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Developing Ceramic Textured Matt Glazes Using Omani Plant Ash: The Contributions of Art Education Teachers

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ABSTRACT

It is widely known that ready-made glazes are hugely expensive, in spite of their widespread availability in Oman. Most students of ceramic art, at various levels of education, depend on foreign materials rather than local materials, which has resulted in high production costs. As an environmentally diverse country, Oman has great potential to take advantage of local crop waste plant waste by using it to make attractive ceramic glazes. Ann experimental study conducted at the ceramic studio in Sultan Qaboos University (SQU) led to the development of some excellent recipes for ceramic glazes using 20% to 30% ash. This study has helped to convert Omani plant waste into textured matt ceramic glazes, which are otherwise expensive to procure for educational and commercial purposes.

Keywords**:** Art Education, Ash glazes, Ceramics, Oman.

1.0 Introduction

One of the most significant current discussions in ceramics and pottery researches is using environment waste materials in developing their creative pottery. Most researches in developing abilities of art education teachers to take advantage of waste materials in teaching process have only been carried out in a small number of studies. So far, however, there has been little discussion about using trees waste materials including their ashes in specific in teaching ceramics courses in Oman. Plant ash is very useful for making unique glazed surfaces on pottery; therefore, it has become important in art-education schools and ceramics studios in recent times. The organic elements found in plant ash supply potters with calcium, potassium, magnesium and sodium, which are essential for making unique glazes. In fact, these elements supply potters with the proportion of fluxes and hardeners and these materials are necessary for making glaze recipes. Historically, Phil Rogers (2003) states that ash glazing began in China in about 1500 BC, during the period of the Shang Dynasty. In approximately 1000 BC, the Chinese became conscious that wood ash was covering the piece. Metcalfe (2008) cites Rogers, who mentions that the Chinese first developed ash glazes for stoneware about 3500 years ago, when the technology of their

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kilns improved sufficiently to enable the kilns to reach high enough temperatures to fuse these types of glazes. Metcalfe also states that it was more than 2000 years before this knowledge reached Japan and Korea, where ash glazes were subsequently produced (2008). In 1991, Rogers employs standard blending methods to test ash glazes containing wood and coal ashes. De Montmollin (1997) contributed in studying ash glazes preparation, composition and testing of a wide variety of wastes plant ashes from straw to lavender to wood. After one year, Tichane (1998) published a book included a wide variety of ashes and acknowledges the use of washed and unwashed ash in glazes and this contribution considered as a jump in the studying ash glazes techniques. It is worth mentioning that Rogers's second edition of the same book which published in 2003 added wider range of examples of contemporary ash glazed works and his contributions were very valuable for ash glazing researches. Considering Oman's environmental diversity, its plants differ from one area to the next. Therefore, this experimental research examined the effects of more than 30 types of Omani plant ash when a percentage is added to textured matt glazes. After very intensive experimental research including lab testing, this research presented a proved ash glazes recipes belonged to Oman environment. This exclusive contribution helped art education teachers and ceramics artists to develop their artworks by using their environment waste materials.

This paper has been divided into six parts. The first part deals with research methodology (experimental research). And the second part will cover preparing and selecting samples of plant ash. The third part will present the XRD analysis including detecting minerals and chemical formulas. The fourth part will present the researcher's calculation of glaze recipes for testing. The Fifth part will introduce the list of tests which conducted in the glazing lab. And finally, the last part will assessing the tests to explore their qualities for applications.

2.0 Research methodology: Experimental research

A considerable part of this research is devoted to answering the question: To what extent can Omani plant waste contribute to the production of textured matt ceramic glazes? By using laboratory tests, this study has revealed that ash from some Omani plants can make a significant contribution to local textured matt glazes that are used to create a surface design, such as on tiles, handicrafts and a range of artistic products. In the SQU ceramics lab, substituting different materials when creating glaze recipes gives the ceramicist many subtle differences in textures and colours. In fact, the possibilities are endless with any glaze; the ceramicist just needs to focus on developing the characteristics that he or she wants. Aside from being cost-efficient, these glazes are also more aesthetically pleasing than ordinary commercial glazes. The ceramic tiles used for the experiments in this research were made of white clay (*PotteryCrafts* white earthenware clays) and bisquette-fired at a low temperature to guarantee the absorption of the glaze sample.

2.1 Preparing selected samples of plant ash

Omani villages produce many kinds of agricultural waste. This waste is produced mainly by farmers and by industries related to agricultural activities. It must be suitably treated in order to be used correctly. Agricultural waste collected from several different areas in Oman included 27 different types of plants (Table 1), which were selected to be examined in this research.

Table 1: The list of 27 different types of plants from several different areas in Oman

No	Plant Name/ Common Name	Environment	Place of Collection
1	Conocarpus	Costal	Saham
2	Lemon	Agricultural	Bahla
3	Banana	Agricultural	Alrustaq
4	Tamarindus indica	Agricultural	Alsuwiqe
5	Rhamnus frangula	Desert	Ibri
6	Pteropyrum	Agricultural	Unqel
7	Tropical almond	Costal	Lewa

8	Vachellia tortilis	Desert	Bedya
9	Mango	Costal	Alkhaboura
10	Citrus reticulata	Agricultural	Sur
11	pomegranate	Mountain	Nizwa
12	Fodder	Agricultural	Almusnia
13	Calotropis Procera	Agricultural	Samail
14	Lawn (Turf Grass)	Agricultural	Alseeb
15	Berry	Mountain	Nizwa
16	Prosopis	Agricultural	Manah
17	Lawsonia inermis	Agricultural	Alrustaq
18	Date Palm	Desert	Bedya
19	Coconut Palm Tree	Costal	Masera
20	Salvadora persica	Costal	Almusnia
21	Straw	Agricultural	Bedya
22	Hyphaene	Mountain	W.B. Khalid
23	Alfalfa	Agricultural	Almusnia
24	Blackthorn	Mountain	Nizwa
25	Cherimoya	Agricultural	Izki
26	Cattails	Agricultural	Dhank
27	Olea europaea	Mountain	Nizwa

The collected samples of each selected plant were burned in metal containers to minimize the risk of any impurities from the ground contaminating the sample. Despite precautions taken during the burning and collection stages, the remaining ashes unavoidably include some undesirable impurities. These need to be removed in order to make a very fine powder that is appropriate for mixing with glaze samples. Each type of ash was washed in a large plastic container that was half filled with ash, and then filled to the top with clean water. The ash was then allowed to settle. This process was repeated several times. The ash was then extracted and, once dry, it was sieved using a ceramic 40-mesh sieve.

In order to guarantee that each sample would be large enough to create the many test tiles throughout the research, the researcher produced at least 500g of pure powder for each sample. The collected ash samples were then stored in plastic containers and labelled. All the information related to each sample was documented in order to be ready for experimentation in the SQU ceramics laboratory.

2.2 XRD analysis: Detecting minerals and chemical formulas

In order to explore how the mineral content of the selected ash samples plays a role in creating special textures in ceramic glazes and slips, the researcher sent samples to be tested using an X-ray powder diffraction (XRD) analysis system. The XRD is "a rapid analytical technique primarily used for phase identification of a crystalline material and can provide information on unit cell dimensions" (SERC, 2016). The reports of the collected data for the selected samples contained hundreds of pages, including extensive data and figures; however, the most important data were provided in the tables of minerals and chemical formulas. To illustrate, the test report for the ash sample of the Calotropis Procera tree includes full data about the minerals and chemical formulas it contains, as shown in table 2.

Table 2: Chemical formulas in the tested sample of Calotropis Procera

Chemical Formula	Mineral Name	Description
Ca (CO3)	Calcite	Calcium Carbonate
Mg (OH)2	Brucite	Magnesium Hydroxide
O2 Si1	Quartz	Different Types

2.3 Calculation of glaze recipes for testing

One of the most important points to be considered at this stage was that the quantity of ash in each recipe should be as high as possible in order to guarantee its influence on the final result. Therefore, it was essential to keep the other number of ingredients in the recipes to a minimum. The researcher and his assistants at SQU used various methods to develop different recipes; this was compulsory, because this project aimed to test the ashes of 27 types of plants. Therefore, testing methods, including the line blend (blending two recipes), triaxial blend (blending three recipes), and tetrahedral blend (blending four materials), were used by my assistants within the research period (four months). These methods have been used in many ash-glazing research projects, such as those of Metcalfe (2008), Shamsu Mohamad (2005), (Birkhimer, 2006), and Rabena (2008). Because the line blend method was preferred, we mainly used this method in this project.

2.4 The list of tests

More than 1,000 test tiles were produced for this research. Each type of ash was examined in more than 40 tests (or recipes). Consequently, it was essential to categorize the outcomes of these tests and classify them according to artistic and technical standards for ceramics. Nevertheless, it is worth remembering that the main objective of this research is to develop textured matt glazes to be used mainly for sculptures in art schools and by small enterprises. In addition, it was important to compose a base glaze recipe, as this would allow us to observe the differences between the types of ash to be tested. Therefore, we developed the base matt glaze recipe shown in table 3.

Table 3: The recipe of base matt glaze used in experiments

No	Plant Name/ Common Name	Test 1	Test 2	Test 3	Test 4	Test 5	Test 6	Test 7
1	Conocarpus	Base+ Ash Only (40%)	Base+ Ash (30%)+ yellow Iron Oxide (3%)	Base+ Ash (30%)+ Manganese Doxide (3%)	Base+ Ash (30%)+ Red Iron Oxide (4%)	Base+ Ash (30%)+ Lead Oxide (5%)	Base+ Ash (30%)+ Red Iron Oxide (5%)	Base+ Ash (30%)+ Red Iron spongles (4%)
2	Tamarindus indica	Base+ Ash Only (20%)	Base+ Ash (50%)+ Red Iron spongles (4%)	Base+ Ash (40%)+ yellow Iron Oxide (4%)	Base+ Ash (30%)+ Manganese Doxide (5%)	Base+ Ash (40%)+ Lead Oxide (3%)	Base+ Ash (30%)+Red Iron Oxide (5%)	Base+ Ash (50%)+ Purple Iron Oxide (3%)
3	Pteropyrum	Base+ Ash Only (30%)	Base+ Ash (50%)+ Red Iron Oxide (5%)	Base+ Ash (40%)+ Red Iron spongles (5%)	Base+ Ash (50%)+ yellow Iron Oxide (5%)	Base+ Ash (40%)+ Purple Iron Oxide (5%)	Base+ Ash (30%)+ Lead Oxide (5%)	Base+ Ash (50%)+ Magnesium Dioxide (5%)
4	Vachellia tortilis	Base+ Ash Only (50%)	Base+ Ash (50%)+ Red Iron Oxide (5%)	Base+ Ash (50%)+ Lead Oxide (5%)	Base+ Ash (50%)+ yellow Iron Oxide (5%)	Base+ Ash (50%)+ Purple Iron Oxide (5%)	Base+ Ash (50%)+Red Iron spongles (5%)	Base+ Ash (50%)+ Manganese Doxide (5%)
5	Mango	Base+ Ash Only (20%)	Base+ Ash (30%)+ Red Iron spongles (4%)	Base+ Ash (30%)+ Manganese Oxide (2%)	Base+ Ash (40%)+ yellow Iron Oxide (5%)	Base+ Ash (20%)+ Purple Iron Oxide (4%)	Base+ Ash (10%)+Red Iron Oxide (3%)	Base+ Ash (50%)+ Lead Oxide (3%)
6	Citrus reticulata	Base+ Ash Only (40%)	Base+ Ash (40%)+ Red Iron Oxide (3%)	Base+ Ash (40%)+ Purple Iron Oxide (5%)	Base+ Ash (30%)+ yellow Iron Oxide (4%)	Base+ Ash (30%)+ Manganese Oxide (3%)	Base+ Ash (50%)+Red Iron spongles (4%)	Base+ Ash (30%)+Red Iron Synthetic (3%)
7	Lawn (Turf Grass)	Base+ Ash Only (30%)	Base+ Ash (50%)+Red	Base+ Ash (40%)+Red	Base+ Ash (40%)+	Base+ Ash (50%)+	Base+ Ash (50%)+yellow	Base+ Ash (50%)+Red

			Iron Oxide (2%)	Iron spongles (4%)	Manganese Doxide (5%)	Purple Iron Oxide (3%)	Iron Oxide (2%)	Synthetic Iron (5%)
8	Prosopis	Base+ Ash Only (50%)	Base+ Ash (50%)+Red Iron Oxide (3%)	Base + Ash (50%)+Red Iron spongles (4%)	Base+ Ash (40%)+yellow Iron Oxide (4%)	Base+ Ash (40%)+Purple Iron Oxide (5%)	Base+ Ash (50%)+Purple Lead Oxide (4%)	Base+ Ash (40%)+ Magnesium Dioxide (4%)
9	Alfalfa	Base+ Ash (50%)+Red Iron Oxide (5%)	Base+ Ash (50%)+ Purple Iron Oxide (5%)	Base+ Ash (50%)+ Manganese Oxide (5%)	Base+ Ash (50%)+ Lead Oxide (5%)	Base+ Ash (50%)+ Iron Oxide spongles (5%)	Base+ Ash (50%)+ yellow Iron Oxide (5%)	Base+ Ash (50%)+Red Synthetic Iron (5%)
10	Blackthorn	Base+ Ash Only (50%)	Base+ Ash (50%)+yellow Iron Oxide (4%)	Base+ Ash (40%)+ Red Synthetic Iron (4%)	Base+ Ash (40%)+ Purple Iron Oxide (3%)	Base+ Ash (40%)+ Lead Oxide (3%)	Base+ Ash (40%)+ Magnesium Dioxide (4%)	Base+ Ash (40%)+ Black Iron Oxide (4%)
11	Olea europaea	Base+ Ash Only (30%)	Base+ Ash (40%)+Red Iron Oxide (4%)	Base+ Ash (50%)+ Purple Iron Oxide (5%)	Base+ Ash (30%)+ Manganese Oxide (4%)	Base+ Ash (20%)+ yellow Iron Oxide (3%)	Base+ Ash (50%)+ Iron Oxide spongles (5%)	Base+ Ash (30%)+ Lead Oxide (4%)
12	Cordia Myxa	Base+Ash (10%)+Red Iron Oxide (5%)	Base+ Ash (40%)+ Chromium Oxide (5%)	Base+ Ash (40%)+ Manganese Oxide (5%)	Base+ Ash (50%)+ Black Iron Oxide (5%)	Base+ Ash (50%)+ Nickel Oxide (5%)	Base+ Ash (30%)+ Yellow Iron Oxide (5%)	Base+ Ash (50%)+ Yellow Iron Oxide (5%)

Table 4: 12 examples of plants used in the research experiments

Materials	Percentage
Ferro Frit 3195	45%
Kaolin	12%
Whiting	43%
Total	100%

2.5 Assessing the test results

A variety of methods for evaluating the test results were considered by the researcher; these included the descriptive approach and the art practice-based approach (Metcalfe, 2008). To achieve the main objective of this research, the art practice-based approach was considered to be more suitable for assessing the results.

Metcalfe (2008) describes this method as "a more naturalistic approach to the assessment of the results, for the practising ceramic artist, is to focus on those test tiles within each set, which provide glazes appropriate for the production of artworks" (p.86).

Consequently, what ceramicists have sometimes called "common ceramic glaze defects" when glazes are used on tableware objects can be considered as desirable textures when they are used on sculptures. In fact, in this research we were looking for textured glazes, so crazing, shivering, crawling, pitting, pin-holing and blisters are considered to be desired effects in this project.

Besides using the art practice-based evaluation approach, in consideration of the desired effects mentioned above, a specific rubric was designed to assess the final results. This is shown in table 5, and some samples of the research's tests showed in the figure 1.

Table 5: Rubric to assess the final results

Plant Name	Shivering	Crawling	pitting and pin-holing	Blisters
Conocarpus	Not Available	Medium	High	Not Available
Cattails	Not Available	High	Medium	Not Available
Palm Tree	Not Available	High	Low	Not Available
Salvadora Persica	Not Available	Medium	Low	Not Available
Tropical almond	Not Available	Low	Low	Not Available
Tamarindus indica	Not Available	Medium	Medium	Not Available
Pteropyrum	Not Available	High	High	Not Available
Vachellia tortilis	Not Available	Low	Medium	Not Available
Mango	Not Available	High	Medium	Not Available
Citrus reticulate	Not Available	High	Medium	Not Available
Lawn (Turf Grass)	Not Available	Medium	High	Not Available
Prosopis	Not Available	Low	Low	Not Available
Alfalfa	Not Available	High	Medium	Not Available
Blackthorn	Not Available	Medium	High	Not Available
Olea europaea	Not Available	High	Medium	Not Available
Cordia Myxa	Not Available	Low	Low	Not Available
Lawsonia inermis	Not Available	High	High	Available

3.0 Conclusion

This paper has given an account of, and the reasons for, the widespread use of ash in developing glazes for ceramics. Specifically, this study has helped to convert Omani plant waste into textured matt ceramic glazes, which are expensive to procure for educational and commercial purposes. One of the most significant findings to emerge from this study is that when ceramicists used a proportion of 20% to 30% ash, this led to the development of excellent recipes for matt glazes for ceramics. The evidence from this study suggests that craftspeople and ceramic artists can develop their final outcomes by creating very special textured matt glazes for their artworks in order to replace commercial glazes.

This study contained a thoughtful finding with sound recommendations for the development of ceramic teaching as part of art education developments in Oman. So, here follows the set of recommendation based on what is believed to be the most important issues that need to be addressed to use ash glazing in art education. First, it is essential to enforce the new art education's teachers to explore plants

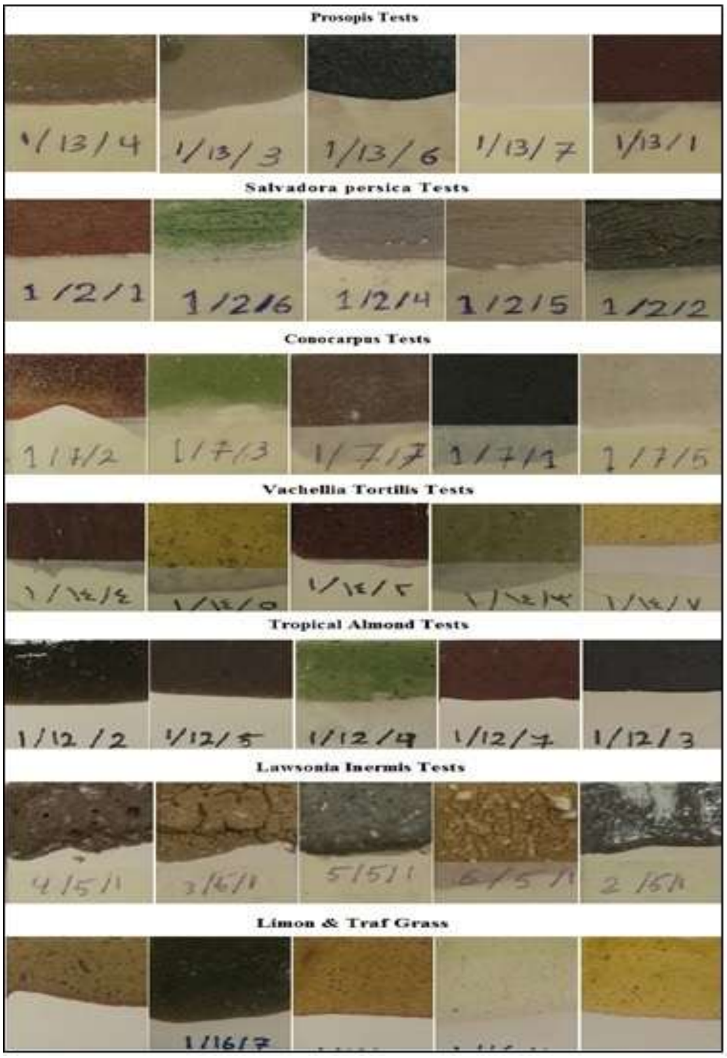

Figure 1: Images of some tests

wastes from their regional environment to use them in developing their students' artworks to avoid using expensive imported glazes. Second, teachers from different environments and territories must exchange their successful recipes to be used later by different schools.

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