5.7                         | 121                         |
|      | 8   | 3.62                 | 0.16                 | 5.3                         | 115                         |
|      | 10  | 3.71                 | 0.13                 | 5.2                         | 112                         |
|      | 12  | 3.21                 | 0.11                 | 5.3                         | 96                          |
|      | 50  | 3.67                 | 0.18                 | 4.2                         | 146                         |
|      | 4   | 3.17                 | 0.27                 | 4.4                         | 156                         |
|      | 6   | 3.28                 | 0.12                 | 4.6                         | 150                         |
|      | 8   | 2.99                 | 0.11                 | 5.5                         | 146                         |
|      | 10  | 3.51                 | 0.14                 | 5.2                         | 149                         |
|      | 12  | 3.84                 | 0.09                 | 5.5                         | 154                         |
|      | 110 | 2.55                 | 0.24                 | 6.8                         | 106                         |
|      | 4   | 2.48                 | 0.09                 | 6.7                         | 116                         |
|      | 6   | 3.17                 | 0.11                 | 5.9                         | 108                         |
|      | 8   | 1.43                 | 0.18                 | 6.7                         | 103                         |
|      | 10  | 3.08                 | 0.08                 | 6.4                         | 102                         |
|      | 12  | 1.60                 | 0.10                 | 6.9                         | 100                         |
| CK   | 3.54 | 0.20                 | 4.6                  | 77                          |

3.3. The changes of nutrient level of the Pisha sandstone

Based on the results of the second soil survey in Beijing and the soil fertility status in Beijing, the evaluation of the nutrient composition of the Pisha sandstone was carried out according to the Beijing Soil Nutrient Grading Standard set by the Beijing Soil and Fertilizer Workstation in December 2006. Soil nutrient grades are classified into five levels: very high, high, medium, low and very low. The standard selects four indicators including soil organic matter, total nitrogen (N) or alkaline nitrogen (N), available phosphorus (P) and available potassium (K), and the weights of the above-mentioned participating indicators are 0.30, 0.25, 0.25 and 0.20, respectively. After calculation, the nutritional index score and the nutrient levels of the Pisha sandstone after treatment with different pH values and temperature is shown in Table 2. From the evaluation results, it can be found that the nutrients in the sandstone have not changed much except for the available potassium after being treated under various temperature and pH conditions. The available potassium content determines the nutrient grade of the sandstone. When the temperature is 50 °C, the nutrient grade of the sandstone sandstone is raised from very low to low.

4. Conclusion

According to the analysis of the test results, it can be found that the physical and chemical properties and nutrients of the sandstone have different degrees of change under different pH values and temperature conditions. The conductivity of strontium sandstone can be improved under acidic or alkaline conditions, and it tends to increase with acid/alkaline enhancement. The available phosphorus content, available potassium content and organic matter content in the Pisha sandstone are all related to temperature. The effective phosphorus increases with the increase of temperature, and the organic matter content is reversed. The available potassium content of the Pisha sandstone at 50 °C is obviously increased by 0.88~1.03 times. At the same time, when the pH value is 4, the available potassium content reaches the maximum under three temperature conditions. In addition, both pH and temperature have little effect on the total nitrogen content of the sandstone. For the evaluation of the
nutrient grade of the sandstone, the pH and temperature have little effect on it. Only at 50 ℃, the nutrient grade of the Pisha sandstone increases from very low to low.

**Table 2** The Pisha sandstone nutritional index score and levels after treatment with different pH values and temperature

| T/℃ | pH | Organic matter | Total nitrogen | Available phosphorus | Available potassium | The nutrient levels |
|-----|----|----------------|---------------|---------------------|-------------------|-------------------|
| 25  | 2  | 20             | 20            | 20                  | 60                | very low          |
|     | 4  | 20             | 20            | 20                  | 60                | very low          |
|     | 6  | 20             | 20            | 20                  | 60                | very low          |
|     | 8  | 20             | 20            | 20                  | 60                | very low          |
|     | 10 | 20             | 20            | 20                  | 60                | very low          |
|     | 12 | 20             | 20            | 20                  | 40                | very low          |
| 50  | 2  | 20             | 20            | 20                  | 80                | low               |
|     | 4  | 20             | 20            | 20                  | 100               | low               |
|     | 6  | 20             | 20            | 20                  | 80                | low               |
|     | 8  | 20             | 20            | 20                  | 80                | low               |
|     | 10 | 20             | 20            | 20                  | 80                | low               |
|     | 12 | 20             | 20            | 20                  | 80                | low               |
| 110 | 2  | 20             | 20            | 20                  | 60                | very low          |
|     | 4  | 20             | 20            | 20                  | 60                | very low          |
|     | 6  | 20             | 20            | 20                  | 60                | very low          |
|     | 8  | 20             | 20            | 20                  | 60                | very low          |
|     | 10 | 20             | 20            | 20                  | 60                | very low          |
|     | 12 | 20             | 20            | 20                  | 40                | very low          |
| CK  | 20 | 20             | 20            | 20                  | 40                | very low          |

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