

THE DEVELOPMENT OF RED SLIP CLAY FROM *DOGO* BENUE STATE FOR THE DECORATION OF CERAMIC WARES

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Abstract

The need for the exploration of new alternative sources of ceramic glaze materials by modern ceramic studios and industries led to the investigation of local red clay obtained from Dogo community in Benue State for use as ceramic colourant. The sample of this clay material was collected, and the chemical constituents were scientifically analyzed through (XRF) Spectrophotometer with iron oxide (Fe_2O_3) having the highest percentage of 39.70% and insignificant amount of Lead Oxide (PbO) 0.58%. The aim of the research was to use Dogo red slip as an alternative under-glaze colourant to dull and undefined colouration of Nigeria indigenous ceramic products, which is also hoped to address the challenge in the high cost of imported ceramic glaze materials. This material been a natural clay material, it can be used to function as glaze colourant without necessary further processing beyond washing and sieving. Result from the chemical analysis of the material, and the studio research on various bodies of earthenware, stoneware and porcelain indicated that, application of Dogo red clay slip was most suitable on raw white earthenware body at 900°C-1000°C in an oxidized atmosphere. The slip also adhered to stoneware although indicating a purplish-grey colour but poor adherence on porcelain body. The property tests of the clay material on water absorption, shrinkage, fusibility and colour show that the clay material is suitable on low-fire temperature clay bodies to retain its bright colour. This result enables utilization of Dogo red clay slip in a conventional approach as a viable new alternative low temperature ceramic colourant. In view of the result therefore, the red slip was applied on raw wares before biscuit firing, and gloss fired with low temperature transparent glaze. This result provides convincing evidence that utilizing Dogo clay slip in a conventional approach has been viable as low temperature ceramic colourant. Thus, the research recommends for further exploration into Nigeria's indigenous raw materials to enhance the aesthetic appeal and marketability of its pottery products for economic growth.

Introduction

The inadequate exploration of new alternative sources by modern pottery industries and ceramic studios constitutes a major challenge to practicing potters in Nigeria. The consequence however, is a monotonous rendition of dull and undefined colouration of wares thus causing consumers of such products to opt for foreign products to satisfy their aesthetic needs. Ekechukwu (2014) in Adeyemi (2015) “states that the current devaluation of Nigerian Naira which is aimed at discouraging high rate of importation requires the support of researches that will provide local substitutes for socio-economic gains”. Similarly, Gukas (2003), states that “for Nigeria to be able to develop her ceramic sector, she needs to look inward into ways of developing her needed ceramic resources for self-reliance”. Based on that, the study exploits Dogo red clay through a conventional approach as an alternative source of red slip to be used as under-glaze colourant on low fire ceramic wares. The clay

material enhances body composition and decoration of finished ceramics, it is easy to acquire and less expensive in processing, thus reducing the cost of acquiring the glaze material. The clay slip is suitable and stabilizes upon firing on earthen-ware as well as enhances the aesthetics of the indigenous products especially the decorative wares thus reducing the quest for importation of ceramic wares with its attendant drain on our foreign exchange reserve.

According to Worrall (1978) in Mathias (2015), red earthenware clays are the most available and abundant mineral in the earth crust. Also, Rhodes (1973) in Mathias (2015), posits that common red clay that is high in iron oxide and other impurities may fire to hardness and density at about 1000°C and may melt to a liquid at about 1250°C. Similarly, the result of the elemental analysis from Dogo red clay of Benue State of Nigeria too does not require any other additional material for a positive result as an under-glaze ceramic colourant on low-fire

temperatures of about 1000°C. The adherence of this clay slip to bodies is as a result of its high iron content as suggested by Hansen (2015), that iron is amphoteric like alumina so it can stabilize and stiffen the melt.

Ceramic slip primarily, is clay that has been thinned down with water and sometimes additional chemicals used for various purposes. Peterson (2016), opines that it differs from slurry because it is generally thinner and has more clay content than engobe and is often used in decoration. Thus Dogo red clay is used for the purpose of the study for decoration of ceramic wares.

Methodology

The sampled red clay material used for this paper was sourced from a pit of the local potters of Dogo community of Buruku Local Government Area of Benue State. Although, the physical examination of the clay alone is undoubtedly of red iron dominance yet the chemical analysis was conducted at National Geoscience Kaduna. The result indicated high percentage of Fe_2O_3 iron oxide with 39.70%, SiO_2 - 27.40% and Al_2O_3 - 12.00% and other element and oxides in low percentages. This clay, due to its colour and preliminary characteristics, was tested and found suitable as low fire ceramic colourant.

The sampled clay material was in the form of fine grain with lumps, soaked in water for two days, stirred thoroughly into homogenous slip and sieved through a 200 Tyler mesh size (74 μm), dry and store as fine powdered clay. This was in agreement to Nelson (1971) in Aluwong (1988), the natural red clay contain sufficient fluxes to function as glazes without further preparation beyond washing and sieving. While Kankara kaolin and Rafintukurwa ball clay for body composition were both processed through 100 Tyler mesh size (149 μm).

The low-fire clay body for this slip application was composed of Kaolin 70% and ball clay 30% as white body for earthenware with little addition of sodium silicate (deflocculant) for slip casting of decorative wares. Low-fire clay body according to Peterson (2017), are other varieties of “earthenware” because they mature in the earthenware temperature range. The mixtures are relatively made up of kaolin and ball clays to obtain white bodies which may be composed of about half clay and half added fluxing agent, such as talc. The red clay slip was also tested on stoneware body of kaolin 45%, feldspar 35%, ball clay 10%, Quartz 10%, while the porcelain

body was made up of kaolin 40%, feldspar 40%, Quartz 15% and ball clay 5% and bentonite 2% respectively. The researcher conducted some property tests to determine the clay properties as stated by Ahuwan (2002) on Dogo clay, earthenware, stoneware and porcelain bodies. The tests were on shrinkage rate, absorption rate, fusibility and colour.

Dogo Slip Application

The right consistency of water ratio to Dogo powdered clay was obtained then application on wares was done at leather-hard and green-ware stages as suggested by Peterson (2016), Morris (2014) and Hopper (2012). Some common methods of slip applications were experimented during the study such as spraying, dipping and brushing methods. However, the researcher adopted brushing method on green-wares to achieve some delicate designs hence, decorative wares.

Results/Observation

The result of biscuit firing Dogo red slip-on wares has indicated strong adherence to green wares at the temperatures of between 900°C and 1000°C. The red slip was also tested on stoneware and porcelain bodies, each to their various biscuit temperature of 1000°C, 1240°C and 1280°C respectively. The slip was most suitable on low temperatures between cone 09 and 06, giving the wares a vanadium red colour. Also, on clay body temperature of 1150°C for three hours, the red slip turns to dark brown colour. The slip also adhered to stoneware body producing a purplish-grey whereas on porcelain, this red slip exhibited some great amount of shivering which was possibly as a result of incompatibility of the body hence the differences in the body's absorption rate. The clay slip was also tested on biscuit-ware object still at low-fire temperature, the result was poor adherence but when blended with yellow oxide, it recorded a good result. In view of the result therefore, the red slip was applied on raw wares before biscuit firing, and finally gloss-fired with low temperature transparent glaze. Results of this study, provides convincing evidence that utilizing Dogo clay slip in a conventional approach can be viable as a low temperature ceramic colourant.

Findings and Observations

The following findings and observations were recorded based on the experiments conducted in the studio by this study:

1. The result of the chemical analysis of this material indicated high content of iron oxide with 39.70wt % with other elements in minor composition.
2. This study observed that *Dogo* slip was more suitable on low-fire temperature clay body especially at temperatures between 900°C and 1000°C to sustain colour brilliancy. Therefore, the firing temperature of *Dogo* slip was maintained at 1000°C within the earthenware temperature range.
3. This study also observed that when *Dogo* material was fired at stoneware temperature, the colourant bonded to the body but appeared greyish-purple. While on porcelain body, high amount of flaking, crazing and dark patches were observed which was susceptible to lack of compatibility of the materials.
4. This study however utilized the locally prepared *Dogo* slip on wares through the conventional approach and a suitable result of dark red or vanadium colour was obtained.
5. Apart from deriving slip for decoration from *Dogo* clay, the clay itself can be used for throwing sizeable ceramic object.
6. It was observed that application of transparent glaze enhances the quality of *Dogo* slip on wares thus rendering the wares waterproof and glossy.
7. Application of *Dogo* slip on raw wares before biscuit firing has indicated the best result than on biscuit wares where little flaking was noticeable.

Conclusion

The result from this study has revealed that Nigeria's indigenous raw materials can still be explored in a conventional approach to substitute for imported glaze materials. This research ascertains the prospects of utilizing *Dogo* clay slip as an alternative source of glaze material for low-fire temperature clay bodies especially on decorative ceramics, and also revealed its high economic importance with added aesthetic value. The study has also discovered the possibility of blending *Dogo* clay slip with oxide for colour variations.

Recommendations

The paper recommends for further exploration of Nigeria's raw materials for extraction of glaze colourant to enhance the aesthetic appeal and

marketability of indigenous pottery products for economic growth. Also, the paper strongly recommends the use of *Dogo* red clay for ceramic purposes to tackle the challenges of dull and undefined colouration of indigenous ceramic wares.

Table: 1 Chemical Analysis of Dogo Red Clay

Element /Oxide	%
Fe ₂ O ₃	39.70
SiO ₂	27.40
Al ₂ O ₃	12.00
K ₂ O	1.10
TiO ₂	1.26
Na ₂ O	0.06
CaO	0.55
MgO 0.003	
V ₂ O ₅	0.047
MnO ₂	0.001
Cr ₂ O ₃	0.042
ZnO	0.058
CuO 0.081	
Rb ₂ O	0.074
ZrO ₂ 0.28	
BaO 0.320	
Eu ₂ O ₃ 0.38	
Re ₂ O ₇ 0.04	
PbO 0.58	
L.O.I 16.02	

Sources: National Geosciences Research Laboratory, (NGRL) Kaduna (2016) and Zauro (2007).

Table 2: Result of Property Tests on the selected Bodies

Test	Temperature	<i>Dogo</i>	Earthenware	Stoneware	Porcelain
Shrinkage	Dry	6%	4%	4%	3%
	Fired	8%	7%	13%	12%
Absorption	1000°C	22.5%	12.2%	-	-
	1250°C	-	-	7%	-
	1280°C	-	-	-	3.5%
Fusibility		-	Very Good	Good	Shivered
Colour		Red	Vanadium	Purplish blue	Dark Brown



Plate 1: Dogo Clay Sample

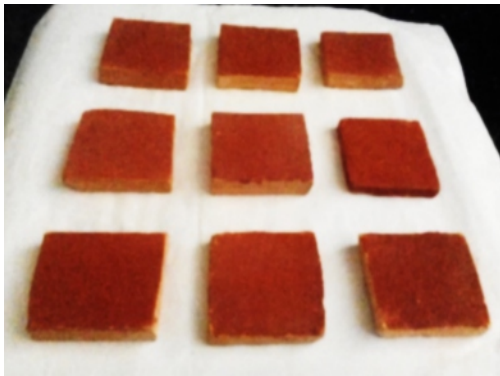


Plate 2: *Dogo* Slip Test Tile at 900°C.



Plate 3: *Dogo* slip on green-ware pots



Plate 4: Biscuit-fired assorted wares



Plate 5: *Dogo* slip on biscuit-fired ware



Plate 6: *Dogo* slip mixed with Yellow oxide



Plate 7: *Dogo slip on Stoneware*



Plate 8: *Dogo slip crazed on Porcelain*



Plate 9: *Dogo glazed decorative piece at 1000°C*



Plate 10: *Dogo glazed ware at 1150°C*

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