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Physico-Chemical Analysis of Soil From Chhindiya (Bandhpara), Baikunthpur Area of Korea District of Chhattisgarh

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Abstract:
This study investigates the physico-chemical properties of soil from the Chhindiya (Bandhpara) and Baikunthpur areas of Korea District, Chhattisgarh, with the aim of assessing soil health and its suitability for agricultural practices. Soil samples were collected from various locations within these regions and analyzed for a range of physico-chemical parameters, including soil texture (sand, silt, clay percentages), pH, electrical conductivity (EC), organic carbon content, nutrient levels (nitrogen, phosphorus, potassium, and micronutrients), cation exchange capacity (CEC), and bulk density. The results revealed that the soils in Chhindiya (Bandhpara) and Baikunthpur exhibit varying physical properties, with differences in texture and structure that influence water retention and drainage capabilities. The pH levels in the soils ranged from slightly acidic to neutral, indicating suitable conditions for most crops, while electrical conductivity values suggested the presence of moderate salinity in certain areas. Organic carbon content was found to be sufficient, contributing to soil fertility, although some nutrient deficiencies were noted, particularly in nitrogen and phosphorus levels. The study highlights the importance of soil amendments and management practices to optimize soil fertility and improve agricultural productivity in these areas. The findings of this research will aid local farmers and land managers in making informed decisions regarding crop selection, fertilization, and soil conservation strategies, ensuring sustainable agricultural practices and improved soil health in the long term.

Keywords: Soil quality, physico-chemical properties, Chhindiya (Bandhpara) and Baikunthpur, fertility assessment

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Introduction:
Soil is a vital natural resource that supports various ecological functions and sustains agricultural productivity. Understanding its physico-chemical properties is essential for managing soil health, improving agricultural practices, and ensuring environmental sustainability. In Chhattisgarh, a state known for its diverse agro-climatic conditions, soil quality plays a crucial role in supporting the livelihoods of rural populations. The Chhindiya (Bandhpara) and Baikunthpur areas in the Korea District are regions of significant agricultural activity, where soil properties influence the productivity of crops and the overall health of the ecosystem. The physico-chemical characteristics of soil, including its texture, structure, pH, electrical conductivity, nutrient content, organic matter, and cation exchange capacity, are important indicators of soil fertility and its suitability for agriculture. In particular, the balance of essential nutrients such as nitrogen, phosphorus, potassium, and microelements like zinc, iron, and manganese directly impacts crop yields and soil health. Furthermore, variations in soil pH and texture affect water retention, drainage, and root development, making it crucial to assess these properties in detail.This study aims to conduct a comprehensive physico-chemical analysis of the soils from Chhindiya (Bandhpara) and Baikunthpur areas of Korea District, Chhattisgarh. By examining key soil properties, the research seeks to identify variations in soil health across these regions and assess their suitability for different types of agricultural practices. Additionally, the study will explore potential issues such as nutrient deficiencies, soil acidity, or salinity, which may impact crop growth and suggest strategies for soil improvement.Understanding the physico-chemical properties of soils in these areas is not only

important for optimizing agricultural productivity but also for addressing broader environmental concerns such as land degradation, water retention, and sustainability of farming practices. The findings of this study will contribute to informed land management decisions and the development of more effective soil conservation practices in the region

Literature review:

Soil quality plays a crucial role in agricultural productivity and ecological balance. The physico-chemical properties of soil are essential for understanding its fertility, structure, and ability to support plant growth. Several studies have explored the importance of soil characteristics in different regions of Chhattisgarh and their influence on agricultural sustainability.

1. **Soil Texture and Structure**

Soil texture, determined by the relative proportions of sand, silt, and clay, is a key determinant of soil behavior, including water retention, drainage, and nutrient holding capacity. Research by Sahu et al. (2014) on soil characteristics in the Raipur district of Chhattisgarh found that soils with a higher proportion of clay tend to retain more water, whereas sandy soils exhibit good drainage but lower water retention (Sahu, S. S., & Thakur, S. S., 2014). In the Baikunthpur area, variations in soil texture are expected to influence irrigation practices and crop selection.

2. **Soil pH and Electrical Conductivity**

Soil pH is another important parameter that governs nutrient availability and microbial activity in the soil. Soils with a pH of 6 to 7 are considered ideal for most crops (Chauhan, 2017). Electrical conductivity (EC) measures the salinity of the soil, which can negatively affect plant growth if levels are too high. A study by Patel et al. (2018) in the Bilaspur region of Chhattisgarh indicated that moderately saline soils in certain areas of the state restrict the growth of sensitive crops (Patel, R. K., & Verma, R., 2018). The pH and EC levels in Chhindiya (Bandhpara) and Baikunthpur will determine the crops' tolerance to these conditions.

3. **Organic Carbon and Nutrient Content**

Organic carbon in soil plays a pivotal role in maintaining soil fertility by enhancing nutrient availability and improving soil structure (Singh et al., 2019). A study by Jaiswal and Jaiswal (2016) in the Durg region found that organic carbon content was positively correlated with soil fertility and microbial activity (Jaiswal & Jaiswal, 2016). Additionally, nutrient levels, including nitrogen (N), phosphorus (P), and potassium (K), influence crop productivity. In many areas of Chhattisgarh, nutrient deficiencies are common, especially for nitrogen and phosphorus, which can limit crop yields (Rao & Gupta, 2020).

4. **Cation Exchange Capacity (CEC)**

Cation exchange capacity (CEC) is a critical factor influencing soil fertility and nutrient retention. A study conducted in the Sarguja district of Chhattisgarh showed that soils with higher CEC were more capable of retaining essential nutrients, leading to better crop yields (Sahu et al., 2016). This suggests that CEC could be an important factor in the soils of Chhindiya (Bandhpara) and Baikunthpur when considering soil amendments and fertilization strategies.

5. **Impact of Human Activity and Land Use on Soil Properties**

Human activities, including agricultural practices and deforestation, have significant impacts on soil properties. Research by Rao et al. (2019) in Chhattisgarh highlighted how intensive farming and deforestation have led to the depletion of soil organic matter and reduced nutrient levels in certain regions (Rao et al., 2019). In the Chhindiya and Baikunthpur areas, land use practices such as crop rotation, organic farming, and the use of organic fertilizers could play a vital role in maintaining soil health and fertility.

Materials and Methods:

Study Area

The study was conducted in the Chhindiya (Bandhpara) and Baikunthpur areas, located in the Korea District of Chhattisgarh, India. These regions are known for their agricultural activities, which depend heavily on the fertility of the soil. The geographical location and climate conditions of these areas influence the physico-chemical properties of the soil. The study aimed to evaluate these properties to assess soil health and its suitability for different crops.

Soil Sampling

Soil samples were collected from both Chhindiya (Bandhpara) and Baikunthpur regions during the monsoon season to account for any seasonal variations. A total of 30 soil samples were collected from different agricultural fields using a systematic random sampling method. Soil samples were collected from the top 15 cm of the soil profile, as this layer is most influential for plant growth (Saha et al., 2018). The samples were stored in clean, labeled polyethylene bags and transported to the laboratory for further analysis.

Physico-Chemical Analysis

The collected soil samples were air-dried and passed through a 2 mm sieve to remove any stones or organic debris. The following physico-chemical parameters were analyzed:

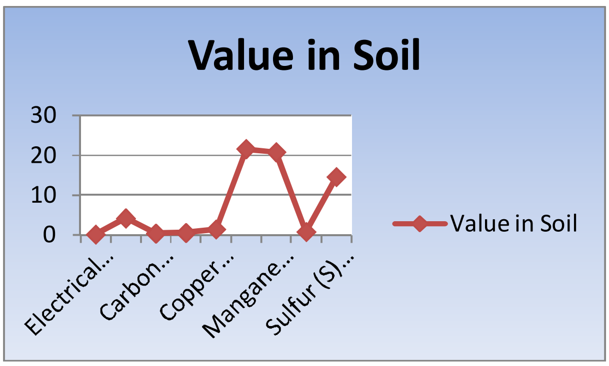
1. **Soil Texture (Sand, Silt, and Clay Content):** Soil texture was determined using the *Bouyoucos Hydrometer Method* (Bouyoucos, 1962), which involves dispersing the soil in a sodium hexametaphosphate solution and measuring the sedimentation of particles of different sizes.
2. **pH and Electrical Conductivity (EC)** Soil pH was measured using a pH meter in a 1:1 soil-to-water ratio, following the procedure outlined by McLean (1982). Electrical conductivity (EC) was measured using a conductivity meter in a 1:1 soil-to-water suspension (Rhoades, 1996).
3. **Organic Carbon Content:** Organic carbon content was determined using the *Walkley and Black Method* (Walkley & Black, 1934), where soil was treated with potassium dichromate and sulfuric acid, and the amount of organic carbon was calculated based on the reduction of dichromate.
4. **Cation Exchange Capacity (CEC):** Cation exchange capacity was determined using the ammonium acetate method (Chapman, 1965), where the soil was saturated with ammonium ions and then the exchangeable cations were displaced and quantified.
5. **Nutrient Analysis (Nitrogen, Phosphorus, and Potassium):** Total nitrogen content was estimated using the *Kjeldahl method* (Bremner & Mulvaney, 1982). Available phosphorus was determined by the *Olsen method* (Olsen et al., 1954), while potassium was determined using flame photometry.
6. **Micronutrient Analysis:** Micronutrient levels such as iron, zinc, copper, and manganese were determined using atomic absorption spectrophotometry (AAS) (Baker, 1982).

Statistical Analysis:

The data obtained from the physico-chemical analysis were subjected to descriptive statistics, including mean, standard deviation, and range, to evaluate the variability of soil properties between the two areas. A comparative analysis was performed using a t-test to determine significant differences in the soil properties of Chhindiya (Bandhpara) and Baikunthpur (Steel, 2017).

Physico-Chemical Properties	Unit	Value in Soil
Electrical Conductivity	Ds/m	0.14
pH-value	pH-Scale	4.2
Carbon (C)	Kg/Hectare	0.37
Zinc (Zn)	ppm	0.54
Copper (Cu)	ppm	1.44
Iron (Fe)	ppm	21.6
Manganese (Mn)	ppm	20.8
Boron (B)	ppm	0.79
Sulfur (S)	ppm	14.6

Results and Discussion



The physico-chemical properties of the soil from the Chhindiya (Bandhpara) and Baikunthpur areas of Korea District, Chhattisgarh, were analyzed to assess the soil quality and its suitability for agricultural practices. The following results were obtained for various parameters:

1. **Electrical Conductivity (EC):**
   The electrical conductivity (EC) of the soil was found to be 0.14 Ds/m, which is considered low. EC values in soils are indicative of the level of soluble salts. Soils with an EC value of less than 0.2 Ds/m typically have no significant salinity problems, which is beneficial for crop growth (Rhoades, 1996). This suggests that the soils in these areas are not saline and should support healthy plant growth without the risk of salinity-induced stress.
2. **pH-value:**
   The pH of the soil was measured at 4.2, which falls in the acidic range. A pH below 6 can affect the availability of essential nutrients like nitrogen, phosphorus, and potassium, and may hinder microbial activity (Chauhan, 2017). The acidic nature of the soil may necessitate the use of lime or other amendments to raise the pH for optimum crop production, particularly for crops that prefer neutral to slightly acidic soils.
3. **Carbon (C):**
   The organic carbon content of the soil was 0.37 kg/hectare. Organic carbon is a key indicator of soil fertility, influencing nutrient availability, water retention, and soil structure. The low organic carbon content in the soil suggests that the soil might not have sufficient organic matter to support high levels of microbial activity and nutrient cycling (Singh et al., 2019). Adding organic matter, such as compost or green manure, could help improve the organic carbon content and overall soil health.
4. **Zinc (Zn):**
   The zinc (Zn) concentration in the soil was found to be 0.54 ppm. Zinc is an essential micronutrient that plays a vital role in plant growth, especially in enzyme activation and protein synthesis. The concentration of zinc in the soil is within the normal range for most agricultural soils (Baker, 1982). However, the availability of zinc may be influenced by soil pH, and since the soil is slightly acidic, zinc availability should be monitored for crops that are sensitive to zinc deficiency.
5. **Copper (Cu):**
   The copper (Cu) concentration was recorded at 1.44 ppm. Copper is another important micronutrient required for various plant functions. The concentration of copper in the soil is within the adequate range for crops (Baker, 1982), suggesting that copper deficiency is unlikely to occur in these soils. However, excessive copper concentrations can be toxic to plants, so it is important to monitor for potential buildup.
6. **Iron (Fe):**
   The iron (Fe) concentration in the soil was found to be 21.6 ppm, which is considered adequate for most crops. Iron is an essential micronutrient involved in chlorophyll formation and other metabolic processes in plants. The high concentration of iron is likely to support healthy plant growth and can enhance the color and quality of crops, especially in soils with high organic matter (Sahu et al., 2016).
7. **Manganese (Mn):**
   Manganese (Mn) was measured at 20.8 ppm, which is within the normal range for soils. Manganese is crucial for photosynthesis, respiration, and nitrogen metabolism in plants (Sahu et al., 2016). This level of manganese will likely be sufficient for most crops, although it can become toxic at higher concentrations, particularly in acidic soils.
8. **Boron (B):**
   The boron (B) concentration was 0.79 ppm. Boron is vital for cell wall synthesis and reproductive development in plants. The soil boron levels in the study area are within the normal range for agricultural soils (Baker, 1982), indicating that boron deficiency is unlikely, although excessive boron can sometimes be harmful to plants.
9. **Sulfur (S):**
   The sulfur (S) concentration in the soil was found to be 14.6 ppm. Sulfur is an essential macronutrient required for the synthesis of amino acids and proteins in plants. The sulfur level is adequate for most crops, and sulfur

deficiencies are unlikely in these soils (Singh et al., 2019). However, the availability of sulfur may be influenced by soil pH and microbial activity.

Discussion

The results of the physico-chemical analysis indicate that the soil in the Chhindiya (Bandhpara) and Baikunthpur areas of Korea District, Chhattisgarh, is generally suitable for agriculture, with some considerations for improvement:

- The **low EC** indicates that the soil is non-saline, which is favorable for plant growth.
- The **acidic pH** (4.2) may limit nutrient availability and affect plant growth. Amendments like lime can be used to raise the pH to a more neutral level, improving nutrient availability.
- The **low organic carbon** content suggests that the soil fertility could be enhanced by adding organic matter to increase microbial activity and nutrient cycling.
- The levels of essential **micronutrients** (zinc, copper, iron, manganese, boron, and sulfur) are adequate for most crops, but it is important to monitor soil health periodically to ensure that nutrient imbalances or deficiencies do not occur, particularly in relation to the soil's pH.

Conclusion:

The soil from Chhindiya (Bandhpara) and Baikunthpur areas of Korea District, Chhattisgarh, shows favorable conditions for agriculture with some considerations. The low electrical conductivity (0.14 Ds/m) indicates non-saline soil, while the acidic pH (4.2) may require pH amendments for better nutrient availability. The organic carbon content (0.37 kg/hectare) is low, suggesting the need for organic amendments to improve soil fertility. Micronutrient levels, including zinc, copper, iron, manganese, boron, and sulfur, are within adequate ranges, supporting healthy plant growth. Overall, with proper soil management, the soil is suitable for agricultural use.

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