DEVELOPMENT OF CERAMIC GLAZES USING RAW MATERIALS FROM OSUN STATE OF NIGERIA

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Abstract
This research is focused on developing ceramic glazes using raw materials from Osun state. The art of making glazes may be traced back to ancient civilizations. Glazes are important factors in ceramic production. Glaze raw materials are solid minerals that are milled often calcined, crushed and mixed to form glazes. For this study, feldspar, quartz and ball clay were sourced from Osun State. These were beneficiated, analysed by means of x-ray fluorescence spectrophotometer (XRF). Triaxial blends of 66 tile samples were prepared for the purpose of glaze making and fired to a temperature of 1260^{o}C. The results of x-ray fluorescence (XRF) analysis conducted on these samples show that Majeroku feldspar is rich in 63.7% of SiO_2, 14.1% of $Al_2O_3$and 20.53% of K_2O, Awo quartz is 98.69% made of SiO_2, while Ilesa ball clay was made up of 61.9% SiO_2, 19% of Al_2O_3, with 6.86% of Fe_2O_3 .Test samples, 2 (90% Feldspar and 10% Clay), 3 (90% Feldspar and 10% Quartz), 4 (80% Feldspar and 20% Clay), 5 (80% Feldspar, 10% Clay and 10% Quartz), 7 (70% Feldspar, and 30% Clay), 8 (70% Feldspar, 20% Clay and 10% Quartz), 9 (70% Feldspar, 10% Clay and 20% Quartz), 11 (60% Feldspar, and 40% Clay), 12 (60% Feldspar, and 40% Clay), 13 (60% Feldspar, 20% Clay and 20% Quartz), 14 (60% Feldspar, 10% Clay and 30% Quartz), 16 (50% Feldspar and 50% Clay), 17 (50% Feldspar, 40% Clay, and 10% Quartz), 18 (50% Feldspar, 30% Clay and 20 Quartz), 22 (40% Feldspar, and 60% Clay), 23 (40% Feldspar, 50% Clay, and 10% Quartz), and 24 (40% Feldspar, 40% Clay, and 20% Quartz), fused so well and showed evidence of glossiness. The results on the whole showed a good prospect and suitability of the materials in glaze making and production; especially stoneware glazes.

Introduction

Man has been able to discover industrial minerals which in turn have been valuable in numerous and countless ways from time immemorial. The mineral industries of the world are basic to human progress and civilization. Today man lives in an age of super abundance of ceramic raw materials. According to Agonzi (2011), Ceramic raw materials are everywhere; 90% of raw materials used in ceramic production are sourced locally here in Nigeria. The principal raw materials for ceramic production are available in Nigeria, nevertheless, domestic production is low and imports are large constituting a major drain to the scarce foreign reserves for Nigeria.

Over-dependency on costly imported ceramic raw materials and equipment has also not helped the profession. Akintonde, Abiodun & Akinde, (2014) reveal that despite the sufficient presence of clay minerals and competent human resources in Nigeria, the ceramic industry is still retarded/handicapped in production, service and knowledge impartation.

Aluwong (1988), states that the most important issue in ceramics is the replacement of expensive imported materials by ideal raw materials and how to improve their qualities. It is a challenge to Ceramist today in Nigeria to wake up and take ceramics to a higher level with the availability of these raw materials that are widely spread across the whole nation. The basic rudiment for ceramic development which is the raw materials and which are adequately available in our locality has to be explored, identified,

characterized, exploited and developed for ceramics to be in the main stream of industries for national development in Nigeria. Ahuwan, (1999) suggested that researchers should put in their best to see that the profession moves forward by contributing in the processing of locally available materials through tests and experiments.

The art of making glazes may be traced back to ancient civilization. Glaze is a layer or coating of a vitreous substance which has been fused to a ceramic object through firing. Glazes may be coloured, transparent or opaque. The main purpose of glazes is to provide a surface that is hard, non absorbent, and easily cleaned. At the same time glazes provide aesthetically attractive coatings, variety of surface colours and textures (Bassey, 2009). Development of new glazes from our indigenous materials will add a new look to ceramic production in Nigeria. Perhaps this new outlook or unique appearance could be an added advantage that will promote marketability of ceramic product (Alkali, 2009). This study covers the experimentation of indigenous raw materials comprising of feldspar, quartz and ball clay from Osun state of Nigeria in glaze formulations.

Methodology

Ball clay was sourced from Ilesa, quartz from Awo and feldspar from Majeroku. Visual and property field/first in-sight inspection was done at the sites of each material. The materials used were chemically analyzed, using XRF; at the Nigerian Geological Survey Agency National Geosciences Research Laboratories, Barnawa, Kaduna, Kaduna State.

Feldspar and quartz were soaked for a day and washed in water. These were further calcined at 1000^{o}C to break the cleavages and afford jaw crushing. The crushed materials were taken to the Department of Chemical Engineering of the same University for ball milling. The materials were milled to pass through the 200 Tyler mesh i.e. about 72 micron size. Mesh size is one of the factors that affect how a particle melts; smaller particles melt faster than larger ones because there is a larger total surface area to absorb heat. Test samples of triaxial blend of 66 samples (Figure 1) were placed on tiles and sample mixtures was prepared using the three materials: Ilesa clay, Awo quartz, and Majeroku feldspar. The compositions were measured and were mixed dry then mixed with water inside a transparent container. The tiles were prepared for the test blends having small holes and were numbered underneath accordingly. The test tiles were filled with the compositions having the corresponded number and allowed to dry. The blends were fired to observe their melting behaviour.

Test samples of glossy test blend results from the various blends were selected and were tested on stoneware body to check for their adherence and faults. Thrown test pieces having a shape to prevent the glaze running from sticking to kiln shelves was produced for both bodies and was fired. The glazes were dipped allowing the glaze to stay on the upper part of the piece so that running behaviour if any can easily be detected.

Results and Discussion

From the result of the chemical analysis (Table 1), the major components of the raw materials were as thus: feldspar had 63.7% of silica, 20.53% of potassium oxide, and 14.1% of alumina, quartz had 98.69% of silica, ball clay had 61.9 silica, 19% alumina, and 6.86% of iron oxide. Raw materials of ceramic glazes generally include silica, which is the main glass former. Various metal oxides, such as sodium, potassium and calcium, act as a flux to lower the melting temperature. Alumina, often derived from clay, stiffens the molten glaze to prevent it from running off the piece.

Results of the firing of the test samples (Plate 1) show that test samples 2, 7, 15, 20, 25, 26, 30, 31, 32, 33, and 34 fused but not completely melted. Samples 61-66 did not melt samples 6, 10, 15, 21, 28, 35, 36, 45, and 55, produced white coloured glazes but only 6 & 10 fused and appear glossy. Test samples 27, 37-43, 46, 47, 48, 49, 51, 54, 56-59, vitrified and produced matte glazes. Test samples 2-5, 7-9, 11-14, 16-18, 22-24 (Plate II) fused very well and were glossy producing various ranges of brown colour which was because feldspar was prominent in these mixtures and the brownish colour was produced due to the quality of ball clay used especially where the amount of ball clay was more than quartz. The compositions without ball clay gave white colour.

All the good samples fused well with no crazing which means that they adhered properly with the body. From the running test conducted on the melted samples, just two (2) samples which are test samples 3 (90% of feldspar and 10% quartz) and 6 (80% of feldspar and 20% of quartz) did run (Plate III), the rest did not (Plate IV).

Test Results from the test tiles produced same effect when applied on stoneware body comprises of 50% of clay and 50% of kaolin. Plate IV is the result of test sample tile sixteen (16 – 50% of Feldspar and 50% of Clay) while Plate V shows the outcome when applied on stoneware body.

Conclusion

Based on methods used and results obtained in this study, good glazes were developed from these raw materials from Osun State; as these exhibited minimum flaws when applied on stoneware body. Test samples, 2 (90% Feldspar and 10% Clay), 3 (90% Feldspar and 10% Quartz), 4 (80% Feldspar and 20% Clay), 5 (80% Feldspar, 10% Clay and 10% Quartz), 7 (70% Feldspar, and 30% Clay), 8 (70% Feldspar, 20% Clay and 10% Quartz), 9 (70% Feldspar, 10% Clay and 20% Quartz), 11 (60% Feldspar, and 40% Clay), 12 (60% Feldspar, and 40% Clay), 13 (60% Feldspar, 20% Clay and 20% Quartz), 14 (60% Feldspar, 10% Clay and 30% Quartz), 16 (50% Feldspar and 50% Clay), 17 (50% Feldspar, 40% Clay, and 10% Quartz), 18 (50% Feldspar, 30% Clay and 20 Quartz), 22 (40% Feldspar, and 60% Clay), 23 (40% Feldspar, 50% Clay, and 10% Quartz), and 24 (40% Feldspar, 40% Clay, and 20% Quartz) fused well and showed evidence of glossiness. The results on the whole showed a good prospect and suitability of the materials in glaze making and production in Osun State; especially stoneware glazes.

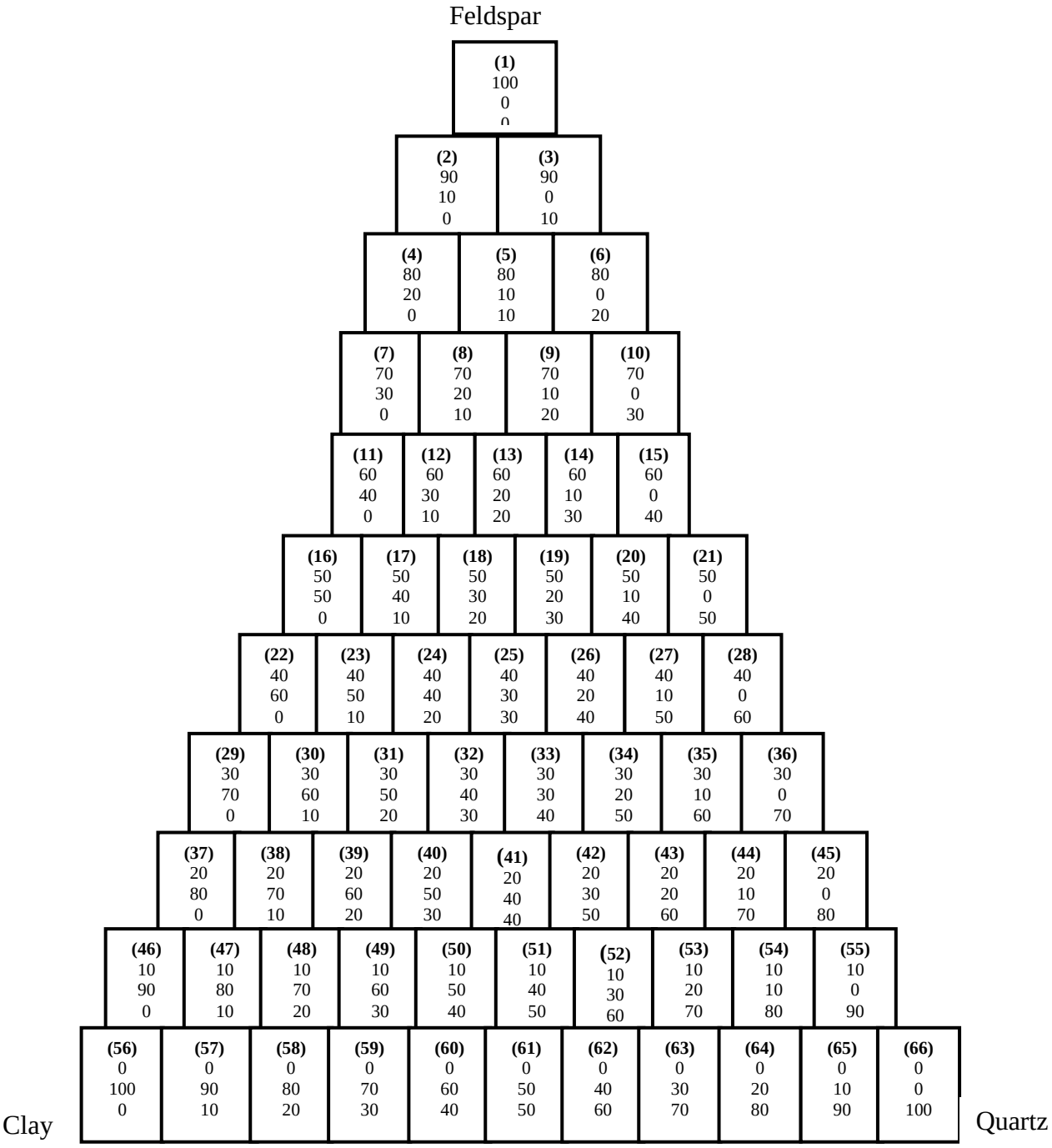

Fig. 1: Triaxial Test Blend of 66 Samples
Source:- Okoruwa, 1986

Table 1: Chemical Analysis of Feldspar, Quartz, and Clay

Oxides	Feldspar (%)	Quartz (%)	Clay (%)
SiO_2	63.7	98.69	61.9
Al_2O_3	14.1		19
Fe_2O_3	0.456	0.073	6.86
MgO			0.08
CaO	0.012	0.455	0.87
Na_2O	0.07	0.01	0.62
K_2O	20.53	0.11	4.4
SO_3			
MnO	0.032	0.01	0.14
TiO_2			2.01
L. O. I	1.09	0.71	3.68

Plate I: Triaxial Blend Result of 66 Samples using Clay, Feldspar, and Quartz

Plate II: Result of Successful Glazes

Plate III: Test Samples whose Glazes did run

Plate IV: Test Samples whose Glazes did not run

Plate IV: Fired Result of 50% of Majeroku Feldspar and 50% of Ilesa Clay.

Plate V: Fired Result of 50% Majeroku Feldspar and 50% Ilesa Clay on Stoneware body

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