# INCORPORATING SHORT CLAY INTO CLAY BODY COMPOSITIONS AS ALTERNATIVE TO GROG IN ORDER TO MITIGATE DEFECTS FOR CERAMIC BEGINNERS

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## Introduction

Clay is an essential material in ceramic. Its selection and composition determine products got from it. It is important for ceramic beginners to understand the importance of incorporating different clays into the clay body in order to ensure successful drying and firing of a finished piece. Ceramic beginners are often challenged by the defects of warping, cracking, and excessive shrinkage at drying and bisque firing state. Non-plastic clay such as grog is used in clay body to mitigate these defects at green, dried and fired state. The use of 10% grog has become a useful addition to clay body composition. However, due to the strenuous preparation of grog it is sometimes difficult for beginners to incorporate it into their clay body compositions. When this is not done, deformation and distortion of wares during drying and bisque firing occur. As it is reported in Dinsdale (1986) no magic about having a successful sundry and fired ware without a well-balanced clay body. These include essential components such as flux easy melting material like feldspar, refractory such as kaolin, and filler materials for example, grog. Highly plastic clays composed mainly of ball clay and kaolin for throwing or hand built with little or no filler when exposed to rapid drying will definitely crack or warp, and at the same time, experience excessive shrinkage. Ceramic beginners; those who are new in the art of ceramic production sometime find it difficult to go through grog preparation process and prefer to use highly plastic clay because it is easier to prepare and throw with. Preparation of grog requires a lot of time and effort. This paper offers an alternative to grog for beginners by incorporating short clay into clay body compositions. It focuses on investigating grog and short clay compositions and their effects on ball clay and kaolin base-clay bodies. The goal is to identify the optimal percentage of short clay for beginner's clay body compositions.

## Clay and Clay Body

Clay consists of fine-grained natural soil material primarily composed of hydrated aluminum silicate. Clay body is the mixture of different clays and materials used to create ceramic pieces. The selection and composition of the clay body significantly impact the final result, affecting strength, and durability of the ceramic piece. Therefore, it is important to select the right clay for the right combination that will provide the desired result. Dinsdale (1986) reiterated that clay body is formed from a very wide range of inorganic materials, but the practical choice is severely restricted by the special properties needed in the manufacture of those wares. For instance, clay body needed for the production of earthenware is not the same with the stoneware and porcelain body. The reason for this selection of materials is to identify those characteristics that are of crucial importance, and the possession of them makes the material fit the purpose desired.

As for the ceramic beginner it is important to study any given clay or clay body in order to determine their plasticity, shrinkage and absorption porosity rates when creating ceramic pieces. These ensure that the finished product has the desired size and shape. Mathias (2023) observed that ceramics

made out of highly plastic clay or base-clay comprise of ball clay and kaolin alone experience excessive shrinkage, warping and cracking at drying and firing state. It is imperative and pertinent to pay attention to clay body composition formula as wrong composition can lead to distortion of finished products. Al-Habib et al (2020) proof the use of non-plastic clay, said it helps to maintain the pieces' shape and size, no matter how it is dried, making it a vital part of any beginners' clay body. As a result, beginners can ensure that their piece will not crack, warp or shrink excessively when dried, allowing for more accurate result.

**Effect of Grog in Clay Body**

Grog is a fired clay pounded into small pieces which are convenient and admitted as common filler incorporated into clay bodies by ceramic professionals to open up the clay body. Kenny (1976) asserted that addition of 10% grog to clay body provides openings through which moisture can escape so that thick pieces will not crack during drying and firing and also prevents thin pieces from warping. Incorporating grog into clay body reduces shrinkage and adds strength to the clay during firing. However, there are some negative side effects of using grog in clay body composition that are not favoring the ceramic beginners. Apart from difficulty in pounding, it can be hard to work with, as it requires more water and tends to be more difficult to shape and form when it is not proportional. When the content is higher than the expected amount it can be more susceptible to cracking due to its low or zero plasticity, and can be more difficult to fire and glaze due to high level of porosity. That is why Casson (1977) asserted that not only grog can open a clay body, said there are many number of things a ceramist can do to improve an ultra-smooth or highly plastic clay body. One of them is the addition of 8% to 10% of fine clean silica sand which provides opening and equally reduces the rate of warping and cracking of wares by providing an adequate expansion and contraction coefficient of body during drying and firing. Therefore, due to the aforementioned disadvantages of using grog, the study seeks to introduce the use of short clay which is not totally or zero plasticity and it is easier to prepare for inclusion into clay body by beginners.

**Short Clay (non-plastic clay)**

Short clay is also called lean clay or non-plastic clay or more correctly, clays of low-plasticity. Clays with large particles are naturally low in plasticity and require treatment to improve it. Short clays have no strength in the forming process and usually little at green state and dry state (Hamer, 1975). It is this character of short clay that allows many traditional potters to use it for earthenware production, for it is less likely to crack and deform during drying and firing, and is more stable at dried state. The porous nature of the clay body allows the moisture to escape freely during expansion and contraction of the piece in the fire. There are many types of short clays such as late rite, which builders use for bricks, traditional potters coarse clay, among others. This research is utilizing the short clay traditional potters used in Dzumah community, Hong LGA Adamawa State, in fashioning their earthenware pots. The clay does not require many additives. Sometimes with little addition of plastic clay the wares dried and fired to bisque successful in an open fire method.

**Materials and Methods**

**Materials**

The materials of this research are the short clay traditional potters in Dzumah use for the production of their earthenware pots, ceramic studio ball clay, kaolin and grog from recycled fired damaged studio wares.

**Methods**

The short clay was dug from the traditional potter's pit. This short clay was compounded with the studio ball clay and kaolin. Grog was obtained by recycling and pounding the ceramic studio damaged wares into powder and included into a clay body composed of ball clay and kaolin. Tests of plasticity, shrinkage and absorption porosity rates were conducted on the various bodies composed.

Recommendations were made based on the character exhibited by the formulated bodies and the optimal percentage of short clay to be added to kaolin and ball clay for the beginners. Wares were produced from both short clay and grogged bodies for observation. Below are the detail explanations of the plasticity, shrinkage and absorption tests conducted on the bodies of short clay and grog.

**The Plasticity Test**

Plasticity is simply defined as the ability of clay to respond to pressure with continuous and permanent change of shape in any direction without breaking apart. Clay is unique in its degree of plasticity. Non-plastic clay will not bend well, but tends to break instead of forming, even when appropriate water is added. Umar (2000) observed that relationship between water and clay is important in any industrial application of clay. The procedure of testing plasticity as recommended in the American Society of Testing Materials (ASTM) Standards and modified by Gukas and Datiri (2002) that a lump of clay could be rolled to pencil size and try rolling it round the finger next to the thumb. The plastic clay maintains its shape or endures the stresses, while non-plastic or fairly plastic will show signs of cracks.

**The Shrinkage Test**

Shrinkage refers to the loss of size that occurs throughout the total drying and firing process. Considerable shrinking occurs as water evaporates from the wet green ware stage to the bone-dry green ware stage Secondly, during bisque firing, and finally at glaze firing, but this research is limited to bisque firing stage only. The method for testing shrinkage value as modified by Umar (2000) who explained that 12cm bars in length will be produced from the sample clay; the bars will be marked 10cm within the length and dried. The wet to dry shrinking will be recorded. The bars will then be fired to bisque temperature, and the wet to fire will be recorded. Datiri (2012) recommended the measurement to be done only after the specimens have been further dried in an oven between $100^0$C to $110^0$C for 24hours. Likewise, the calculation for fired shrinkage is done only after bisque firing. The percentage is calculated as follows:

$$DS = \frac{PL-DL}{PL} \times \frac{100}{1} \text{----------Equation 1}$$

$$FS = \frac{PL-FS}{PL} \times \frac{100}{1} \text{----------Equation 2}$$

Note: DS = Dry Shrinkage
PL = Plastic Length
DL = Dry Length
And
FS = Fired Shrinkage
PL = Plastic Length
FL = Fired Length

**The Absorption Porosity Test**

Absorption porosity refers to a material's ability to absorb moisture or water after the bisque firing. A pore is a tiny space surrounded by particles of clay. According to Gukas and Datiri (2002) that porosity can easily be measured by weighing a matured bisque fired piece of clay or clay body, then placing the sample in a pan of water, letting it get saturated overnight. Then blot off the excess water and weigh again. The percentage increase in weight represents the porosity of the clay. Yohanna (2014) noted the important thing to keep in mind about porosity that is closely linked with firing, said the higher the firing temperature the lowers the porosity of the body. In another perspective adding lower melting ingredients such as feldspar lower the maturation temperature of the body and consequently, decreases the potential for water absorption in the fired ware. The percentage is determined as follows:

$$A = \frac{SW-FW}{FW} \times \frac{100}{1}$$

Note A = Absorption
SW = Saturated Weight
FW = Fired Weight

**Result/Discussion**

**Selection and Sourcing of the Short Clay**

The sample short clay was sourced in the traditional potters' pit in Dzumah. Its selection was based on some characters exhibited during traditional potter's production process. The researcher observed that after production the wares were directly exposed under the sun to dry and were not showing any signs of crack or warping and possible little shrinkage rate. Below is the sampled clay unprocessed and processed.

**Plate 1: Unprocessed Dzumah Short Clay**

**Plate 2: Processed Dzumah Short Clay**

**Formulation of Ceramic Bodies from the Blends of Grog, Short Clay, Kaolin and Ball clay**

**Sample 1: Grogged bodies; comprised of grog, kaolin and ball clay**

| | | |
|---|---|---|
| a) Grog--------10%<br>Kaolin------40%<br>Ball clay----50% | b) Grog----------20%<br>Kaolin----------40%<br>Ball clay---------40% | c) Grog----------30%<br>Kaolin----------40%<br>Ball clay---------30% |

**Sample 2: Short clay bodies; comprised of short clay, kaolin and ball clay**

| | | |
|---|---|---|
| a) Short clay--------10%<br>Kaolin----------40%<br>Ball clay----------50% | b) Short clay-------20%<br>Kaolin----------40%<br>Ball clay---------40% | c) Short clay--------30%<br>Kaolin----------40%<br>Ball clay---------30% |

**The Results of the Shrinkage Test**

**Sample 1: Grogged bodies result**

| Sample 1: | PL cm | DL cm | Result % | FL cm | Result% | Total shrinkage % |
|---|---|---|---|---|---|---|
| a) | 10 | 9.6 | 4 | 9.4 | 6 | 10 |
| b) | 10 | 9.8 | 2 | 9.6 | 4 | 6 |
| c) | 10 | 9.9 | 1 | 9.9 | 1 | 2 |

**Sample 2: Short clay bodies result**

| Sample 2: | PL cm | DL cm | Result % | FL cm | Result% | Total shrinkage % |
|---|---|---|---|---|---|---|
| a) | 10 | 9.6 | 4 | 9.4 | 6 | 10 |

| | | | | | | |
|---|---|---|---|---|---|---|
| b) | 10 | 9.7 | 3 | 9.6 | 4 | 7 |
| c) | 10 | 9.8 | 2 | 9.9 | 1 | 3 |

**Equation 1:** DS = $\frac{PL-DL}{PL} \times \frac{100}{1}$ **Equation 2**: FS = $\frac{PL-FL}{PL} \times \frac{100}{1}$

**Example:**
**Sample 1 (a) of the grogged bodies:**
DS = $\frac{10-9.6}{10}$ x $\frac{100}{1}$ = 4% FS = $\frac{10-9.4}{10}$ x $\frac{100}{1}$ = 6%

Therefore: 4% + 6% = 10% is the total linear shrinkage of sample 1(a) of the grogged clay body. The shrinkage test is done to ascertain the level at which the materials decrease in size both after drying and firing. The same processes were conducted on the remaining sample materials; four bars of 12cm length were made from each material. A line of 10cm within was drowned at the center when the clay bars were still wet as suggested by (Umar, 2000). The measurements were also taken after the sampled materials were well dried and fired at bisque temperature between $900^0$C- $1000^0$C. The result of the linear shrinkage rates of the grogged clay body (a), (b), and (c) are 10, 6 and 2 percent respectively, which shows that the body's shrinkage level decreased as more grog is added. Likewise, the short clay bodies (a), (b), and (c) total linear shrinkage rates are 10, 7, and 3 percent respectively. This indicates that the shrinkage value of grogged and short clay bodies are similar; only that as grog advances in percentage the more the body loses plasticity. However, up to 30% of short clay in the composition makes it more stable and strong enough for production. Therefore, the optimal percentage of short clay as alternative to grog in body compositions for beginners' ranges from 20% to 30%, allows the bodies to shrink moderately.

**The Plasticity Test Results**
**Sample 1: Grogged bodies result**

| | | **Performance** | **Remarks** |
|---|---|---|---|
| **a)** | Grog----------10%<br>Kaolin--------40%<br>Ball clay------50% | Plastic | Good for throwing |
| **b)** | Grog----------20%<br>Kaolin----------40%<br>Ball clay--------40% | Low-plasticity | Not suitable for throwing |
| **c)** | Grog----------30%<br>Kaolin----------40%<br>Ball clay--------30% | Very low-plasticity | Not suitable for throwing |

**Sample 2: Short clay bodies result**

| | | **Performance** | **Remarks** |
|---|---|---|---|
| a) | Short clay----------10%<br>Kaolin----------40%<br>Ball clay----------50% | highly Plastic | Good for throwing |
| b) | Short clay----------20%<br>Kaolin----------40%<br>Ball clay----------40% | Plastic | Suitable for throwing |
| c) | Short clay----------30%<br>Kaolin----------40%<br>Ball clay----------30% | Plastic | Suitable for throwing |

The simple plasticity test conducted on the clay bodies is to ascertain the level of plasticity the body possessed. Sample 1(a) of the grogged body which is 10% grog in the composition is suitable for production as noted by Umar (2000) that addition of 10% of non-plastic clay such as fire clay can

make the body's plasticity moderate and shrink within the acceptable range of 10% to 15%. While (b), and (c) with 20% and 30% grog respectively are not suitable for production due to their coarse nature, difficulty in moulding, but endured the stress of expansion and contraction with no trace of warping and crack during sundry and bisque firing.

Sample 2 (a) which is 10% short clay is good for throwing, but is a bit high in plasticity which caused their little noticeable warping and shrinkage. Sample (b) and (c) of short clay of 20% and 30% respectively are suitable for production with no trace of warping, cracking and moderate shrinkage rate. These bodies have been found to be the suitable clay bodies that replace the acceptable 10% of grog in ceramic body composition.

**The Absorption Porosity Test Results**

**Sample 1: Grogged bodies result**

| | **Fired Weight (gr)** | **Saturated Weight (gr)** | **Absorption %** |
|---|---|---|---|
| a) Grog-----10%<br>Kaolin---40%<br>Ball clay-50% | 61.63 | 64.39 | 4.5 |
| b) Grog------20%<br>Kaolin----40%<br>Ball clay--40% | 61.48 | 64.39 | 4.7 |
| c) Grog-------30%<br>Kaolin----40%<br>Ball clay—30% | 57.96 | 60.87 | 5.0 |

**Sample 2: Short clay bodies result**

| | **Fired Weight (gr)** | **Saturated Weight (gr)** | **Absorption %** |
|---|---|---|---|
| a) Short clay--10%<br>Kaolin-----40%<br>Ball clay---50% | 59.64 | 62.39 | 4.6 |
| b) Short clay--20%<br>Kaolin-----40%<br>Ball clay--40% | 61.17 | 63.75 | 4.3 |
| c) Short clay--30%<br>Kaolin------40%<br>Ball clay---30% | 61.78 | 64.30 | 4.1 |

$$A = \frac{SW - FW}{FW} \times \frac{100}{1}$$

Example 1 (a) of 10% grog, 40% kaolin and 50% ball clay

Fired weight ---------61.63

Saturated weight-----64.39

Absorption rate------4.5

$$A = \frac{64.39 - 61.63}{61.63} \text{ x } \frac{100}{1}$$

Absorption = 4.5% is the porosity rate of the 10% grog in the composition

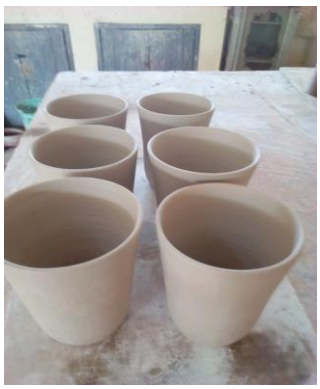
The porosity test conducted on the body compositions revealed the capacity of the fired piece in sipping water or liquid. Sample 1 (a) with10% grog in the body is 4.5% it shows that the body's capacity to sip water or liquid is within the acceptable range. Then bodies (b) and (c) with 20% and 30% grog respectively exhibited high level of porosity rates of 5% each. It is an indication that they cannot be a suitable body for production, because they would be too porous for glaze to adhere properly.

**Sample Wares Produced with the 20% and 30% of the Recommended Short clay in a Composition and Fired to Bisque**

Short clay—20%

Kaolin--------40%

Ball clay------40%



Short clay---30%

Kaolin--------40%

Ball clay-----30%

**Plate 3a and 3b**

## Conclusion

The research has investigated the qualities of short clay and its effects on the composition of clay bodies made from ball clay and kaolin. It concludes that incorporating 20% to 30% of short clay into such clay bodies can open up the material, reducing the risk of excessive shrinkage, warping and cracking during production process.

## Recommendation

This research recommends the use of short clay, especially the traditional potters own, which requires minimal additions of plastic and refractory clay for wheel throwing. Additionally, it can be employed for hand-building techniques, making it ideal for ceramic beginners. The approach ensures end-products that are free from defects.

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