

PRODUCTION OF BONE CHINA WARE USING LOCALLY SOURCED RAW MATERIALS IN NIGERIA

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Abstract

Bone china ware is one of the white body ceramic products that utilizes raw bone as one of its major constituent. Bone china which was widely accepted and presents a high value market over porcelain was firstly done by Josiah Spode. This product is found in local market in Nigeria and is not produced in the country, despite the abundant availability of the raw material in producing them. The quest to produce bone china wares locally necessitates the study. This study thus investigates the availability of bone which is the major raw material in the production of bone china. The bone was processed through calcinations to make it suitable for ceramic use. Three different compositions were produced through experimentation from the materials using slip casting method of production and were analyzed based on the qualities of bone china. The composition that exhibits the best quality of bone china was identified composing of 50% bone china, 20% kaolin, 15% flint and 15 % feldspar. Thus, the composition is thereby recommended for local production of bone china ware.

Introduction

Bone ash experimentation was firstly done by Josiah Spode as a material for ceramic wares production. Its brilliance performance with clay, brought about the development of bone china which was widely accepted and presents a high value market over porcelain due to the properties it exhibited such as good translucency, and much more stronger than porcelain (Jones, 2006). This material has been found useful and of great importance in porcelain to improve its quality and also used as part of glaze materials to perform certain functions such as flux at high temperature and as opacifier. It has also been found useful in other allied industries such as metallurgical, pharmaceutical, fertilizer industries etc.

Bone ash is derived from calcinations of animal bone. Bone which is the source of bone ash, play diverse vital roles in vertebrates. They provide a framework for the body, supporting it and giving it shape. They also provide a surface for the attachment of muscles and act as levers, permitting many complex movements. Many bones protect

softer internal organs; for example, skull bones protect the brain, and rib bones form a cage around the lungs and heart. In addition to these structural and mechanical functions, bones also participate in the body's physiology (Whitebourne, 2012). They store calcium, a mineral essential for the activity of nerve and muscle cells. The soft core of bone, the bone marrow, is the site of formation of red blood cells, certain white blood cells, and blood platelets.

Raw bone is chemically hydroxyapatite [$\text{Ca}_3(\text{OH})(\text{PO}_4)_3$]. However, bone ash is primarily composed of calcium phosphate $\text{Ca}_3(\text{PO}_4)_2$, the hydroxyl group has been removed by the action of calcinations (Ayilaran, 2009). Another form of non-bone calcium phosphate source is called synthetic bone ash which is got from solid mineral apatite [$\text{Ca}_5(\text{PO}_4)_3(\text{OH},\text{F})$]. This is rarely found in the country. The cheapest and easiest way of sourcing for calcium phosphate presently is through processing of raw bones.

Availability of locally made bone china wares is rare in our local market. There are various forms of ceramic wares in the market, including bone china wares which are basically foreign made goods (Akinde, Odeniyi, & Abiodun, 2013). Ironically, the major materials in making these goods locally are lying waste. Thus, this study intends to use bone ash which is an abattoir waste to produce a locally made bone china ware that could meet up with the standard of imported bone china wares.

It is necessary that consideration should be made on the level at which locally sourced materials are under utilized in our environment. The locally sourced materials which could serve as useful materials in the industries are laying waste on the street. In the view of this, this study utilized the use of locally sourced materials especially the waste bone in the abattoir which is the major material needed in the production of bone china. The quest to produce a locally made bone china ware from available raw materials necessitates this studio experimentation with a view of domesticating the production of bone china ware in Nigeria.

Materials and Method

Cattle bones were collected from abattoirs within Akure, Ondo State. The bone was sourced in two different abattoirs within the Akure metropolis; FUTA junction abattoir behind chicken republic and, abattoir at Onyearugbulem market (Bussa) along Owo expresses way, Akure.

The bones collected were gathered, washed and boiled in order to remove impurities such as dirt and unwanted fat that are present in the bone. The bones were boiled at water boiling point (100°C) to help in softening the adhered beef for easy removal and to de-fat the bones.

The bones were rinsed with water immediately after boiling; this is to ensure that the fat is removed to a barest minimum, and the adhered beef were also removed through this process. The bones were further subjected to calcinations through the use of a kiln, in order to remove organic matters present in the bones and to weaken the structure of the substance for easy grinding. The bones were calcined for three hours in

the kiln without pre-heating to 800°C in order to ensure that the entire organic compound is almost completely burn out as a result of subjecting the substance to heat.

The calcined bones were further crushed into smaller pieces by pounding the bones with the use of mortal and pestles and later grinded. This is to make the pulverizing of the bone easier and faster in the ball mill. The finer the particles, the smoother and densely packed the wares produced from the materials will be. The materials used for this experimentation were milled at Ceramic section, Federal Institute of Industrial Research Oshodi, Lagos. (FIIRO), using a giant ball mill as this is to achieve a finer particles size of the materials.

Three different body compositions were compounded with additional material at variance in order to determine their suitability for the production of bone china wares. The compositions are as presented in Table 1. 10kg of each samples were in batch equivalent to 100 percent were measured and used for the experiment. As a result of tearing of the sampled wares in the mould and cracking during drying, 10ml of Bentonite was introduced into each batch composition to act as binder.

Slip was produced by mixing each batch samples in little quantity of water with a pint of Sodium silicate otherwise known as water glass which acts as deflocculant. The mixtures were properly mixed in a ball mill to ensure homogeneous mixing and the free flow of the slip. Slip casting was done by assembling mould(s) and pouring the casting slip into it and the excess slip was poured out of the mould immediately the required wall thickness of 0.5 cm was achieved. The mould was turned upside down in order to properly drain the excess slip which might not make the ware to have a free flow. In few minutes after, the cast piece was de-moulded and allowed to hardened and dried in an open air.

Firing of the wares

Firing is an act of drying ceramics wares at a very high temperature into the kiln. There are two types of firing of wares in ceramics; these include bisque firing which is also known as biscuit firing and also the gloss firing. The bisque firing for this study was done at temperature of 1150°C due to the body

composition and the gloss firing at the temperature of 1100°C.

Results and Discussion

The bone dried wares were bisque fired in the kiln at 1150 °C and later gloss fired to 1100 °C. All the body compositions that were formulated survived firing and gives smooth white surfaces. However, sample C proved to be the best out of the composed samples. It was whiter, translucent and harder than the other compositions, and posses all the quality of a good bone china ware.

Conclusion

It was observed in the course of this study that bones are readily available in our environment without getting to abattoir. There a lot of products that could be generated from bone instead of disposing them as waste. This will also help in sanitizing our environment, as well as converting waste to wealth. Bone china ware can be produced locally in Nigeria and prospective ceramic industry should look inward on how to produce this ware locally. Nigerians are also encouraged to patronize locally made products in order to improve our Gross Domestic Product (GDP).

Table 1: Bone China ware body compositions in percentage

	Bone Ash	Kaolin	Flint/Quartz	Feldspar
Sample A	50	15	10	25
Sample B	40	20	20	20
Sample C	50	20	15	15



Plate 1: Bones sourced from abattoir



Plate 2a: Glazed sample ware produced



Plate 2b: Unglazed sample ware produced

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