

RECYCLING OF GLASS INTO PIGMENTED MATERIAL FOR ARTS APPLICATION

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Abstract

Sample of waste post-consumer glass was collected from dump sites and pretreated, it was pulverized into granules using hammer mill, beneficiated and heat treated at 100°C for 1 hour. The granules were characterized using sieve analysis. Batch design for aggregate colouration was composed, they were processed into primary colour and shades of black using the mass colouration techniques and dried in an oven at 30°C for 2 hours. Result of the study were discussed as follows; beneficiation established that flint is the most common waste glass readily available as it accounts for 50% of glass waste, sieve analysis show that particle characterization is possible medium size (55%) aggregate of 0.6-1.18mm is readily available and treatment with colorants established that coloration of waste glass is possible and that brilliant colouration is possible with flint waste glasses. In conclusion, just like other forms of materials used for art production, processed post-consumer glass can double as substrate and pigments for cold glass design such as mosaic or other forms of glass art rendition that does not require high temperatures.

Keywords: Art, Waste Glass, Pigments, Art material

1.0 Introduction

Arts in any form played a significant role in the cultural history and development of man, it has helped man in records keeping, manage the preservation and transformation of information, interrogate issues with a view to drawing attention of its intended audience, to mention but a few (Hodgson & Verpooten, 2015). Art in this process is largely possible through critical and creative reasoning on how to approach issues, a typical example is seen in the historical account of the cave man where he engaged in art activities by inscribing his games and events on caves and rocks surfaces through the use of material such as pigment produced from coloured earth (Ochre) and animal fat. These inscriptions serve as means of dissemination, expression and preservation of information for younger generation especially those yet unborn (Gray, 2010), (Bahn, 2010), (Tague, 2017) & (McDermott, 2021). These processes serve as bedrock for contemporary Art expression as such, artist today regardless of their specialization creates art

forms using specialized skills, suitable art techniques and materials be it natural or synthetic, virgin or found object (recyclable materials). Halem & Othman (2022) observed that for every piece of art work produced regardless of its dimensions, material usage plays a vital role however the researchers in their study decry about the steady use of virgin and processed material for art expression leaving behind waste material such as waste ceramics pieces, waste glass, metal scraps to mention which has a high tendency of being recycled or upcycled into art piece and given rise to a clean and sustainable environment.

Glass is one of the very few materials that has found application in virtually every sphere of human endeavours owing to its user friendliness, and non-degradability, it exists in different forms depending on its composition and the area of application. In our world today, Soda-lime silicate glass largely accounts for about 90% of the glasses readily available for usage (Kilinc & Hand, 2015),

however over 70% of this glass exist as post-consumer glasses which are found on landfills and are not able to returned back to the industry for recycling (Olofinnade *et.al.*, 2017). Though several researchers have attempts to remove waste glass from the environment by developing them into composites materials for applications in various spheres such as Arts (Mosaic, Collage, Fusing, Slumping, Sagging and Casting), Engineering, Medical, Science, Technology to mention but a few however, these effort did not still completely address this issues as there is a steady rise of waste glass generation which is directly proportional to population growth and technological advancement (Omololu & Lawal, 2013), (Andeobu *et.al.*, (2021). and (Jazat *et. al.*, 2023). Also, EPA in her 2013 report observed that despite the effort on waste recycling particularly waste glass, there are steady generation of waste from glass recycling and about 74% of these waste glass is collected and disposed on landfills (Waite, 2013). Jomboh (2017) observed that in areas where post-consumer glass has been employed as composite for technological and artistic expression, sorting into different colouration is one of the fundamental challenges that accounts for the indiscriminate and incomplete recycling of waste glass. In other to attaining a green and sustainable environment, this study sets to address the issue of glass waste through the recycling it into pigment material for artist usage and application.

2.0 Methodology

2.1 Sample collection and Processing

Sample of post-consumer glass (PCG) was collected from dump sites while colorant was purchased from chemical store. The post-consumer glass was beneficiated through sorting, washing, pulverization and characterization using the sedimentation process as suggested by Jombo (2017), Olashehide (2017), and Yahuza (2018). Collected sample of PCG was sorted based on their colours as stipulated by Jombo (2017), using a dual-purpose crushing machine, the samples were pulverized into discrete sizes to enable the easy of removing unwanted materials (metal, plastic, cork, polyethylene, and paper) and the remnants of its

contents through soaking in soapy water for 72 hours in order to enable easy of treatment, the sedimentation process of beneficiation of samples was employed as stipulated by and Yahuza (2018). The samples of PCG were oven treated at a holding temperature of 100°C for 3 hours so as to remove moisture content in the beneficiated PCG and also burn off any remnants of impurities in the batch.

2.2 Particle size Characterization (Sieve Analysis)

Using British Standard sieve, sieve analysis was conducted on the beneficiated PCG samples into workable sizes of fine (0.08 - 0.4mm), medium (0.6 – 1.18mm), and coarse (1.4 – 2.36mm) particle size respectively this classification is in line with the study of Adejo, (2016).

2.3 Material colouration

Adopting the mass colouration techniques as stipulated by Asim and Roy (2017), the PCG was processed into primary colours and shade of shade of black such that it will suitable for art material. 4g of the styrene-acrylic binder was weighed and poured into an empty plastic container; 0.25g of pigments i.e. either of black (carbon black), blue (copper-phthalocyanine blue), red (metalize azo red or azo red), and yellow (monoarylide yellow or azo yellow) was measured and poured into the same container. This was mixed thoroughly for 20 minutes to form a gelatinous solution. 91.75g of PCG was weighed and added to the mixture; this was mixed thoroughly for an order 20 minutes. The processed PCG was allowed to drying at 30°C for 3 hours and finally cooled at normal room temperature.

Table 2.3. Batch design for the treatment of PCG into coloured extender Source: Asim and Roy, (2017)

Reagent	Weight Composition (g)	Percentage composition %
Polyvinyl acetate (Binder)	4.0	4
Pigment	0.25	0.25
PCG Granules	95.75	95.75

3.0 Result and Discussion

3.1 Sample collection and Processing

Beneficiation of PCG show that through physical observations most of the found glasses in the various dump site of study are in their mix form and it has high possibilities of sorting into flint, amber and green; in every 20kg of Mix PCG collected, the result of sorting shows that Green PCG account for 50% while Flint PCG account for 35% and Amber glass account for 15%. And that 9n other to upscale or upgrade the quality of the processed PCG, removal of labels and reminates in the PCG is possible through washing and drying.

3.2 Particle size Characterization (Sieve Analysis)

The particle size characterization analysis of the PCG shows the material can be pulverized into discrete sizes of usage depending on the choices for application, (see fig. 3.2 and fig.3.2.1a-c). As the sieve size increase so the weight of the percentage retained of the aggregate also increase but based on the classification, the medium aggregate has about 55%, the fine 30%, and the coarse 15% this is in accordance with the study of Olashehide (2017) on the role of particle size for material application. By implication this analysis inferred that PCG can be characterization into working particle size that is recycleable into pigmented material for arts application..

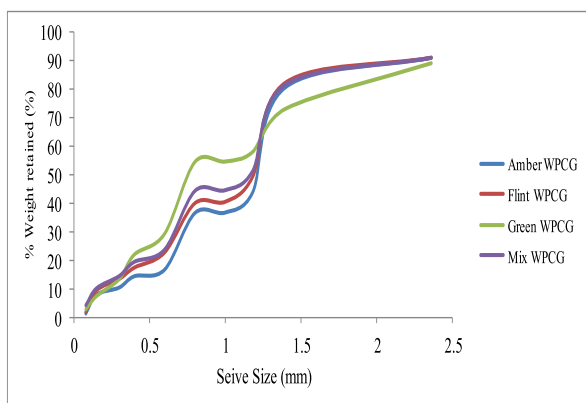


Fig. 3.2.: Sieve analysis of postconsumer glass

3.2.1. Sieve analysis of classified beneficiated postconsumer glass

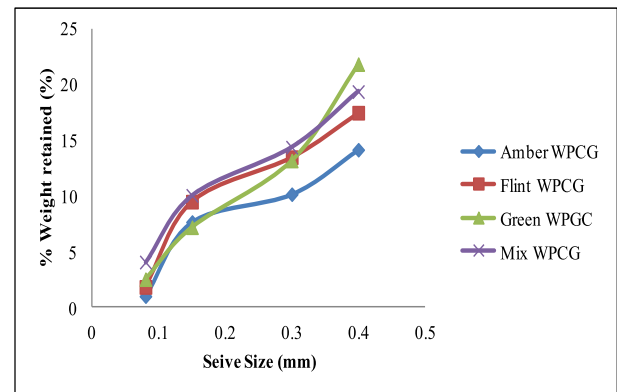


Fig. 3.2.1a: Sieve Analysis of Fine Post Consumer Glass

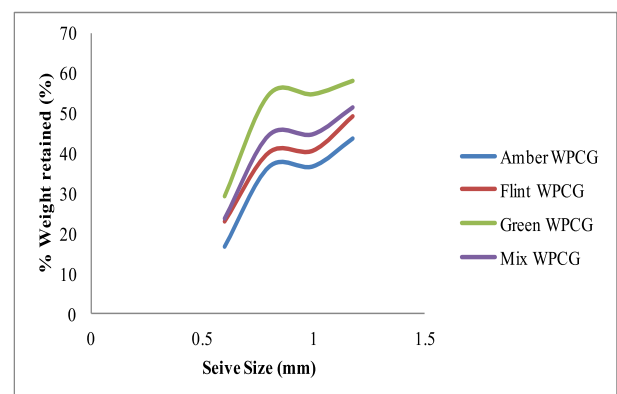


Fig. 3.2.2b: Sieve Analysis of Medium Post Consumer Glass

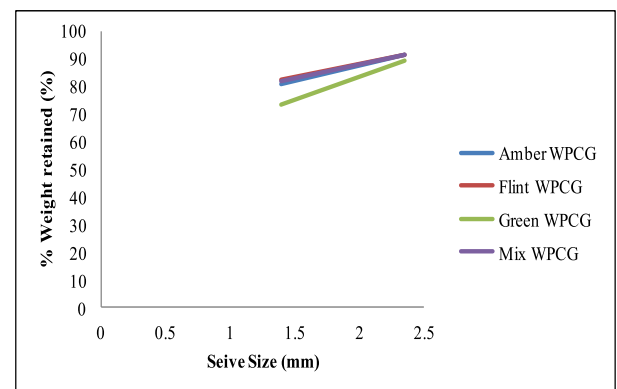


Fig. 3.1.2c: Sieve Analysis of Coarse Post Consumer Glass

3.3 Material colouration

Study explore the colouration of PCG with pigment that are composed of primary colours and carbon black on the PCG of Flint, Amber, Green, and Mix coloured glasses, this is done in a bid to create coloured granules of pulverized PCG into material for art application. Result from the study shows that using the mass colouration technique, yields shades of coloured PCG was achieved with an excellent

light and wet fastness (See plate I – XX). However some variation was noticed in the different source of the PCG as the colouration seems to have some level of interference from their parent sources. Flint PCG (plate I-V) shows almost 100% value of colouration as the substrate (Flint PCG) was able to absorb colourant in their true colour with little or no deviation from the pigment colourant value, other forms of PCG (plate VI-XX) such as; Mix (Green, Flint, and Amber) PCG, Green PCG, and Amber PCG exhibits about 70-85% colouration value with some interference from their parent colour shades tend to affect the applied colourant thereby reducing the value of the colouration into one with darker shades. Also the study shows that during processing with colourant, fine dust of pulverized PCG is reduced into and intermediate sizes between the medium and fine granules.

3.3 Material Colouration

3.3.1 Colouration of Flint postconsumer glass

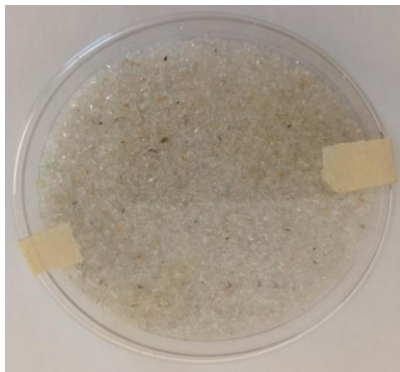


Plate I: Post Consumer Flint Glass before treatment

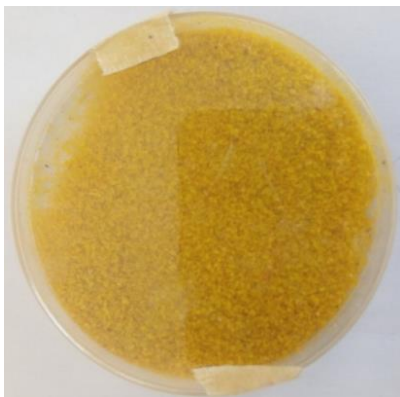


Plate II: Treated Flint PCG with Monoarylide Yellow Pigment (Azo Yellow)

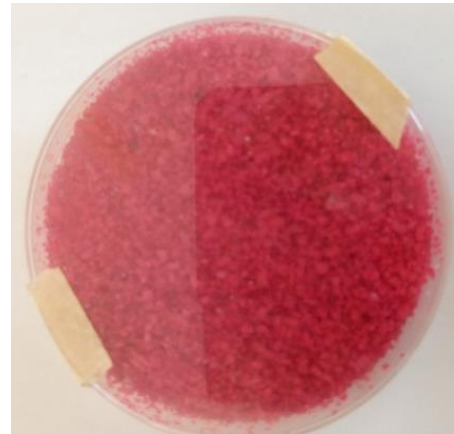


Plate III: Treated Flint PCG with Metallic Azo Red Pigment (Azo Red)

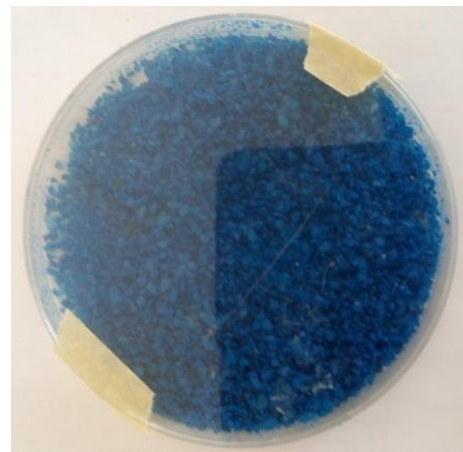


Plate IV: Treated Flint PCG with Copper Phthalocyanine Blue Pigment

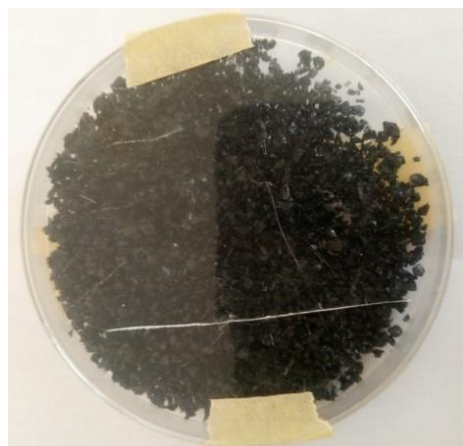


Plate V: Treated Flint PCG with Carbon Black Pigment

3.3.2 Colouration of Mixed postconsumer glass

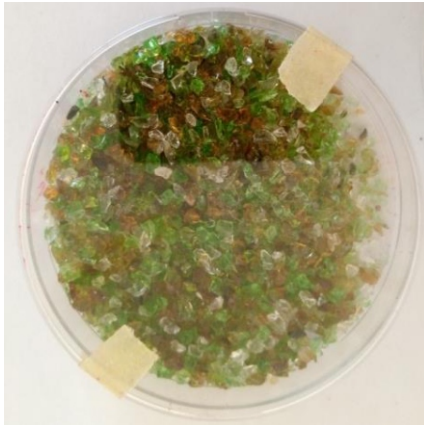


Plate VI: Post Consumer Mixed Coloured Glass before treatment

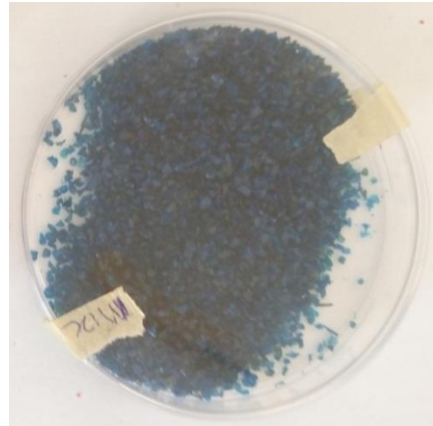


Plate IX: Treated mix coloured PCG with Copper Phthalocyanine Blue Pigment

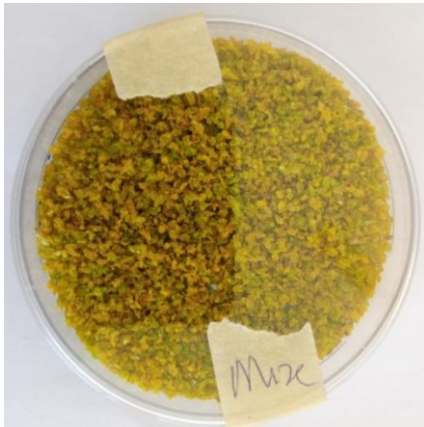


Plate VII: Treated mix coloured PCG with Monoarylide Yellow Pigment (Azo Yellow)

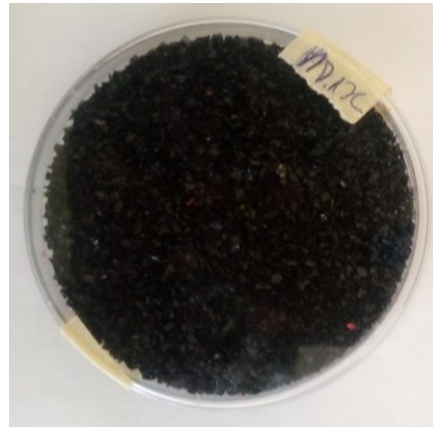


Plate X: Treated mix coloured PCG with Carbon Black Pigment

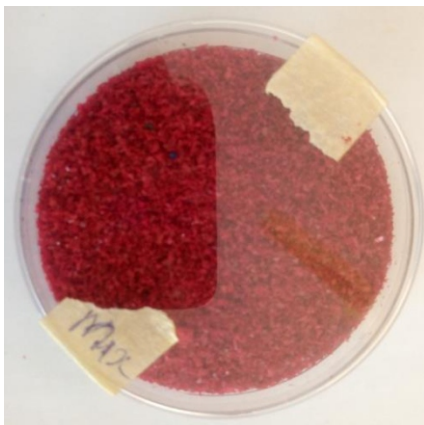


Plate VIII: Treated mix coloured PCG with Metallic Azo Red Pigment (Azo Red)

3.3.3 Colouration of Green postconsumer glass

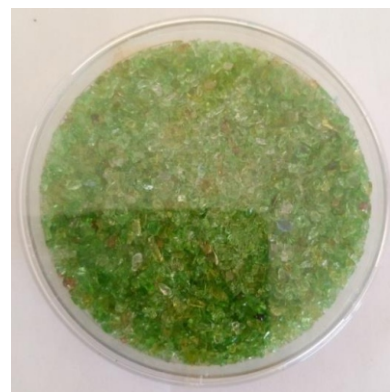


Plate XI: Post Consumer Green Glass before treatment

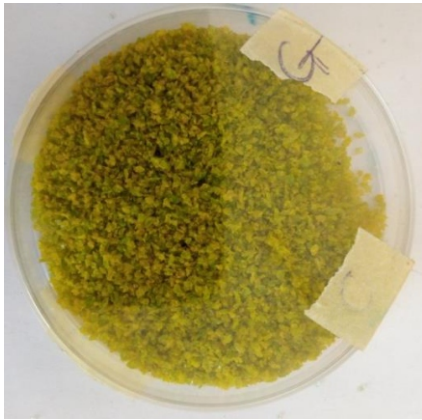


Plate XII: Treated green PCG with Monoarylide Yellow Pigment (Azo Yellow)

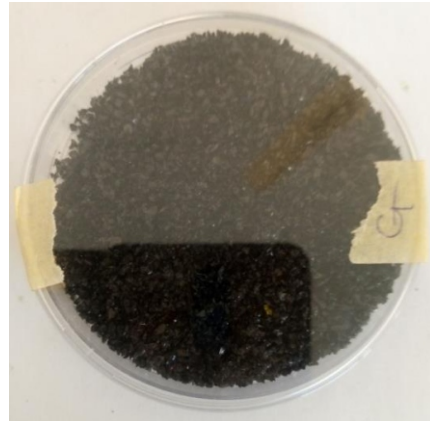


Plate XV: Treated green PCG with Carbon Black Pigment

3.3.4 Colouration of Amber postconsumer glass

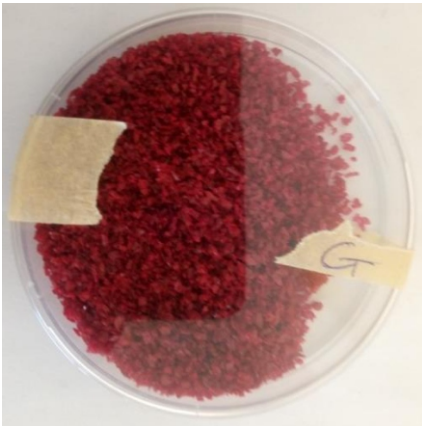


Plate XIII: Treated green PCG with Metallic Azo Red Pigment (Azo Red)

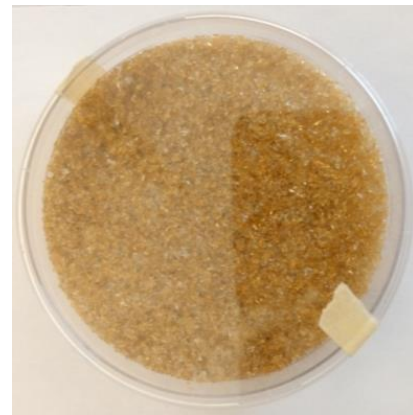


Plate XVI: Post consumer amber glass before treatment

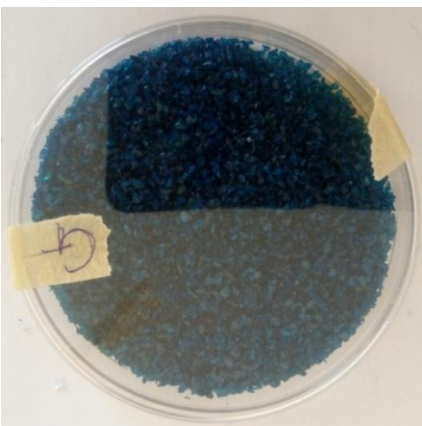


Plate XIV: Treated green PCG with Copper Phthalocyanine Blue Pigment

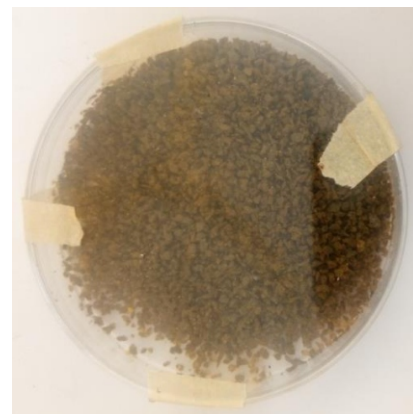


Plate XVII: Treated amber PCG with Monoarylide Yellow Pigment (Azo Yellow)

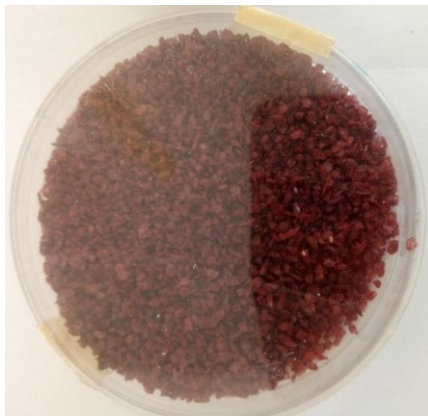


Plate XVIII: Treated amber PCG with Metallic Azo Red Pigment (Azo Red)

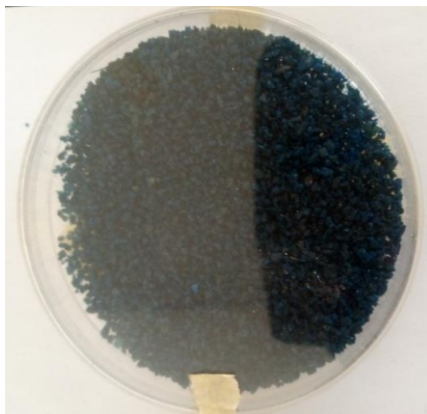


Plate XIX: Treated amber PCG with Copper Phthalocyanine Blue Pigment

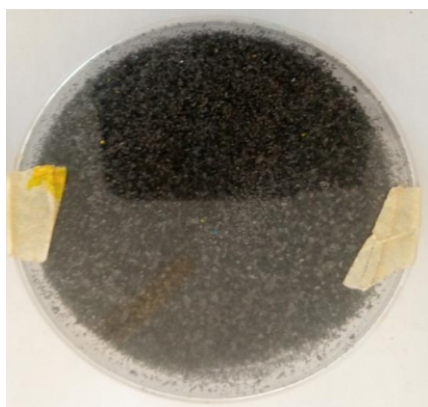


Plate XX: Treated amber PCG with Carbon Black Pigment

4.0 Conclusion

Owing to the results obtained from the study, findings shows that waste post-consumer can be processed into discrete sizes and pigmented suitable raw materials of Yellow, Red, Blue and Black for artist expression.

5.0 Recommendation

In other to achieve a greener and sustainable environment amidst aesthetics, this study recommends the application of the pigmented glass material for application in painting and relief or three dimensional sculptural pieces using cold setting resins or binders. Also that effect of particle sizes be investigated as its affect colouration in artistic painting.

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