UTILIZATION OF RICE HUSK ASH FOR THE PRODUCTION OF GLAZES

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ABSTRACT
The overall objective of this work is to utilized rice husk ash, produced by burning of rice husk, which is a by product of milling of rice. Currently, the bulk of this husk is being land filled or burnt with its attendant environmental hazard. This can be converted as a major raw material to manufacture value added ceramic glazes and to commercialized the technology. Rice Husk Ash (RHA) was incorporated in the formulation of glazes. The experimental results show that suitable incorporation of rice husk ash can result in a glaze with good properties, such as non-crazing effect, whitish in colour and smooth.

Introduction
Rice is a stable food for billions of people around the world. Rice husk is the shell produced during de-husking of paddy. Globally, approximately 600 million tons of rice paddy is produced yearly worldwide and this figure is increasing annually (FOA). Paddy on an average consists of about 72% of rice, 5%-8% of bran, and 20%-22% of husk. It is also estimated that every ton of paddy produces about 0.18t to 0.20t of ash, depending on the variety, climatic conditions, and geographical location sources.

Rice husk ash (RHA) is obtain by the burning the rice husk, and in particular it is produce in plants where rice milling is performed. In general, the R.H.A is done as a waste. Assuming a husk to padding ratio of 20% and an ash to husk ratio of 18%, the total global ash production could be as high as 21million tons per year. RHA is a general term describing all types of ash produced from burning rice husk. In practice, the type of ash varies considerably according to the burning technique. The silica in the ash undergoes structural transformation depending on the conditions like time and temperature of combustion.

Based on temperature range and duration of burning of the husk, crystalline and amorphous forms of silica are obtained. The crystalline amorphous of silica have different properties and it is important to produce ash with correct specifications for specific end use (Muthadhi, Anitha and Kothandaraman, 2006).

This ash contains nearly 95% mass silica and is an important renewable source of silica. Burning is a cheap method of extracting the silica from rice husk for possible commercial use, but it brings up the associated problems of uncontrolled particles size and variable impurity levels, mainly in the form of intimately mix carbon. Because growing environment concern and the need to conserve energy and resources, efforts have been made to burn the husks under controlled conditions and to utilize the residual ash in a variety of end products. The controlled burning of the rice husks in air leads to production of white rice husk ash (WRHA) or ‘white ash’ containing almost pure (95%) silica in a hydrated amorphous form, similar to silica gel, with high porosity and reactivity. This silica can use as excellent starting material for the production of whitewares and glazes (Bondioli, Barbieri and Manfredini, 2009)

The presence of silica in RHA was known since 1983 and an extensive literature search highlighted many uses of RHA as silica replacement (Prasad, Maiti and Venugopal, 2000). Two main industrial uses were identified: as an insulator in the steel industry and as a pozzolana in the cement industry. RHA is used by the steel industry in the production of high-quality flat steel. Moreover, RHA is an excellent insulator, having low thermal conductivity, high meting point, low bulk density, and high porosity. It is this insulating property that makes it an excellent “tundish powder” that prevent rapid cooling of the steel and ensures uniform solidification in the continuous casting process. In addition, substantial research work carried out on its use in the manufacture of concretes. In particular there are two area in which RHA is used: in the manufacture of low cost building blocks and in the production of high quality cement. The addition of RHA to cement enhances the cement properties. Addition of RHA to Portland cement not only in improves the early strength of concretes, but also leads to the formation of calcium silicate hydrated gel round the cement particles, which become highly dense and less porous. This may increase the strengths of concretes against cracking.

Generally, concretes made with Portland cement containing RHA as a higher compressive strength (Saraswathy and Song, 2007). The use of RHA as silica replacement in the ceramic field was studied at a laboratory level by several authors. Prasad, Maiti and Venugopal (2000) investigated the effect of RHA in traditional whiteware compositions completely replacing the quartz without substantial modification to the physical and mechcanical properties of the products. Okunna (1983) as well as Wattanasirwech, Polpuak, Danthalson and Wattanasirweh, (2008) reported the use of RHA and its recycling as quartz substitute for the production of ceramic glazes.

Starting from this work, in this paper the use of RHA in complex glassy systems, such as the chosen ceramic glazes, was reported. Evaluating the possible uses of this agricultural waste its important not only from the scientific point of view. In fact, considerable effort are being taken worldwide to minimize the cost of the frits and glazes that are very incident on the total price of a low added value product as the ceramic tile (Bondioli, Barbieri, Ferrari and Manfredini 2009). In this end waste should be looked as resources that are extracted and therefore usable and the recycling of the material can be seen as prevention of waste produced in the context of extracting raw materials. To design the glazes, characterization of RHA collected from a local rice mill was conducted in order to evaluate mainly the chemical composition of the RHA (Table 1).

Experimental Procedure

All the raw materials used for this study are abundant in Nigeria and are being used for the production of glaze. The raw material selected where rice husk ash, wood ash and potash feldspar. Rice husk that was incorporated in the glaze was prepared by controlled burning of the rice husk in the open air so as to avoid the presence of carbon as far as practicable. Calcined feldspar (700^oC) was ground in a ball mill to around 200 mesh. The slurry was sieved with the 200 mesh and dried. Wood ash was soaked in water for five days so as to reduce the acidity which affects the nature of the glaze if not washed away. Twice on each of the five days, the water that had collected on top of the mixture poured away and a fresh one poured onto it. On the fifth day, the soaked wood ash was sieved to remove debris and dried.

The three obtained materials (rice husk ash, wood ash and feldspar) were compounded into various batches of glazes based on the triaxial test blends the preceding chart and were separately wet ground in the ball mill to enhance homogeneity and even particle distribution of materials. Each of the test batches was sieved and applied onto bisque fired tile in a uniform glaze layer. All the test specimens were then fired between 1200 and 1260^oC.

Results and Discussions

The chemical analysis as presented in chart confirms that the rice husk ash though with 8 wt% of unburned carbon, is a waste that contain 80 wt% of very pure silica. Others oxides like Fe_2O_3 and TiO_2 that can influence the development of colours are all lower than 1.5wt%.

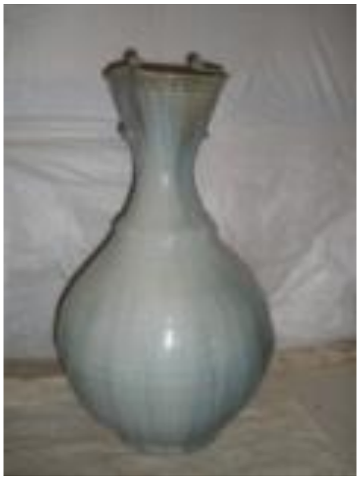
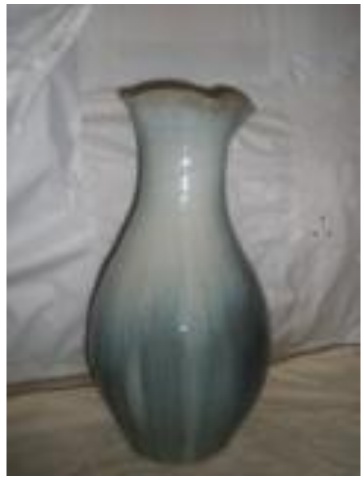
From the experimental tests carried out, the results shows that the triaxial test blend No.9 (Feldspar 40%, rice husk ash 20% and wood ash 40%) fired to a temperature of 1260^{o}C was the best. It was glossy and whitish in colour without crazing. However, 200gramms of bentonite was added to give more adhesions to the fired bisque ware to prevent the glaze from flaking off due to its powdery nature.
Based on the triaxial blend tests conducted, the following findings are made:

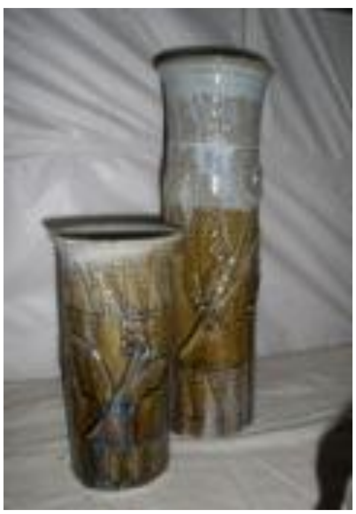
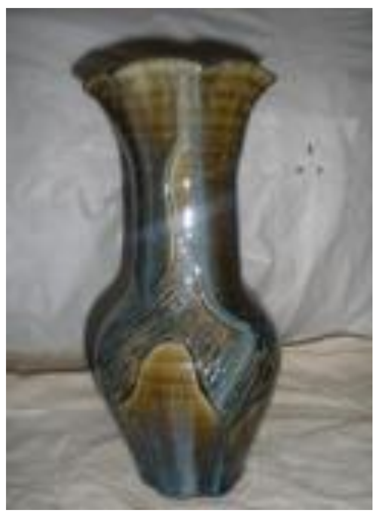
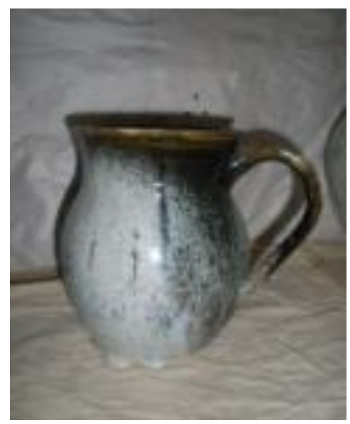
- That the materials (feldspar, wood ash and rice husk ash) can be utilized for high temperature glazes
- Mixture of wood ash, rice husk ash and feldspar produces glossier white glaze.
- In spite of the lack of analysis like differential thermal analysis, a careful and methodical beneficiation of the raw materials for high temperature glazes is possible.
- That the proper blending of all the constituent raw materials of the raw glaze is necessary for a successful and a more uniform result
- Above cone 9 (1260^{o}C) the glaze becomes fluid and runs.

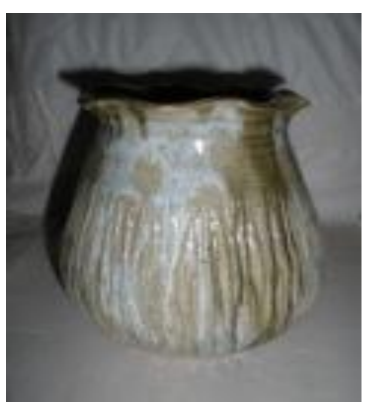
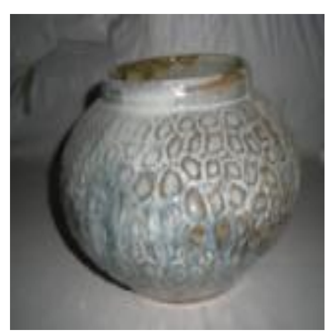
Based on the results of these tests, a large batch was compounded from test blend No 9 and used to glaze larger wares. Sample of wares glazed with the white glazed are attached. Some of the wares were also glazed in combination with other glazes that overlapped the test glazed to produce very pleasing effects.

Conclusion

This work confirms the possibility to use RHA as silica precursor for the development of glazes for ceramic wares. It is obvious from this investigation that a glaze compounded from wood ash, rice husk ash feldspar gave a practical glossy white glaze when applied on the ceramic are. The selection of these local raw materials was based on the fact that they are available in abundance at all times, and easy to process. It is possible with further research to build up knowledge on the potentials of these materials for proper development as resources for the ceramic industry.

TRIAXIAL BLEND CHART

1 (**F**) Feldspar 100%

2 F=80% R=20%
3 F=80% w=20%

4 F=60% R=40%
5 F=60% R=20% W=20%
6 F=60% w=40%

7 F=40% R=60%
8 F=40% R=40% W=20%
9 F=40% R=20% W=40%
10 F=40% w=60%

11 F=20% R=800%
12 F=20% R=60% W=20%
13 F=20% R=40% W=40%
14 F=20% R=20% W=60%
15 F=20% R=80%

16(**R**) Rice Husk Ash
17 R=80% W=20%
18 R=60% W=40%
19 R=40% W=60%
20 R=20% W=80%
21(**W**) Wood ash 100%

Table 1: Chemical analysis and mineralogical composition of Rice Husk Ash

Oxide	(Mass %)
SiO_2	80.85
Fe_2O_3	0.14
TiO_2	0.15
CaO	1.07
P_2O_5	3.22
K_2O	1.39
RuO_2	0.28
MnO	0.33
L.O.I	4.62

Source: XRF Analysis conducted at the National Metallurgical Development Centre, Jos. Plateau State, Nigeria.

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