A Comparative Study to Determine the Quality of Glaze Colorants Used in Ceramic Art Education: Zhong Guan Ceramic vs. Pottery Crafts Pigments

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Abstract:

The issue of developing glazes in the ceramics industry, as well as in art schools, has received considerable critical attention. The past fifteen years have seen increasingly rapid advances in the field of ceramic glazing among artists and craftspeople in Oman. The importance of creativity in making special glazes to decorate ceramics has become an important aspect within the ceramic art community. A primary concern in making glaze recipes in ceramics labs at schools and universities is the differences between commercial materials, such as artificial pigments, and their percentages in each recipe. The main aim of this study is to investigate the differences between Zhong Guan Ceramic (Z.G.C) and Pottery Crafts (PC) pigments to help students and craftspeople to detect the quality of these types of stains for their ceramic artwork.

Keywords: *Ceramics, Glazes, Pigments, Art.*

I. INTRODUCTION

Ceramics Pigments are considered to be fired mixtures of metal added to ceramic oxides that are ground into a fine powder. Despite the toxic oxides contained in pigments, ceramicists can use them without substantial risk. The main feature of pigments is stability, as they produce consistent and reproducible colors, which are very hard to make when artists use standard natural oxide colors. Additionally, when artists introduce pigments into glaze recipes, they can target a specific color, as it is often difficult to achieve ceramic colors with consistency and accuracy.

According to Frank and Janet Hamer (2016), different percentages of pigments can be used for coloring in glaze, slip, and clay body recipes. They confirmed that to achieve full color in glaze recipes, the pigment ratio must be at least 5%, but can be as high as 10% when composing opaque glazes and must be as high as 15% when coloring clay bodies.

Fortunately, pigment producers have investigated ceramists' problems with using natural oxides for ceramicists in coloring. Ceramicists have made limitless mixtures to achieve countless color tones that function consistently. By altering oxides with pigments in ceramics workshops, artists and craftspeople have the benefit of working with safer, more responsive and reliable materials. Since ceramic pigment colors have been pre-fired, the raw and fired colors match. For many decorating applications and easily achievable colors, oxides pigments are suitable and more economical because both artists and craftspeople can save time and costs on experimenting. Nevertheless, when all costs are considered and when the final quality is assessed, using pigments to color ceramics can be less expensive.

The aforementioned positive features of artificial ceramic pigments are appreciated by ceramicists, but they also face many challenges when using pigments. For example, in some cases where stains are used, the decorations are dusted and smudged when the pot is handled. Moreover, pigments used in fired glaze surfaces sometimes bubble or wrinkle. Also, a defect called "crawls" can appear when pigments, like glazes that use natural oxides, are used. So, testing pigment use in ceramic glazes has become very significant and exploring the differences between pigments has become a very important part of ceramic art in order to save time and money.

In general, Pottery Crafts (PC) glazing stain comes in a powder form and can be added to opaque and transparent glazes to add color and can be added to slips to produce engobes and colored bodies. PC stains can similarly be applied to an unfired glaze surface with concentrations of 5% for glazes and 10% for slips. According to producers' suggestions, the prepared recipes must be mixed and sieved to

avoid specking, and the maximum firing temperature is 1280°C (PotteryCrafts, 2020). In comparison, Z.G.C glazing stains can be used as coloring in both glaze recipes and clay bodies. The company website claims that all their glaze stains can be fired between 1250°C to 1300°C (Z.G.C. China, 2020). This study seeks to obtain experimental data that will help ceramic artists to explore the quality and limitations of using PC and Z.G.C glazing pigments.

II. RESEARCH METHDOLOGY: LAB EXPERMINTS

Several techniques have been developed to test ceramic glazing color recipes, such as the CAD system and manual testing methods. One of the most well-known tools for assessing the quality of ceramic glazes are tests developed in ceramics labs using raw materials. In fact, many researchers have utilized glaze recipe testing methods to measure color stability, consistency, and repeatable tones. To guarantee similar circumstances when testing all collected samples, the researcher composed a single base glaze recipe (100g of base recipe + 3g of test coloring pigment), used an electric ceramic kiln, and applied all glazing tests to a similar white, earthenware clay. To examine the pigments' ability to withstand high temperatures, all recipes were fired two times. First, the samples were fired at 1000°C, then photos were taken of the glazes for evaluation, and then the samples were returned to the kiln to be fired at a higher temperature of 1280°C. Table 1 shows the base recipe used in this project.

TABLE I
The base glaze recipe used in this project.

Chemical Item	Percentage
P3110 Frit	80%
Ball Clay	10%
Flint	5%
Tin Oxide	2%
Bentonite	3%
Test Pigment	**+ 3%**

In the Ceramic Lab at Sultan Qaboos University, 8 base glaze samples (100g each) were made using dry powder, and 3g of the test pigment was added to each sample. Table 2 shows the test pigments, where pigments 1 and 2 were compared, 3 and 4, 5 and 6, and 7 and 8.

TABLE II

Test pigments used in the project from both Zhong Guan Ceramic (Z.G.C) and Pottery Crafts (PC).

No.	Test Pigment		Company Code	Company Brand
1	Pr. Yellow	VS.	ZY- 3068	Z.G.C
2	Canary/Golden Yellow Stain		P4140.5	PC
3	Brown	VS.	ZY- 3808	Z.G.C
4	Brown Stain		P4142.5	PC
5	Co-Blue	VS.	ZY- 6388	Z.G.C
6	Sky Blue		P4129.5	PC
7	Lilac	VS.	ZY- 6063	Z.G.C
8	Lilac Deep		P4182.5	PC

III. ANALYSIS OF RESULTS

The aim of this study was to assess the quality of different pigments used in ceramic glazes by comparing PC and the Z.G.C stains. An initial objective of the project was to identify if both brands meet their own descriptive features. It was found that the tested glaze recipes using both PC with Z.G.C pigments had excellent results, without any glaze defects such as shivering, crawling, or blistering. However, with such a small sample size, caution must be applied, as the findings might not be sufficient enough to assess both pigment brands thoroughly.

Figure 1 includes all tested recipes fired at a temperature of 1000°C and Figure 2 includes all tested recipes fired at a temperature of 1280°C. The results indicate that some colors used in the tested glaze recipes disappeared when temperatures reached 1280°C, including test coded *Pr. Yellow* (No. 1) from Z.G.C and *Canary/Golden Yellow* (No. 2) from PC, which

can be seen when No. 1 and 2 in Figure 2 (1280°C), where the yellow color has nearly vanished, are compared with No. 1 and 2 in Figure 1 (1000°C). A similar defect can be seen in the case of *Sky Blue* (No. 6) from PC, where the blue color also vanished at a temperature of 1280°C.

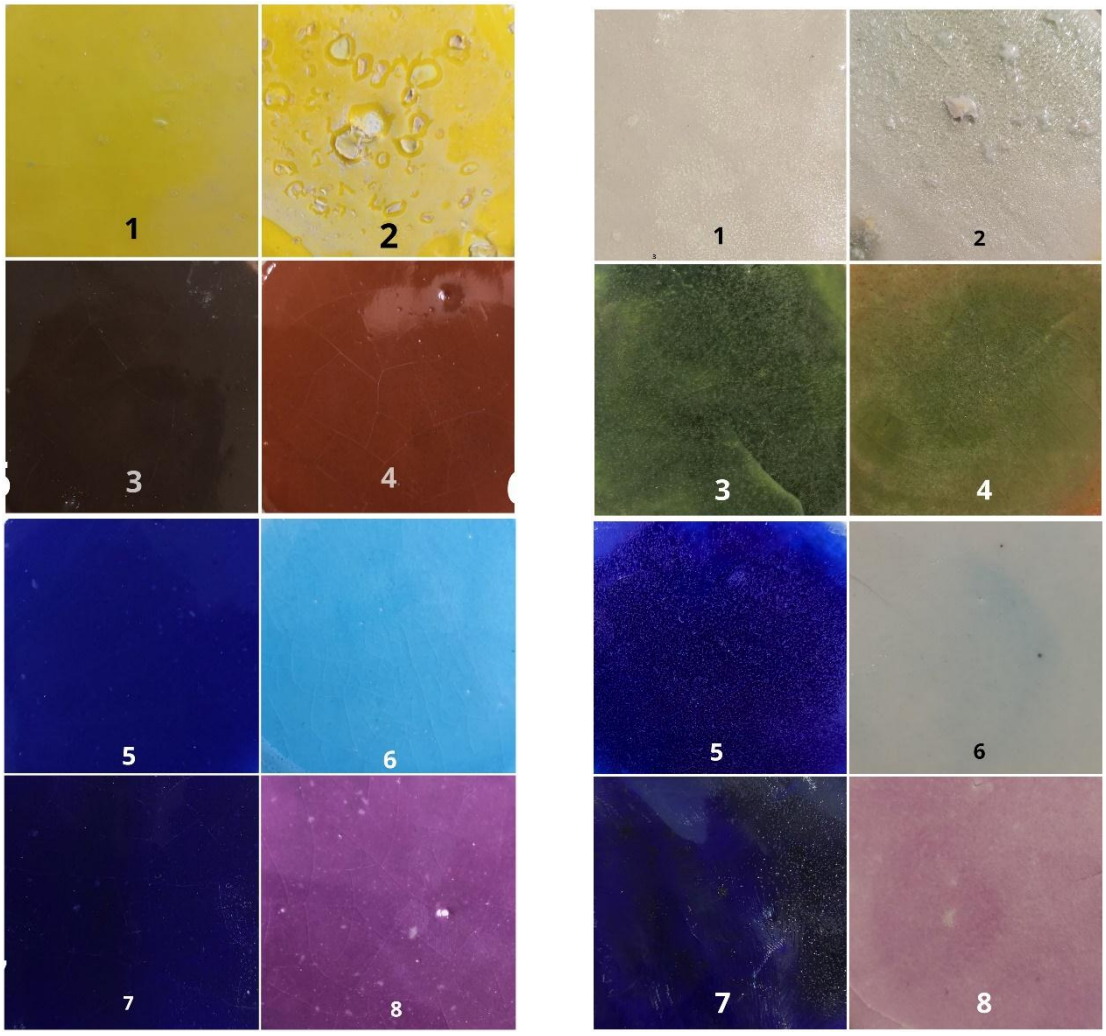

Fig 1. All tested colors when fired at a temperature of 1000°C (left). Figure 2. All colors when fired at a temperature of 1280°C (right).

The most interesting finding regarding the changing colors of the stains at high temperatures was No. 3 (*Brown)* from Z.G.C and No. 4 (*Brown Stain)* from P.C. In both of these cases, the brown colors (Figure 1, No. 3 and 4) turned an attractive green color (Figure 2, No. 3 and 4) when fired.

According to John Britt (2019), each color is not guaranteed in all bases, and being aware of these reference notes will help ceramicists achieve greater success. Furthermore, ceramic stains are not meant for all firing conditions and are generally designed for neutral or oxidation firing atmospheres (although some may work in reduction atmospheres). Britt also confirmed that because ceramic stains contain metal oxide coloring along with other materials, such as opacifiers, silica, and alumina, adding them to certain glaze bases can cause a glossy glaze surface to turn matte. Moreover, ceramic stains are generally added at 5-8% in a glaze and 15-25% in slips and clay bodies. At 8%, most of the glazes are opaque and flat, but if you add smaller amounts of stain (1-3%), it is possible to get transparent colors, including transparent celadon-colored glazes, when fired in an electric kiln or similar neutral atmosphere (Britt, 2013).

All abovementioned notes must be taken seriously where in this project, for example, firing processes achieved in oxidation firing atmospheres for both 1000°C and 1280°C.

To understand glaze defects and color changes, as they occurred in this study, Richard Eppler and Mimi Obstler (2005) explain that "when using pigments in glazes, usually in concentrations of 1-10%, a little more care must be taken because some pigment systems react with materials in a glaze. Some pigments are affected by the presence, or lack of, boron, zinc, calcium, and magnesia. Manufacturers provide information on specific reactions. While most pigments can be used in both oxidation and reduction atmospheres, some are limited to certain maximum temperatures".

IV. CONCLUSION AND RECOMMENDATIONS

The most obvious finding to emerge from this study is that it is extremely hard to evaluate the quality of any glaze stain without lab testing in low- and high-temperature atmospheres. Changing and disappearing colors of pigment glazes emerged as the reliable and major outcomes of the experimental research in this study. In fact, this research was not built to gauge or compare between the two brands, but to help ceramicists select the best and suitable raw materials for their artwork. The findings of this study have several important implications for future practice in the general field of ceramics, and specifically in ceramic art. Taken together, these findings do not support strong recommendations to ceramic art as a field of study without conducting extra tests and experiments by other artists or researchers. Therefore, greater efforts are needed to ensure the quality of ceramic stains from all commercial manufacturers at temperatures between 1000°C (low temperature) to 1300°C (high temperature).

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