DEVELOPING A SUITABLE PORCELAIN BODY FOR DIGITAL IMAGE TRANSFER USING SOME SELECTED LOCAL MATERIALS

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Abstract
Many techniques of surface embellishments like scratching, incising, cutting, etc have been used among studio potters in Nigeria. But over time, these techniques have become obsolete, thereby making pottery less appealing due to the monotony of same form and surface decoration. While other ways of adding aesthetic value to ceramic surfaces like digital transfer exist, it is yet to be fully explored within Nigeria, perhaps due to ignorance or it is perceived to be too expensive. Digital ceramics is a technique that allows the transfer of photographic images onto ceramic surfaces. This paper examines digital ceramics as a tool for creating durable and aesthetic imagery on porcelain surfaces.

Introduction
Technology has revolutionised visual design and has given birth to many techniques of transferring designs done on one surface onto another. Such transfer techniques include lithography, photography, screen printing, intaglio etc. Akinbogun (1991) explored many screen printing techniques and observed that as popular and as old as transfer printing is, its usefulness and creative potentials have not been fully exploited by studio potters in Nigeria.

Digital image transfer which is another transfer technique is a process by which designs or pictures are made on special water slide paper (decals) and transferred unto ceramic surfaces. This form of art embraces techniques from both photography and ceramics and has the potential of producing wares of high aesthetic quality and photographic durability. White backgrounds help in enhancing image and colour sharpness. Therefore it is important that a white body is developed.

For this research porcelain body was selected because one of its physical attributes is its whiteness. There are three major ingredients in a porcelain body; kaolin, feldspar and quartz. The mixture is fired at temperatures ranging from about 1250˚C to 1450˚C. Rathus (2007) defines porcelain is hard, nonporous, and usually white or grey in colour. It is made from fine, white kaolin clay and contains other minerals like feldspar, quarts and flint in various proportions. It makes a characteristic ringing sound when struck with a fingernail.

Locally developed porcelain bodies have been used in the production of several wares like table wares, electrical insulators, jar mills, laboratory wares, etc. this to an extent has not been used to produced some wares like planters. The crux of this research is to experiment with local materials for the development of a porcelain body suitable for digital image transfer.

Materials and Methods
Kankara kaolin, Itakpe quartz and feldspar, Ikpeshi calcium carbonate and bentonite were sourced, processed and compounded as porcelain body and the glaze compositions.

Procurement / Sourcing of Materials
Kaolin was sourced from Kankara in Katsina State, feldspar and quartz from Kogi State and Bentonite was bought from a chemical store in Zaria. Calcium carbonate in was bought from a local market in zaria

Raw Materials Processing
Kaolin

- Soaked in water for two days and stirred thoroughly.
- Sieved through 75µm(200 Tyler mesh)
- Allowed to dry for seven days

Feldspar and Quartz

- Were separately soaked in water for two days and washed to remove surface impurities.
- They were calcined at a temperature of 960ºC
- Thereafter, they were manually crushed with hammer.
- Crushed using a jaw crusher
- Separately ball milled for about six hours in a jar mill.
- A 75µm (200 Tyler mesh) was used to sieve each the materials.

Calcium carbonate
The calcium carbonate was already processed so it was used directly. Its source is from Ikepeshi in Akoka in Edo state as affirmed by Okpoku (2015)

Chemical Analysis of Quartz, Feldspar and Kaolin
X-ray Fluorescence Spectrophotometer (XRF) test was carried to determine the elements present in the materials. This test was done at National Geosciences Research Laboratory, (NGRL) Kaduna.

Formulation of the Porcelain Body using a Triaxial Blend
As the word implies, a triaxial blend is a composition of three materials. According to Vince (2001) it is a method for testing three-way combinations of glaze or body materials, where proportional amounts vary through a series of samples between three limits. It may involve change in glaze materials, or addition of colorants or modifiers. For the purpose of this project, the three materials are feldspar, quartz and kaolin. Triaxial blend is one among many methods used in the formation of ceramic composite such as earthenware body, stoneware body, white body, porcelain body, etc physically mixed. The samples were fired to 1260^{o}C in a kerosene kiln to determine their suitability porcelain body formulation. Tile sample no. 24 was s elected since it exhibited observational characteristics of porcelain. The triaxial blend usually consists of a 21, 36, 66 and various other blends. The 66 blend model was adopted from Mamza (2014) for this research work. A chart blend was drawn and the materials in various ratios were inserted. The first figure in each rectangle represents Feldspar, the second is Kaolin and the last is Quartz. From the 66 tiles (Fig. 1) that made up the chart, small quantities were measured and mixed.

Slip Preparation
Tile sample 24 which is made up of 40% feldspar, 40% kaolin, 20% quartz was selected and used for slip preparation and production of planters. The sample was adjusted because there was a need to add a plasticiser (Table 2). 2% bentonite was introduced as the plasticiser as suggested by Hansen (2008). According to him the addition of just 2% bentonite results in a marked improvement in the workability and dry strength of porcelain with little effect on the fired colour. 30kg of slip was formulated. These materials were carefully measured with a digital scale and thoroughly mixed using a blunger. Then it was allowed to age for 7 days before it was used for casting.

Modelling and Casting
Sketches of desired forms (planters) were made. Then a clay model was made. Thereafter, the seam line was marked then it was placed on a work table. Cottle was built around the model before separator was applied. Water was mixed with plaster of Paris in a ratio of 100:130. The mould was taken in three pieces (two sides and a base). The mould was then allowed to dry for about 5 days before the commencement of slip casting.

Slip Casting
The three pieces were coupled and held together with rubber bands then the slip was poured into the mould. It was allowed to absorb for 4 minutes before it was poured out. It was allowed to stay in the mould for 4 hours

before it was removed. When it became leather hard, seam lines were eliminated. It was allowed to dry for 14 days, then it was fettled then fired (Plates I and II).

Firing and Glazing

Firing converts ceramic work from weak green-ware into a strong, durable and impermeable material, as the temperature in a kiln rises; many changes take place in the clay body. The glaze composition was 40% feldspar, 30% quarrtz 20%, kaolin and 10% calcium carbonate. Bisque firing was carried out at 1160°C and glaze firing at 1280°C. It was an oxidized firing in a kerosene kiln. Bisque firing was done in 4 hours and Glaze firing was done in 7 hours.

Production of Decals

Hopper (2004) described how decals are transferred. According to him, the desired image is printed or painted with oil based ceramic paint unto the gummy side of the decal paper. When dry, it is covered with a cover-coat. The cover-coat creates a thin plastic film which holds the pigment image. When placed in warm water, the gum will soften enabling the film to slide off the backing paper. The film can then be carefully placed on the glaze fired surface and smoothened out to expel any air. The pigment image now has contact with the ceramic surface and the film burns away during firing.

Image Sourcing and Editing

Images were sourced on the internet while some were taken using a digital camera. The images were edited using adobe Photoshop and the following specifications were adhered to as suggested by ceramicdecalprinting (2011).

- Adobe Photoshop or any compatible software should be used to edit the images
- the images should be laid on a white background
- a maximum dpi of 400 dpi should be used
- Red, Green and Blue (RGB) mode of colour
- Tagged Image File Format (TIFF), Photoshop Document (PSD) or Joint Photographic Experts Group (JPEG) file format should be used

Plates III and IV are some of the images that were sent abroad to *fotoceramic* (Units 3-5 Craftsman Works Cambridge Stoke on Trent, ST62 2NZ (United Kingdom) for printing.

Decal Transfer

The ceramic products were washed with clean water to remove dust from its surface, then the decals were cut to size and immersed in water for 60 seconds, the water will make the decal to separate from the backing paper. When the transfer uncurled, it was removed from water and placed on the surface of the planters. The backing paper was gently pulled from the decal, and then it was readjusted. A squeegee was used to expel air bubbles that were trapped under so that the decals were laid flat. After that, it was allowed to dry outside in the atmosphere for 3 hours after which it was fired.

Results and Discussion

This section gives the various results as per the experiment, observation and the physical as well as the photographic elements of the porcelain planters. Tile sample 24 which is made up of 40% feldspar, 40% kaolin, 20% quartz was selected because it exhibited some desired properties. The planters produced from this sample were white and warped less even when they were thinly cast.

Decal firing

According to Baldwin, Evele and Pershinky (2010) Ceramic decals can be fired at various temperatures ranging from 720ºC -1200ºC. The decals were fired after being transferred to the porcelain planters. At 840°C the decals the matured and resulted in the addition of permanent colourful, aesthetic finishing to the porcelain wares

Findings

The formulated body was white and deemed suitable for image transfer. The planters were bisque fired in two batches. In the first, it was observed that some of the planters that were placed on warped shelves warped but in subsequent firing the planters did not warp because flat and even shelves were used. This indicates that it is essential that porcelain wares be placed on flat shelves to avoid warping. Glaze firing was also done in two batches and it was observed that the warping increased in the planters that warped during the bisque firing but those that did not warp remained intact. Firing the decals resulted in a permanent transfer of digital images on

porcelain planters and also added aesthetic value to the wares.

Conclusion

In conclusion a suitable porcelain body was formulated for digital image transfer. Also, images were sourced, edited and used for digital transfer, which added aesthetic as well as cultural value on the planters casted from the formulated porcelain.

Table 1: Chemical Composition of the Raw Materials

Oxide	Quartz (wt%)	Feldspar (wt%)	Kaolin (wt%)
SiO_2	99.3	63.6	54.8
Al_2O_3	-	18.4	31.6
Fe_2O	0.12	0.3	0.8
MgO		0	0
K_2O	0.08	16.9	0.8
CaO	0.243	-	0.409
Cr_2O_3	-	0.02	-
MnO	0.01	0.01	0
TiO	0.01	0.01	0.2
BaO	0.09	0.08	0.02
CuO	0.01	0.01	0.01
NiO	0.011	0.12	-
CeO_2	0.01	0.009	-
Nd_2O_3	0.016	-	-
Ga_2O_3	-	0.015	-
GeO_2	-	0.019	-
SeO_2	-	0.10	-
Ag_2O	-	0.09	-
Vb_2O_3	-	0.01	-
Na_2O	-	-	-
LOI			11.09

Table 2: Composition of Casting Slip

Materials	Percentage (%)	Weight (kg)
Feldspar	35	10.5
Kaolin	48	14.4
Quartz	15	4.5
Bentonite	2	0.6
Total	100	30
Water	50	15

Table 3: Result of firing the 66 samples at 1260°C

Title No.	Colour before firing	Texture & appearance after firing
1 – 13	Pale pink	Vitreous looking glassy and lustrous
14 – 26	Pale pink	Vitreous and less glassy
27 – 39	Pale pink	Vitreous and opaque
40 – 52	Pale pink	Porous white
53 – 66	Pale pink	Very porous and white

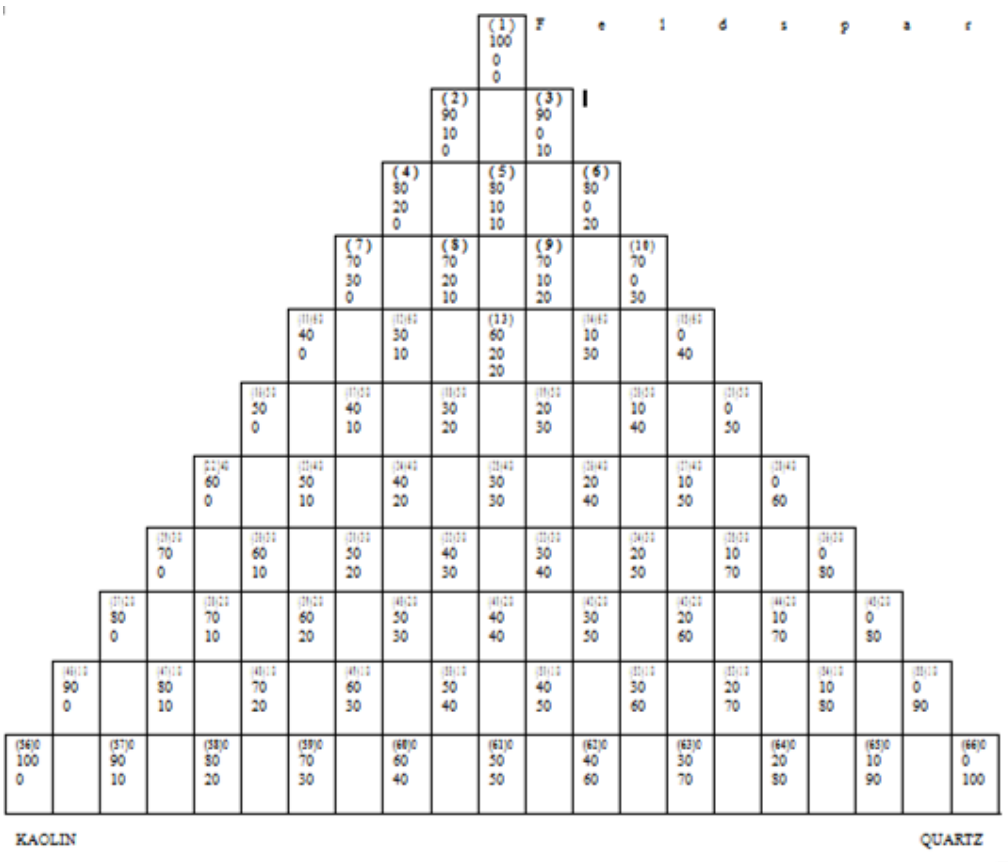

Figure 1: Triaxial test blends of 66-member materials
Source: Mamza (2014)

Plate I: Leather hard cast in a mould

Plate II: Bone dry cast pieces

Plate III: Zaria city
Source: Wikipedia

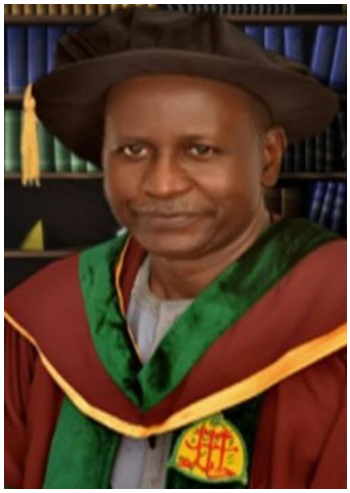

Plate IV: Prof. Ibrahim Garba
Source:thenationonline.nettag/abu

Plate V: Transfer of Decal to Planter

Plate VI: Glazed fired Planters ready for Decal application

Plate VII: Planters with Decal

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