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An Investigation of Some Selected Ceramics Raw Materials in Niger State College of Education, Minna for Table Wares Production

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Abstract: This study investigates some selected ceramic raw materials sourced within the premises of Niger State College of Education, Minna, with the aim of determining their suitability for tableware production. The growing need to utilize locally available raw materials for sustainable ceramic development informed this investigation. The research involved the systematic collection and analysis of key raw materials such as ball clay, feldspar and quartz, The three raw materials was identified in mapping unit (CI, F2and Q3) These materials were subjected to physical and chemical tests, including plasticity evaluation, shrinkage rate, firing behavior, and mineralogical composition through X-ray diffraction and chemical analysis. The results revealed that the ball clay samples exhibited adequate plasticity and workability required for shaping and molding, while the quartz and feldspar provided the necessary vitrification and structural integrity during firing. Additionally, the chemical compositions fell within the standard range suitable for ceramic tableware, particularly in terms of silica and alumina content. The findings affirm that the raw materials within the study area possess the essential qualities needed for the production of functional and durable tableware. Consequently, the research underscores the potential of local raw materials in advancing indigenous ceramic practices, reducing dependence on imported materials, and promoting sustainable ceramic industries in Nigeria. It also opens pathways for future studies in improving ceramic material refinement and developing locally based production techniques for quality enhancement. The study recommends further pilot scale production to test product reliability and consumer acceptance.

Keywords: *Investigation, Selection and Sustainability of Ceramic Raw Materials Testing.*

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I. INTRODUCTION

Ceramics play a fundamental role in human society, serving both functional and aesthetic purposes. They are indispensable in daily life, particularly in the production of household items such as plates, bowls, cups, and saucers. The desirable attributes of these products including strength, durability, thermal resistance, chemical stability, and aesthetics are intrinsically linked to the quality, availability, and composition of the raw materials employed (Obianyo et al., 2021; Yakubu & Umar, 2020). The critical raw materials required for ceramic production include clay, feldspar, quartz (silica), and kaolin. Each of these materials must meet specific physical and chemical requirements to optimize product performance and ensure sustainability in the ceramics industry (Ike, 2018; Nnuka & Obiorah, 2018).

Nigeria is richly endowed with abundant ceramic raw materials distributed across different regions, including Niger, Ogun, Kogi, and Plateau States (Musa et al., 2020; Adeyemi et al., 2022). Despite this abundance, these resources remain largely underutilized, as many industries, research centers, and educational institutions still rely heavily on imported materials or focus predominantly on theoretical aspects of ceramics, rather than practical applications of indigenous resources (Eze & Akinlabi, 2021; Olorunfemi et al., 2020). The underutilization of these local resources hampers industrial growth, increases production costs, and

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diminishes opportunities for innovation and local content development in ceramic production.

This study seeks to bridge this gap by investigating the suitability of locally sourced raw materials within the premises of Niger State College of Education, Minna, for the manufacture of ceramic tableware. Such an investigation is vital not only for reducing dependence on imported raw materials but also for promoting self-reliance, fostering skill development, preserving indigenous knowledge systems, and encouraging sustainable practices in ceramic industries (Adefioye et al., 2023; Opoku, 2003). Moreover, strengthening local resource utilization can enhance research-based training in tertiary institutions and build stronger linkages between education and industry.

Furthermore, the global shift toward sustainable development underscores the need to harness indigenous raw materials for industrial processes. The utilization of locally available clays, feldspars, quartz, and kaolin can reduce production costs, minimize environmental impacts associated with long-distance material transport, and revive traditional ceramic production techniques (Nwosu et al., 2022; Idenyi et al., 2021). Such approaches not only contribute to the United Nations' Sustainable Development Goals (SDGs), particularly goals 8 (decent work and economic growth), 9 (industry, innovation, and infrastructure), and 12 (responsible consumption and production), but also open pathways for waste-to-wealth initiatives through innovative processing and recycling methods (Adefioye et al., 2023).

In light of these considerations, this research investigates the mineralogical, chemical, and physical properties of raw materials collected from Niger State College of Education, Minna. The objective is to evaluate their suitability for the production of standard ceramic tableware and to provide scientific evidence supporting the viability of local raw materials as substitutes for imported ones. This aligns with earlier recommendations by Opoku (2003), who emphasized the urgent need to explore and utilize indigenous raw materials to accelerate the growth and competitiveness of the ceramics industry in Nigeria.

II. BACKGROUND

Ceramic production in Niger State and Nigeria has strong cultural and historical roots, linked to indigenous knowledge, traditional practices, and everyday utility. Ethnic groups such as the Gwari and Nupe have for centuries produced functional and decorative pottery using local clays through hand-building, open firing, and rudimentary kiln methods. Post-independence government programs (from the 1960s) recognized ceramics' cultural and economic value, integrating ceramics research into institutions such as Ahmadu Bello University, Zaria, and the Nigerian Institute for Trypanosomiasis Research.

Recently, colleges with fine and applied arts departments, including the College of Education, Minna, have expanded ceramics education to include tableware production. Renewed attention on the ceramic sector in Nigeria aims at reducing import reliance, promoting local innovation, and employing semi-automated technologies to align with national industrialization, sustainability, and youth empowerment goals.

III. MATERIALS AND METHODS

- *Study of Site*

An exploratory research approach was employed to identify and analyze ceramic raw materials around Niger State College of Education, Minna (coordinates approximately 9.6°N, 6.55°E). The area's terrain is predominantly upland with mining activities and visible deposits of clay, feldspar, and quartz.

- *Field Study*

A preliminary field survey on June 24, 2025, to identified sampling sites. Samples of ball clay, feldspar, and quartz were collected using hand tools, labeled (figure, C1 clay, F2 feldspar, Q3 quartz), and documented with GPS data and photographs.

- *Sample Collection.*

Collected samples were air-dried for 3–5 days, crushed, and sieved through a 60-mesh to ensure uniform particle size before storage in airtight containers for laboratory testing.

- *CLAY as a Primary Ceramics Raw Material.*

Clay in Niger State College of education are predominantly kaolinite, exhibiting desirable plasticity and thermal stability. These characteristics have been documented by Abdullahi (2008) and further supported by Akinshipe and Olatunji (2015) as well as malu et al. (2014).

- *Silica (Quartz)*

Quartz deposits rich in crystalline silica are found in the vicinity of the school. these resources contributed significantly to the stoneware and porcelain formulations Okunlola, (2011).

- *Feldspar*

Feldspar is one of the most important raw materials in ceramics, widely use in production of tiles, tableware, sanitary ware, and glass. It is a group of alumina silicate minerals containing varying amount of potassium, sodium, and calcium. In ceramics, feldspar functions mainly as a flux. Ewais. (2004).

Table 1 Physical Tests on Clay

Physical Tests on Clay		
Property	**Observation**	**Remarks**
Color	Orange-yellow powder	Moderately plastic
Moisture Content	53.2%	High water retention
Plasticity Index	49%	Highly plastic and moldable

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Compression Test	Good green strength	Suitable for shaping forming
Bulk Density	1.36 – 1.57 g/cm³	Indicates good packing

Table 2 Oxide Percentage Significance

Oxide	Percentage	Significance
SiO_2	41.94%	Provides refractoriness and strength
Al_2O_3	24.51%	Contributes to plasticity, durability
Fe_2O_3	17.14%	Affects color (reddish hue) and firing
TiO_2	Trace	Influences color and opacity
CaO	Trace	Acts as minor flux aiding vitrification

Mineralogical analysis raw material, within the vicinity of Niger State College using XRD confirmed the presence of quartz, feldspar, and clay which are essential for ceramic tableware production.

IV. PRODUCTION AND EVALUATION

Tableware items including plates, jugs, and bowls were produced using standard wheel-throwing techniques. Green ware samples were bisque fired at 900 °C and glaze fired at 1150 °C. Evaluation focused on workability, firing behavior (shrinkage, color, vitrification), and final xproduct qualities such as strength, durability, surface finish, glaze adhesion, and thermal shock resistance. Results meet or exceed industry standards for high-quality ceramic tableware.

V. CONCLUSION

This study validates the potential for sustainable local production of ceramic tableware using indigenous raw materials sourced from Niger State College of Education, Minna. Key raw materials ball clay, feldspar, and quartz possess the necessary plasticity, thermal properties, and vitrification qualities required for functional, durable, and aesthetically pleasing ceramic products.

Utilizing these materials can reduce Nigeria's dependency on imported ceramics, stimulate local small and medium scale industries, and encourage innovation in ceramic processing. The College of Education, Minna, represents an ideal center for integrating research, skills training, and industry collaboration. Strengthening such synergies will support Nigeria's industrialization and sustainability goals while preserving indigenous craftsmanship and cultural identity.

Future work should include pilot scale production trials to assess product reliability and consumer acceptance, as well as further research to refine material processing and enhance product quality.

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INDEX OF RESULTS

Table 3 Index of Results

Category	Parameter / Material	Result / Observation	Remarks / Significance
Raw Materials Identified	Ball Clay (C1)	Present in mapping unit	Primary plastic material for shaping
	Feldspar (F2)	Present in mapping unit	Acts as flux for vitrification
	Quartz (Q3)	Present in mapping unit	Provides strength, rigidity
Physical Tests (Clay)	Color	Orange-yellow powder	Moderately plastic
	Moisture Content	53.2%	High water retention
	Plasticity Index	49%	Highly plastic, moldable
	Compression Test	Good green strength	Suitable for shaping & forming
	Bulk Density	1.36 –1.57 g/cm³	Indicates good packing
Chemical Composition (Clay - XRF)	SiO_2	41.94%	Provides refractoriness & strength
	Al_2O_3	24.51%	Contributes to plasticity & durability
	Fe_2O_3	17.14%	Affects reddish color & firing behavior
	TiO_2	Trace	Influences color & opacity
	CaO	Trace	Minor flux aiding vitrification
Mineralogical Analysis (XRD)	Quartz	Confirmed present	Essential for ceramics
	Feldspar	Confirmed present	Flux material
	Clay minerals	Confirmed present	Plasticity provider
Production Results	Workability	Adequate	Suitable for wheel-throwing
	Shrinkage	Normal range	Acceptable for firing
	Firing Behavior	Good vitrification	Stable and durable
	Color	Acceptable after firing	Aesthetic quality retained
	Glaze Adhesion	Good	Smooth surface finish
	Strength & Durability	High	Meets industry standards
	Thermal Shock Resistance	Adequate	Suitable for functional tableware
Final Evaluation	Plates, jugs, bowls	Successfully produced	Comparable to standard ceramic tableware
Overall Conclusion	Local raw materials (Ball clay, Feldspar, Quartz)	Possess necessary qualities	Functional, durable, aesthetic, and sustainable for tableware production

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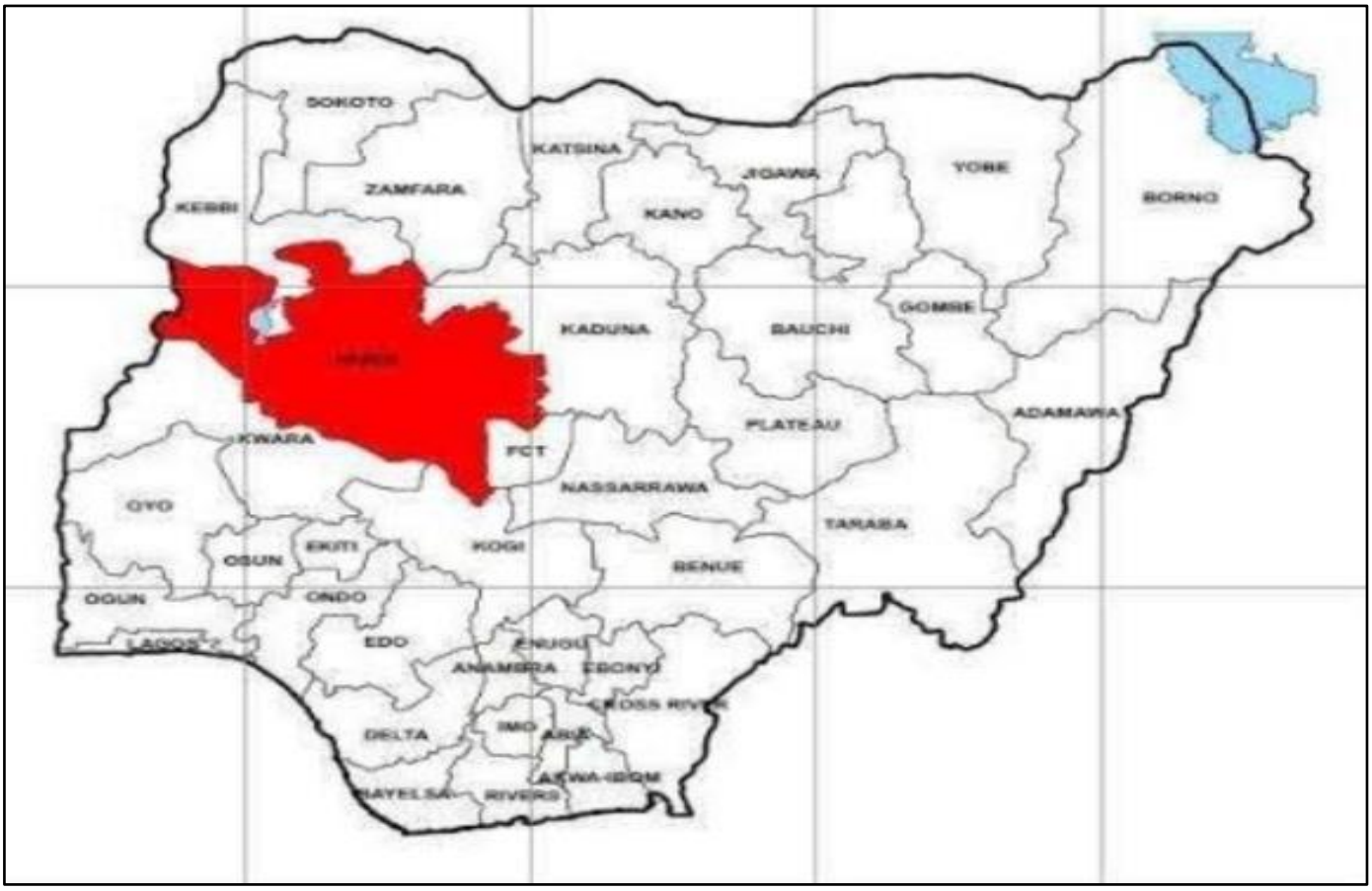

Fig 1 Map of Nigeria Showing Niger State.

Fig 2 Map of Niger State Showing Bosso LGA.

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Fig 3 Map Bosso LGA Showing Research Area.


Fig 4 Upland Mapping of Raw Quartz


Fig 5 Showing Collection of Raw Materials


Fig 6 Prepared Plastic Clay for Throwing.


Fig 7 Testing the Suitability of the Clay for Throwing


Fig 8 Finished Ceramic Wares Produced from the Research Clay