Preparation of Ceramic Glaze Using Corn cob Ash as a Replacement for Longan wood Ash

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Abstract

The objectives of this research were to prepare ceramic glazes using corn cob ash as a substitute for longan wood ash for stoneware applications, and to develop glaze colors by adding nickel, cobalt, titanium, and manganese oxides. Corn cob ash was replaced longan wood ash in the original glaze formulation in the range of 0–20 wt%. The bisque-fired samples, fired at 800 °C, were dipped into glaze slips with a specific gravity of 1.65. The glazed samples were subsequently fired at 1,250 °C under a reduction atmosphere. The thermo-physical characteristics of the glaze surfaces were evaluated, including melting behavior, surface smoothness and glossy, crazing, and adhesion to the bisque-fired samples. The results indicated that corn cob ash can effectively substitute for longan wood ash. The obtained glazes exhibited complete melting, forming a transparent layer with smooth, uniform, and glossy surfaces. Crazing was observed on the glaze surface, while good adhesion to the bisque-fired samples was achieved. In this study, corn cob ash could replace longan wood ash up to 15.76 wt% without adversely affecting glaze characters. Therefore, the addition of nickel oxide, cobalt oxide, titanium dioxide, and manganese dioxide at 1.4, 0.3, 0.1, and 0.01 wt%, respectively, a grayish-blue glaze was achieved. Furthermore, the glaze color became lighter blue and more transparent when the cobalt oxide content was reduced to 0.2 wt%.

Introduction

Ceramic glazes play an important role in improving the surface quality and appearance of stoneware products. Wood ash is commonly used as a flux in glaze formulations, especially longan wood ash. However, the limited availability of this material encourages the search for alternative resources. Agricultural waste such as corn cobs is abundant and may contain minerals suitable for ceramic glazes. Therefore, this study investigates the use of corn cob ash as a substitute for longan wood ash and examines the development of glaze colors using metal oxide additives.

Objective

- To prepare ceramic glaze using corn cob ash as a substitute for longan wood ash for stoneware products fired at 1250 °C under a reduction atmosphere.
- To develop ceramic glaze colors using nickel oxide, cobalt oxide, titanium oxide, and manganese oxide.

Methods

- Test materials



Corn cob ash



250 mesh

X-ray Fluorescent (XRF) Analysis

- Glaze Preparation

Raw materials
- Feldspar
- Quartz
- Calcium Carbonate
- Barium Carbonate
- Kaolin
- Long wood ash
- Corn cob ash
- Metal Oxides



Milling with water
8 hr , Sp.Gr. 1.65

Glaze slip



80 mesh

Glaze on Biscuits stoneware fired at 800 °C

Firing at 1250 °C under a reduction atmosphere

Conclusions

Ceramic glazes play an important role in improving the surface quality and appearance of stoneware products. Wood ash is commonly used as a flux in glaze formulations, especially longan wood ash. However, the limited availability of this material encourages the search for alternative resources. Agricultural waste such as corn cobs is abundant and may contain minerals suitable for ceramic glazes. Therefore, this study investigates the use of corn cob ash as a substitute for longan wood ash and examines the development of glaze colors using metal oxide additives.

Results

- X-ray Fluorescence (XRF) Analysis

Table 1
Chemical compositions of Two Types of Corn Cob Ash (%wt).

Type of Corn cob ash	Chemical compositions (Weight %)																	
	SiO_2	Al_2O_3	K_2O	CaO	MgO	TiO_2	Fe_2O_3	P_2O_5	As_2O_3	ZrO_2	BaO	SO_3	Cl	CuO	MnO	ZnO	Br	%LOI
Type l	16.00	1.76	36.00	26.20	3.83	0.135	1.19	9.42	-	0.0286	0.112	1.36	3.71	0.0203	0.136	0.0607	0.0025	4.04
Type ll	16.8772	0.3356	43.653	18.608	3.7972	-	0.5340	14.042	-	-	-	0.8796	0.8732	0.0261	0.1339	0.0380	-	0.22

Table 2
Chemical compositions of Longan Wood Ash (%wt).

Type of Longan Wood Ash	Chemical compositions (Weight %)																	
	SiO_2	Al_2O_3	K_2O	CaO	MgO	TiO_2	Fe_2O_3	P_2O_5	As_2O_3	ZrO_2	BaO	SO_3	Cl	CuO	MnO	ZnO	Br	%LOI
Type l	4.35	1.20	2.03	80.20	4.12	-	0.488	7.14	-	-	-	0.323	0.087	0.126	0.047	0.026	-	2.850

- Seger Formula

Seger formula of glaze formulation 1 containing 10 %wt of corn cob ash type 1 and type 2 with 8%wt of longan wood ash.

Type l of corn cob ash

0.27 Na_2O 0.10 K_2O 0.19 BaO 0.40 CaO 0.04 MgO 0.0002 ZnO 0.0005 MnO 0.00005 CuO
0.21 Al_2O_3 0.003 Fe_2O_3 0.0005 TiO_2 0.00005 ZrO_2 0.03 P_2O_5
2.74 SiO_2



Type ll of corn cob ash

0.28 Na_2O 0.12 K_2O 0.19 BaO 0.37 CaO 0.04 MgO 0.0003 SrO 0.0005 MnO 0.0001 ZnO
0.21 Al_2O_3 0.002 Fe_2O_3 0.03 P_2O_5
2.77 SiO_2



Seger formula of glaze formulation 2 containing 1.38 %wt of corn cob ash type 2 without longan wood ash.

0.24 Na_2O 0.02 K_2O 0.59 CaO 0.03 MgO 0.12 BaO
0.34 Al_2O_3
2.73 SiO_2

Table 3
Oxide Pigments(%wt) in glaze formulation 2 and results.

No.	Oxide (Weight %)					Results
	TiO_2	Fe_2O_3	MnO	CoO	NiO	
A1	0.09	0.16	0.04	0.25	1.23	
A2				0.55	0.93	
A3				0.85	0.63	

Seger formula of glaze formulation 3 containing 14.09 %wt of corn cob ash type 2 with 17.08 %wt of longan wood ash.

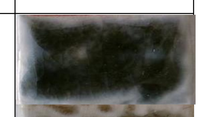
0.133 K_2O 0.127 Na_2O 0.561 CaO 0.076 MgO 0.063 BaO 0.032 NiO 0.006 CoO 0.002 MnO
0.196 Al_2O_3 0.004 Fe_2O_3 0.002 TiO_2
1.567 SiO_2 0.043 P_2O_5



Seger formula of glaze formulation 4 containing 15.76 %wt of corn cob ash type 2 without longan wood ash.

0.111 K_2O 0.106 Na_2O 0.602 CaO 0.081 MgO 0.100 BaO
0.186 Al_2O_3 0.005 Fe_2O_3
1.642 SiO_2 0.047 P_2O_5

Table 4
Oxide Pigments(%wt) in glaze formulation 4 and results.

No.	Oxide (Weight %)					Results
	TiO_2	Fe_2O_3	MnO	CoO	NiO	
B1	0.10	-	0.01	0.30	1.40	
B2				0.20		
B3				0.30	1.20	