Cross-Currents: An International Peer-Reviewed Journal on Humanities & Social Sciences
ISSN 2394-451X (Print) & Open Access
http://crosscurrentpublisher.com/
DOI : 10.36344/ccijhss.2018.v04i04.007

Design and Production of Water Sustainable Planter

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Abstract: Improper irrigating of plant is the most frequent cause of plant mortality. Many people are frustrated with the quantity of water to give to their plants and also do not get time to water their plants regularly. This could be difficult to keep plants healthy and fresh. This study specifically experiment on the body that will enhance the seeping of water at a given time and to design series of water sustainable planter that will suit the require plants (flowers). Studio-based method of qualitative research design was employed in the study. Results from observations aided in the production of the water sustainable planter. The study unveiled that water sustainable planter can be produced using locally available materials such as Mfensi clay, Keyansi clay, grog and sawdust. The sustainable planter was able to sustain water, making the soil moist and helps plants to grow fresh and healthy. The study recommends that further research should be done by using different materials for the production of water sustainable planter and other plants should also be explored for the planter. Further reviewing of designs based on the planter should be made to suit the required plant.
Keywords: Water sustainable planter, Glaze, Production, Design.

INTRODUCTION

Ceramics are generally made by taking mixtures of clay, earthen elements, powders, and water and shaping them into desired forms. Once the ceramic has been shaped, it is fired in a high temperature oven known as a kiln. Often, ceramics are covered in decorative, waterproof, paint-like substances known as glazes. According to Carr [1], clays are very fine particles of dirt which float in a stream or river and then sink to the bottom, where they press on each other and stick together. The clay is found along the banks of a river or stream, wherever the river is pulling dirt down off the mountains or hills and dropping it in a quiet part of the river lower down. Abubakar [2] asserts that clay is the common name for a number of fine-grained, earthy materials that become plastic when wet. Clays chemically, are hydrous aluminum silicates, ordinarily containing impurities such as potassium, sodium, calcium, magnesium, or iron, in small amounts. Many clays, however, are used just as they come from the earth and may be modelled or thrown on the potter‟s wheel without any adjustments in composition. Ashanti Region for instance has different types of clays, of which some include Mfensi clay, Afari clay and Trabuom clay. Mfensi clay as mentioned in the above region is one of the commonly used type of clay.

Some ceramic wares are used for interior decorations and exterior decorations. Ceramic vases for instance, are mostly used for decoration. Vases, as the name implies, are earthenware used mainly to hold cut flowers or for decoration. Vases are vessels of pottery, glass, metal, stone, wood, or synthetic material. The pottery vase was anciently employed as a container for water (a hydria), wine and other products (an amphora), or oil (a lekythos), or for mixing and serving wine and water (a crater). It had one or two handles, sometimes a lip or spout, and frequently a base or foot and sometimes pointed to thrust into the ground and also was set into a frame holder for support. Large covered vases were used for general storage purposes. The cinerary vase, or urn, has been common throughout historical times and the famous one being the Portland vase. Modern vases are widely used for flowers which was beautiful in form and embellished with incised patterns, modeled, or painted figures or scenes, and sometimes inscriptions, which means the vase became a work of art in early times [3].

Gyamfi *et al*. [4] further explains that, vase is an open container, often used to hold cut flowers, made from different kinds of materials which include; ceramics and glass. The vase is often decorated and thus used to extend the beauty of its contents. Flower vases over the years have served the purpose of ornamentation and beautification in the houses of many citizens. Initially, indigenous Ghanaian vases were meant as containers for food and other household items, this however, has changed as a result of external cultural influences. Today, the shapes of vases have evolved from the conventional ones to modern designs and shapes and also the vase has developed as an art medium unto itself.

Due to its high functionality, there is a need to give the flower water daily to attain its growth. The advantages of a method whereby the moisture supply of a potted plant may automatically be kept approximately uniform during long periods of time are obvious to all who have to grow plants in pots for any purpose [5]. Self-watering a plant in soil contained in a common pot having a bottom with at least one drainage hole defined

there, through comprising the steps of providing a wicking action through the bottom of the common pot without intrusion of any object into the pot. A water reservoir is defined beneath the pot [6]. People living in urban areas often keep flowers, shrubs, trees, and other plants in flowerpots (flower vase) and place the pots on terraces, balconies or decks [7].

The water seeps out through the clay wall of the buried clay pot at a rate that is influenced by the plant‟s water use. This leads to very high efficiency, even better than drip irrigation, and as much as 10 times better than conventional surface irrigation. The self - watering planter is a way or method of watering plants where the water is introduced into the reservoir which is always at the bottom of the vase, allowing the water to soak upwards to the plant through a capillary action [8]. The self-watering method is one of the most efficient traditional systems of irrigation [8, 9]. Improper irrigating of plant is the most frequent cause of plant mortality. Many people are frustrated with the quantity of water to give to their plants and also do not get time to water their plants regularly. This could be difficult to keep plants healthy and fresh. According to Luke [7], a conventional flowerpot includes neither self-water storage facility nor automatic water drainage facility. The plant in the pot is frequently subjected to a water problem and either an excessive water or a shortage of water, this will therefore lead to poor irrigation. Again, watering plants regularly is also time consuming and somehow waste water.

Abubakar [2] states that, potters and ceramists have used a variety of techniques to decorate and finish the surface of their wares, from carving plastic clay, incising groves or burnishing the leather hard clay surface to achieve varied alluring effects. Throughout history, different colored clays have been put together for distinctive decorative effect. Incising, impressing, slipping, glazing, painting etc. are some of the decorating and finishing techniques available for potters and ceramists. Wisegeek as cited in Okewu & Jonathan [10], ceramic glaze may be used for purely decorative reasons, to strengthen the underlying ceramic, or to waterproof the vessel. Ceramic glaze is used for finishing vases, bowls, Figures, and also to decorative any pieces of ceramic artwork. Furthermore, early glaze was used primarily to make earthenware vessels suitable to hold drinks and liquid foods. Without the glaze the clay easily soaks up the liquid since it has been there over time, saturating the vessel with its taste, and weakening the vase. Peterson [10] as cited in Okewu & Jonathan [10] explain that glazes are a type of glass that is especially made to stick onto pots and other ceramic surfaces. According to Lauer & Pentak [11], design is inherent in the full range of art discipline of painting and drawing to sculpture, photography, and time-based media such as film, video, computer graphic and animations. They further explain that it is integral to crafts such as ceramics, textiles and glass, architecture, urban planning and all apply visual design principles. Furthermore, Lawson [12] cited in Imbeah[13] asserts that, “design is a generic activity, yet appear to be of real differences, between the products created by the designer in various domains.”

This study specifically experiment on the body that will enhance the seeping of water at a given time, to design series of water sustainable planter that will suit the require plants (flowers) and to produce and test the water sustainable planter that will be suitable for any of the plants.

MATERIALS AND METHODS

Materials, Tools and Equipment

Mfensi clay, Keyansi clay, grog and sawdust were the materials used for the execution of the project. The Mfensi clay, obtained from Mfensi in the „Atwima Nwabiagya‟ District of Ashanti Region and Keyansi clay was also obtained from the Keyansi in the Ashanti Region. These clays were in the rock-like form and they were used because of its plasticity and also added green strength to the piece. Keyansi clay nodules were fired and ground into grog in the laboratory which add strength to the body. The sawdust was obtained from the K.N.U.S.T wood workshop and it was used to create pores in the body.

The tools used were knife, mesh, cutting wire, Electronic scale, turning tool and the beam balance. Knife: General purpose tapered knife for cutting soft and leather hard clay into slices. Mesh: 320 and 212 size mesh were used for sieving the materials for the experiments. Cutting wire: This tool is for cutting soft clay into bits before wedging. Electronic scale: This was used to weigh the test pieces. Turning tool: it was used to straighten to planter at the leather hard state. Beam balance: This was used to weigh the various materials.

Crusher: It is equipment used for crushing the clays and the grog into smaller particles. Grinder: For grinding it into semi powdered form. Pulveriser: This was used to mill the semi-powdered material into a fine powder. Throwing wheel: This was used to throw both the porous (reservoir) and non-porous body (planter). Electric kiln: This was powered by electricity to fire bisque wares into the vitreous permanent state.

Research design

In undertaking of the project, the studio-based research method of qualitative research design was used for the study. According to Lofland [14] as cited in Gyamfi *et al*. [4] “the simplest definition of qualitative research is to say, collection and analysis of data that are non-quantitative. Candy [15] also states "it is an original investigation undertaken in order to gain new knowledge partly by means of practice and the outcomes of that practice. The qualitative approach was used in the discussion and analysis of results in a

descriptive. The Research instrument used for the study was mainly an observation. The observation method aided the researchers to know the type of planters used in homes, offices and the ones sold in the market and also led the researchers to reflect on the right materials to use, the temperature and the behaviour of the various materials as well as which design and finishing technique to incorporate. Observations made were analyzed vividly to execute its results successfully.

Preliminary Design

Series of sketches were made until the final designs of the planters were obtained with the help of software called Rhino. This process was done until the final forms were obtained as shown in Figure 1.

Fig-1: Selected Water sustainable planters

Making of Test Pieces

Table-1: The test pieces were made using the various under listed body compositions

BODY	MATERILAS (%)			ADDITIVE (%) (Sawdust)
	Mfensi	Keyansi	Grog	
A	60	25	15	0.15
B	75	15	10	0.3
C			50% of Body A + 50% of Body B	

The above clay bodies were fired to a temperature of 1000°C. Porosity, water absorption and bulk density were performed using the test pieces. They were tied with threads and then weighed using the electronic scale to determine their weight in the dry state. They were then soaked in the water for 24 hours (Figure 2). The soaked test pieces were weighed to determine their weight after they were soaked in water for 24 hours.

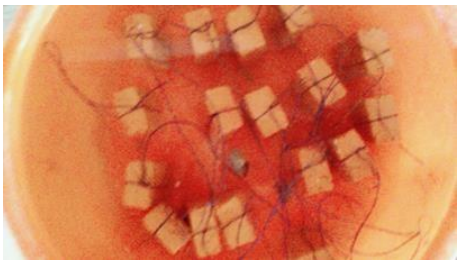

Fig-2: Soaking the specimens in the water for 24 hours

Materials Preparation

Wet and dry clays were used for the project. The wet clay which is the Mfensi clay was soaked in the pit for some two weeks to age. The aging makes the material more plastic. The Mfensi clay in the pit was conveyed on to the working table with the help of the spade and wheelbarrow. This clay was used to mould the planter. The pug mill was fed with clay through the feeder smash and blended the clay lumps and extruded homogenous bars of clay. The clay came out in cylindrical bar. The clays were then packed in a box lined with polythene sheet to prevent them from drying.

The dry clays for the bodies were in the rock-like form. They were crushed to reduce the particle sizes into smaller sizes in order to obtain a finer particle size as shown in figure 3. This process was done with the aid of the equipment. The clays were sieved through 320 mesh (Figure 4). The sawdust was also sieved through 212 mesh. Keyansi clay was used to prepare the grog. It was processed and then formed into nodules. The nodules were dried and then fired to a temperature of 1000°C and they were crushed into powder.

Fig-3: Crushing the clay

Fig-4: Sieving the materials

Mixing, Kneading, Throwing, Drying and Firing

In order to obtain a uniform mixture for the reservoir to enhance the seeping of water, the sieved materials which come with different compositions were mixed together. Least amount of water was added to it in order to make it workable, but not to make it watery shown in Figure 5-6. The mixed compositions were kneaded differently, for good mixture and also to take out the amount of moisture. The already pugged-mill clay in varied proportion used for the planter was also kneaded.

Fig-5: Mixing materials

Fig-6: Nodules of the Clay body

To obtain the forms of the planters and its reservoirs, the kneaded clays were thrown on the throwing wheel. The already pugged clay for the planters was first thrown. Then the reservoirs which are the porous body were carefully thrown because of the grog and the sawdust content in the clay. At the leather hard state, they were turned on the wheel shown in Figure 7 to straighten and to take out the excess clay.

Fig-7: Straightening the planters

The reservoirs (porous) and turned planters were finally arranged on shelves for complete drying. At this stage, almost all the moisture in the clay had evaporated. They were then ready for firing. The Planters and its reservoirs were loaded into the kiln and fired once, to a temperature of 1000°C. Figure 8 shows the fired planters and its porous reservoirs. The reservoirs are those behind the planters.

Fig-8: Bisque fired planters and reservoirs

Application of Glaze

To obtain a vitrified body and a quality appearance, glaze was applied on the planters. Glazes were applied on the planters by dipping, painting and sprinkling. The application was done by first dipping the planters in the glaze and then, allow to dry. Then different glaze was applied by using the brush to paint on them. The painting method was used in order to bring out the hidden designs on the planters, then the last application was used. The glazed planters were packed into the kiln and fired again to a temperature of 1180°C.

RESULTS AND DISCUSSION

Physical Test on the Prepared Bodies

Some factors are considered in choosing a body when producing Water sustainable planter. This will therefore help to attain proper irrigation system. The body was used only for making the reservoir in the planter depending on the design. To achieve this property, the percentage porosity, water absorption and bulk density of Body A, B and C were noted.

Percentage Porosity of Body A, B and Body C

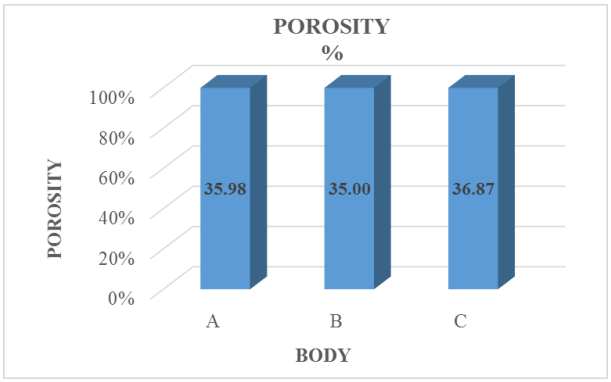

Fig-9: Percentage of Porosity

From the summary of the graph, comparing the percentage porosity of the various bodies at a temperature of 1000°C, Body C (combination of Body A (50%) + Body B (50%)) had the highest porosity of 36.87%, Body A (60% Mfensi + 25% Keyansi + 15% Grog) had the second highest of 35.98% while Body B (75% Mfensi + 15% Keyansi + 10% Grog) had the low porosity of 35.00%.

Percentage Water absorption of Body A, B and C

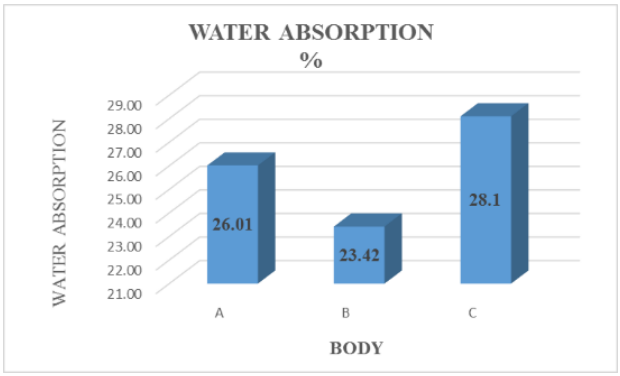

Fig-10: Percentage of Water absorption

With the percentage of water absorption, Body B had the lowest percentage of 23.42% as compared to Body A and Body C which recorded for 26.01% and 28.1%.

Percentage Bulk density of Body A, B and C

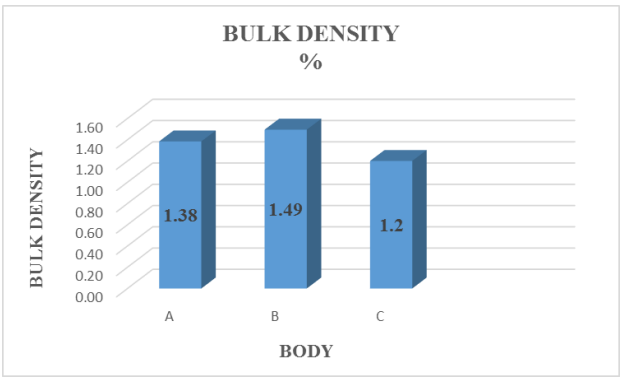

Fig-11: Percentage of Bulk density

Comparing the percentage bulk density, Body B had the highest percentage of 1.49%, Body A having the lower of 1.38% and Body C had the lowest percentage of 1.2%. The sawdust was added to Body A and Body B based on the amount of plastic clays contained in each body. 0.3% of sawdust was added to Body B and 0.15% of sawdust for Body A but yet still Body B had the lowest porosity. This was done in order to obtain workable body for the reservoirs since they were thrown on the throwing wheel.

Inferred of this, sawdust added to a body to in order to achieve a certain percentage of porosity must be done based on the amount of plastic clays in the body. This will help to acquire a workable body, especially for throwing purpose. When the pores of the body are bigger, it reduces its weight as shown in figure 11 and also from the above graphs; all the bodies are suitable for the production of the water sustainable planter.

Testing of the Water sustainable planters

In the choice of every planter there is a need for the user to consider the type of flower to use and its effect in order to avoid under and over watering of the plant. In the selection of the plants for the project, Phobia and Donkey plants shown in Figure 12 were used for the experiment. These plants were obtained from the Horticulture Department, KNUST.

Fig-12: Phobia and Donkey plant

These plants are such that they cannot be fresh and healthy when they are not given the right amount of water. The planters can be used to hold cut flowers indoors and outdoors base on the characteristics of the plant. Before the planting begins, the researchers placed the unglazed pot which is the reservoir in their various finished planters and they were then filled with loamy soil. This soil has an amount of organic matter and is suitable for the plants. Shorter [16] opined that, loamy soil is rich in nutrition and easy to work with. Furthermore, loamy soil is considered ideal for a wide variety of plants as a consequence of its rich nutritional content and ability to retain moisture. The flowers were planted in each planter as shown in Figure 13-14.

Fig-13: Planting Donkey flower

Fig-14: Planting phobia

Water was sprinkled on the loamy soil after planting the flowers to make it moist. The reservoirs were filled with amount water based on the size attached to the planter as shown in Figure 15.

Fig-15: Filling the reservoirs with water

Planter 1 with Body A as the reservoir was used to plant the Donkey flower. It was designed in a way that, the glazed planter was filled with the soil and the water was poured in the porous body which is known to be in the reservoir with a cover shown in Figure 16. The reservoir was filled with a half-liter of water and inserted into the loamy soil. It was designed to have a cover to prevent toad from entering into the water and also prevent mosquitoes from breeding.

Fig-16: Planter 1 with a reservoir within the soil (Body A)

Planter 2 with Body B was used to plant the same Donkey flower. At this stage, the porous body was rather filled with the loamy soil. This means that the planter will rather serve as the reservoir because it was planned as such. 1.5 liters of water were used to fill the planter through the spout. The flower was then planted in the porous body shown in Figure 17. The

same flower was used again in order to compare during the analysis of the results.

Fig-17: Planter 2 with the vitrified body as the reservoir (Body B)

Planter 3 with Body C as the porous reservoir was used to plant the Phobia flower. This planter was also designed to have the same arrangement as Planter 2. The flower shown in Figure 18 was planted and 1 liter of water was used to fill the planter through the perforated hole.

Fig-18: Planter 3 with the vitrified body as the reservoir (Body C)

Observation

Observations were made every day after the plants were planted in their various planters. Series of photographs were taken to see the progress of the growth of the plant and the ability of the planter to hold the plant and also checked the amount of water left in the reservoir. The water irrigates the plant through a capillary action thus; the water seeped through the walls of the porous body. According to Daka [8] as cited in Bayuk [9], buried clay pot filled with water and crop planted adjacent to it, the pot effect sub-surface irrigation as the water seep out of it due to the suction force which attract water molecules to the plant roots. The author further explained that, the suction force is created by soil moisture tension or plant root themselves.

After one week observation, planter 1was able to sustain the water for five days to irrigate the plant. That is, the water in the reservoir got finished within five days and it was refilled with another water. The planted flower started dying in the second week, it was not looking fresh as compared to the day it was planted (Figure 19).

Fig-19: Results after a week

The planter 2 in Figure 17 had enough water to carry on through the second week. It was able to sustain the water for 14 days. The plant was still fresh and healthy as shown in Figure 20.

Fig-20: Results after 14 days

The third planter with the phobia flower in Figure 18 was able to sustain the water for 11 days before it got finished. The planted plant shown in Figure 21 was still healthy and fresh.

The aforementioned days for the refilling of water continued for four weeks. Then after four weeks, the plants appeared to be strong as shown in Figure 22.

Fig-21: Results after 11 days

Fig-22: Results after four weeks

The researchers made extra observations and it was realized that the planted flowers had increased in its growth even though the first planter with the donkey flower for the first week started failing. The plants were still strong and fresh thus; they attained their growth as shown in Figure 23 after five weeks.

Fig-23: Results after five weeks

Generally, the soil was drenched and it was not able to absorb any more water until the soil dried up. This helped to prevent over and under watering of plants. According to Shorter [16], loamy soil helps to resist waterlogged; it drains well. Bott [17] on the other hand, asserts that, too much water is bad for most trees and plant. If the soil becomes waterlogged it can lead to root rot or other diseases. This therefore makes the porous clay pots filled with water deliver controlled irrigation to plants [8]. The design for planter 1 was not the best as compared to planter 2 and 3 because it was not able to seep the water. It was revealed that, half of the plant was failing as compared to the two planters, this proved that planter 1 was not the best.

CONCLUSION AND RECOMMENDATION

The study examined on the production of water sustainable planter using locally available materials such as Mfensi clay, Keyansi clay, grog and sawdust. Materials identified for the project were studied, bodies prepared out of them, and tested to ascertain their suitability in terms of porosity, water absorption and bulk density. Water sustainable planter is the type of planter where water is introduced into the reservoir which is always at the bottom of the planter, allowing the water to seep through the walls of the reservoir to irrigate the plant through a capillary action. The study revealed that when there is too much water in the soil, it becomes saturated, which makes the seeping of water seized. Even though planter 1 was not the best in terms of design, but planter 2 and planter 3 were able to sustain water, making the soil moist and helps plants to grow fresh and healthy. Water sustainable planter can be used in our homes, offices and any other place both indoors and outdoors and also serve as beautification purpose. As a result, the study recommends that further research should be done by using different materials for the production of water sustainable planter. Other plants should also be explored for the planter and further reviewing of designs based on the planter should be made to suit the required plant.

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