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Research, Development and Commercialization of Double Burner Claystove Using Termite Mounds

Rationale

Concurrent with the soaring cost of foods are exorbitant prices of cooking facilities including cookstoves and much so with the needed fuels.

In the Philippines, 70 or 80% cook foods with the use of the traditional tripod whereby, wood sticks or even charcoal are the main fuels being used. Adversely, such practices since time immemorial were identified to have been causing volume of smoke emission that brings much pollution to the environment.

Relatively, usage of these cookstoves were assessed to be creating an immediate human health risk. Also, inefficient stoves are estimated to contribute 2.5 to 10 percent of current climate change through the emissions of black carbon or soot.(U.N. Environment Programme)

Identified illness and sickness specially on the respiratory system such as lungs impairment, as well as the resulting problems on man's eyes have been reported as the adverse effect. These smoke-borne diseases are eventually developed among people with their direct exposure to fire, heat, and smoke during cooking activities.

The foregoing issues and problems resulting and associated with the wide use of tripod for cooking his prodded the study.

Objectives

The following objectives are:

1.To develop a low cost earthen cooking stove;

2.To fabricate a clay cookstove using locally available resources;

3.To determine the efficiency and durability of the earthen cooking stove;

4.To compute the cost of production and,

5.To determine the market acceptability of the double burner clay stove.

Review of Related Literature

Particularly, the following minerals are described and related:

Plagioclase

The Plagioclase series is a group of related feldspar minerals that contain sodium and calcium with varied percentages. Generally, it is composed of Sodium Calcium Aluminum Silicate. The color vary from white, colorless, cream, gray, yellow, orange, pink, green, and others. The striking features are cleavage and hardness.

Plagioclase feldpsars are used widely in the production of ceramics.

Quartz

Quartz is the most well-known minerals on earth which is an important constituent of many rocks. The chemical formula is SiO2 and the composition is Silicon dioxide. The cleavage of quartz is indiscernible and it seldom exhibits parting. The striking features is hardness.

Quartz is widely known for its varied uses. Sand, which is composed of tiny quartz pebbles, is the primary ingredient for the manufacture of glass. It is also used as an abrasive for sandblasting, grinding glass, and cutting soft stones and it is essential in the computer industry, as the important silicon semiconductors are made from quartz.

Mica

The Mica group of sheet silicate(phyllosilicate) minerals includes several closely related materials having highly perfect basal cleavage. Mica is widely distributed and occurs in igneous, metamorphic and sedimentary regimes.

Properties and Uses

The Mica group represent 37 phyllosilicate minerals that have a layered or platy texture. The commercially important micas are Muscovite and Phlogaphite

which are used in a variety of applications. These sheets are chemically inert, dielectric, elastic, flexible, hydrophilic, insulating, refractive, and resilient. Among its famous features and uses are:

1.Mica is stable when exposed to electricity, light, moisture, and extreme temperatures. It acts as a filler and extender, provides a smooth consistency, improves the workablity of the compound, and provides resistance to cracking.

2.In the well-drilling industry, ground Mica is used as an additive to drilling fluids; while in the plastics industry; dry-grounds mica are used as extender and filler, especially in parts for automobiles as lightweight insulation to suppress sound and vibration.

3.In the rubber industry, ground Mica is being used as an inert filler and mold release compound in the manufacture of molded rubber products such as tires and roofing; while in polymer formulations, Mica is used to increase the strength of epoxies, nylons and polyesters.

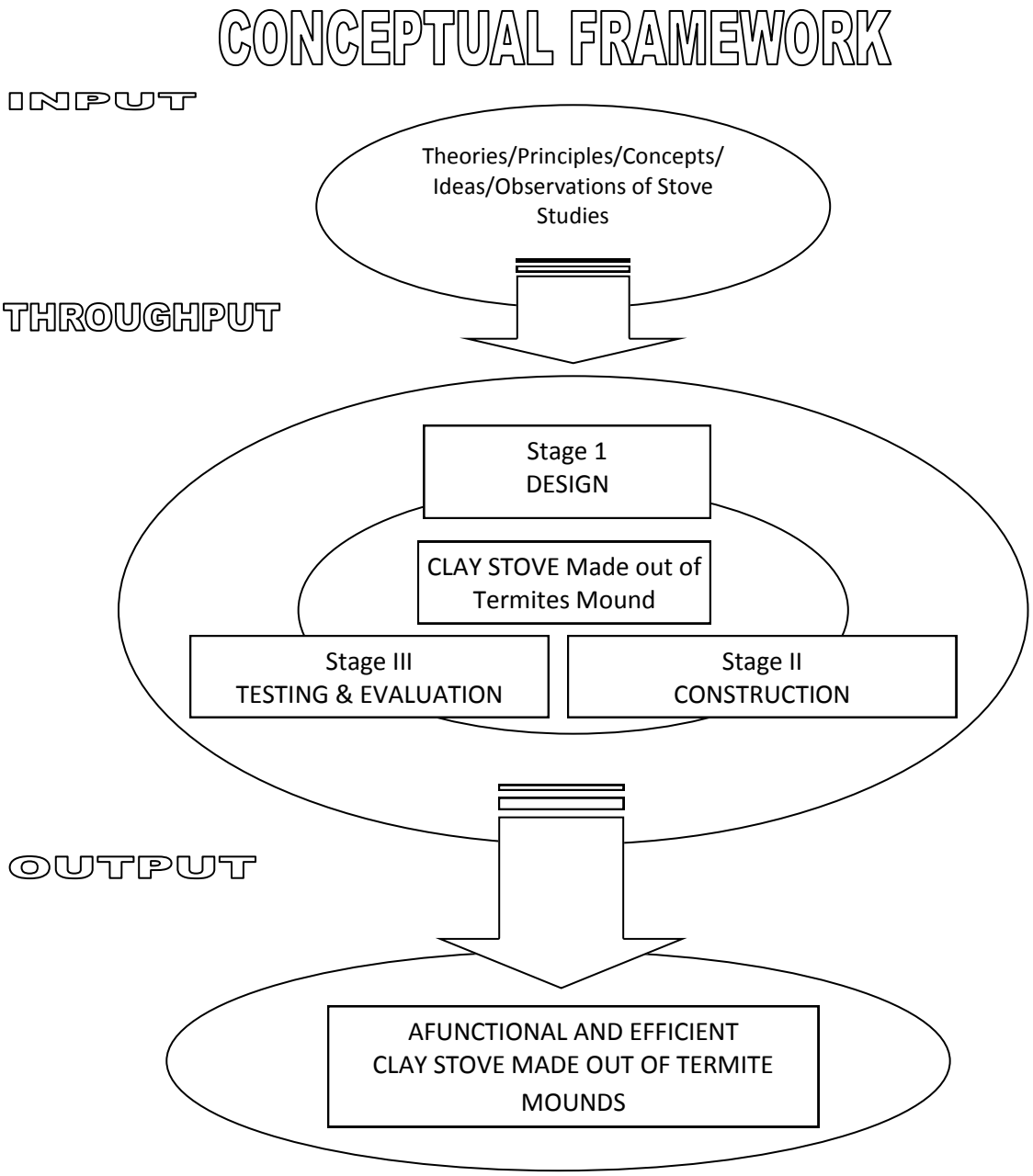
4.In the cosmetic industry, its reflective and refractive properties make Mica an important ingredient in blushes, eye liner, eye shadow, foundation, hair and body glitter, lipstick, lip gloss, Mascara, moisturizing lotion and the like.

Amphibole

Amphibole is the name of an important group of generally dark-colored rock-forming inosilicate minerals, composed of double chain Silicon tetraoxide, linked at the vertices and generally containing ions of iron and/or magnesium in their structures. A member of this group includes Pargasite which is a rare magnesium-rich amphibole with essential sodium, usually found in ultramafic rocks. These are characterized as hard and dense.

CONCEPTUAL FRAMEWORK

This research work was guided with the following conceptual framework.



Methodologies and Strategies

The methodologies have adopted those practices and processes involved in product research and development incorporating principles on other related disciplines in Engineering, Technology, Economy, Health, Sanitation, and Environmental protection. Likewise, soil analyses through X-ray diffraction as well as plasticity/elasticity test were conducted. Strategies have included exploration; screening; product analysis; product development and testing. Stages on material development such as planning, development and evaluation were likewise employed.

Finally, cooking efficiency and market tests on the product completed the research.

Discussion of Results

Results of the research are presented as follows:

On Product Development

The research has resulted in the design, construction and commercialization of a double burner claystove made up mainly of termite mounds and rice hull. The processes involved are natural and environment-friendly using indigenous raw materials which are abundant and cost-free in the area.

On Material Quality Test

The termite mounds soil and the standard clay were both subjected to the following tests:

1.Soil Analysis by X-Ray Diffraction on:

a. On Termite Mounds

Results have revealed the mineral components of the Termite mounds soil which are Plagioclase, Quarts, Mica and Amphibole. Accordingly, Plagioclase represents the highest mineral content that is approximately 5,400 counts per second(CPS) @ 28 degrees scan range, Quartz of approximately 3,000 CPS @ 27 degrees scan range, Mica which is approximately 2,400 CPS @ 22.5 degrees, and Amphibole of 2,100 CPS @ 11 degrees.

Relatively, the features of the minerals are discussed in relation to the stove quality

Plagioclase

Plagioclase which is the highest number component of Termite mounds soil is contributory to the physical hardness and sturdiness of the stove with elements Sodium and Calcium that contributed to the strength .

Quartz

The presence of quartz containing silicon is associated with the strength and durability of the product. It caused the greenish color and the glistening effect.

Mica

Mica makes the stove heat-resilient during cooking activities. It enables the stove retains its shape, position and normal function after being subjected to stress and heat. It adds to the elasticity of the material.

Mica is responsible for the smooth consistency of the soil which is an excellent property needed to make a clay dough. It likewise prevents cracking and breakerage of the product adding with adhesiveness and stickiness of the materials contributory to the strength.

Mica increased the heat holding capacity of the stove that is gradually emitted to the cooking vessel for at least 3 to 4 hours even after the last wood or fuel has been consumed.

Finally, Mica functions as extender and filler that made possible the construction of the ceiling on a hallow hull without any reinforcement. Amazingly, an approximate weight of 200 kilos can be put on-top of the stove without collapsing, braking, or cracking.

Amphibole

This mineral is responsible for the added hardness and sturdiness of the stove.

b. On Standard clay

As compared with the termite mounds soil, the results has revealed that only two kinds of minerals are present namely: quartz and plagioclase.

2.Soil analysis On Elasticity(Plastic Limit)

Table 1 presents the results of the soil elasticity tests of the soils.

Table 1.Soil Elasticity Test

Commodity(Soil Samples)	Unit (Moisture Content)	Quantity/ Percentage
Termite Mounds Soil	**MC**	**16%**
Clay Soil from Iquig, Cagayan	**MC**	**21.6%**

The plastic limit of the Termite Mounds Soil based on moisture content by weight is 16%; while the standard clay is 21.6%.

The above data have reflected that the termite mounds soil is still plastic/elastic even with a low moisture content. On the otherhand, the ordinary clay has an plastic or elastic limit up to 21.6% moisture content.

Implication:

Accordingly, the termite mound soil can still be molded at 16% MC into dough. while as to the standard clay, below 21.6% MC, the soil crumbles. Hence, the termite mounds soil is more elastic/plastic than the other clay that is commonly used.

3.Cooking Performance and Efficiency Test

In particular, the following results and observations are shown as follows:

1. Less Smoke/Smokeless. Smoke only appeared during the fire starting or priming period, and gradually disappeared as combustion takes place. Smoke is burned inside the combustion chamber with the generated heat enough to split carbon dioxide into single elements of Carbon and Oxygen.

2. Healthwise. The design and technology being applied prevents the emission of excess fire or heat from the potholes . As such, the cook is not exposed to heat nor fire that is supposed to cause related diseases or illness to the individuals. Likewise, it avoids the

scattering of ash and other materials in the cooking area.

3. Economy in the use of fuel. Successfully, the claystove is built with two burners using same volume of fuel cooks twice the normal capacity of a tripod resulting to remarkable savings, or even the decrease of fuel usages.

4. Cooking convenience. The design of the cookstove subscribes to the aero-dynamic principle along cooking activities. Combustion takes place without the use of blower either manual or by electric gadget to maintain combustion.

Also, with the firewood being vertically stacked into the firehole, there is the minimal shoving of firewood during activities. Finally, as there is no smoke caused within the cooking area. Possible inhaling of smoke is avoided with no tears from a smoke-inflicted eyes.

5. Cooking Safety. The stove design is built in such a way that the firehole is conically carbed inside the ceiling which is monolithically fused with the base. As such, the fuels are vertically stacked inward the firehole with the fire being confined inside the combustion chamber. Incidence of fire accidents is virtually avoided.

6. Longer retention of heat on cooking vessel. The consistent soil texture allows the longer retention of heat in the hull. Much more, with the design and technology, the heat from the firewood are likewise transmitted to the body or hull of stove that is being emitted gradually to the cooking vessel that keeps the food hot even after the last fuel has been consumed.

7. Productive use of agricultural wastes being used for fuel including agricultural waste such as corn hobs, coconut husks, leaves, twigs, rice straw, coconut shell, cartoons, and the like. The stove help reduce the volume of wastes being scattered in different areas using them as fuels for cooking activities.

Results of cooking efficiency test are shown in table 2.

Table 2. Cooking Efficiency Test

Volume of Water	Trials	Int'l Temp.	Final Temp.	Boiling Time	
				Double Burner	Tripod
1 Liter	1st	25°C	99.7°C	11 min;13 sec.	8 mis;45 sec.
	2nd	25°C	99.7°C	9 min; 22 sec	7 min;52 sec.
	3rd	25°C	99.7°C	9 min; 29 sec	8 min;12 sec
Average		**25°C**	**99.7°C**	**10 min; 1 sec**	**8 mins;16 sec**
2 Liters	1st	25°C	99.7°C	19 min; 35 sec	17min;52 sec.
	2nd	25°C	99.7°C	19 min; 5 sec	18min;3 sec.
	3rd	25°C	99.7°C	18 min; 37 sec	17min;48 sec.
Average		**25°C**	**99.7°C**	**19 min; 6 sec.**	**17min; 54 sec**

The above table recorded the time count to boil water using Gmelina as Firewood on both stoves-the tripod and the double burner claystove.

As shown on the above table, water with the same volume boils faster with the use of tripod than with the double burner clay stove. However, considering that the stove is double burner, it cooks twice the volume of water at same span of time using the same volume of firewood in one setting.

4.Production cost

The production cost is quite fair and minimal. Raw materials including termite mounds, rice hull and water are found abundant and are cost-free in the area. As such, only the direct labor cost as well the materials for chimney commands a price.

In a proper computation, the production of 1 unit double-burner claystove includes an average labor equivalent to 1 manday at P300 per day which is the prevailing labor cost in the area. Also, a total cost of P122.50 is used for the chimney. Hence, total production cost for 1 complete set totaled to P425.

SUMMARY OF RESEARCH OUTPUT

1.The double-burner stove is made up mainly of cost-free and indigenous materials fueled with firewood and other combustible materials mostly of which are considered wastes being vertically stacked into the firehole.

2.It is a durable stove with a longer heat retention capacity that is used for longer extended cooking and heating activity.

3.The stove is very much convenient and sanitary to use characterized with a smoke-free cooking area with a sootless cooking vessels.

4.The stove is economical since it is built with two burners while using the same volume of firewood.

5.The double burner stove has maximized the use of the energy from the firewood and other fuel, thus, increasing the service utility of the cooking facility and fuel.

Product Market Test

Based on the series of market test being conducted including product demonstration, presentations, and exhibits, orders are consistently increasing number. Such determined the high demand for the product. It marked the feasibility of the entrepreneurial or business activity.

Buyers and potential customers include households, businessmen, farmers, developers, private and government employees. Also, increasing orders are coming from the different regions in the country.

Common cooking problems

Identified common cooking problems both by authorities and private individuals are: (1) Health risks specially to humans; (2) Laborious cleaning activities on cooking vessels; (3)Cooking inconvenience; (4)Soaring cost of gas and fuels; (5) Incidence of accidents caused by fire and burns from cookstoves; (6)Dirty/unsanitary cooking area or kitchen; and (7) Smoke pollution and massive forest denudation leading to global warming, climate change, and other environment hazards.

Product Intervention

The design, construction and commercialization of the product has made the following successful intervention:

1.The design and construction of the double burner claystove is made with potholes that fits perfectly the pothole(remedies are available). As such, there is no excess heat or fire draft being emitted around the cooking vessel where the cook is directly exposed; and cooking vessels remain sootless on the outer side except on the pot’s bottom.

2.Cooking convenience with minimal shoving of firewood to maintain combustion. This is facilitated with the design wherein, firewood are being vertically stacked in the firehole that is gradually pulled down with the aid of gravity. Also, the use of chimney sucks the hot air upward that likewise facilitates the entry of cool air through the pothole needed to maintain combustion without the use of blower.

The ash remained confined inside the chamber even after cooking activities, thus, scattering is completely avoided. Also, the minimal smoke that is usually generated during the fire-starting activities is being pushed upward through the chimney outside the cooking area, it leaves the cooking room free from smoke avoiding suffocation and pollution

3. The stove promotes economy with the use of wood fuel for cooking. Cost of firewood and other waste materials are far lesser and more affordable compared to fossil fuel such as LPG and the like. In fact, firewood are commonly cost-free in the countryside or mostly in the rural areas. Likewise, since it is a double burner stove, literally, it make possible the cooking or heating with two vessels at the same time without necessarily increasing the volume of firewood to be used.

With the wood that is vertically stacked in the firehole, the entire firewood is consumed completely without leaving an unused portion. The design and use of this claystove which functions with a lesser volume of firewood directly reduce the practice of massive cutting of trees for wood and fuel.

4. The product is designed and constructed with a hallow hull that also serves as combustion chamber. Made out of clay, there is no possibility of over-heating even when used continuously. Also, the fire and heat is totally confined inside the hull during and even after cooking activities thus, eliminates completely risks of accidents possibly because of fire scatter.

PRODUCT IMPACT and CONTRIBUTIONS

1.Technology Transfer

The research has generated and transferred profitable technology to people particularly the molders and makers for a more productive economic activity.

2.Economic Impact

The research has resulted to poverty alleviation having created an employment initially to 10 skilled molders/makers with the number gradually increasing.

Likewise, it made possible the conversion of idle and waste materials into an economic resource for the production of a highly functional stove. Also, the use of the product caused much savings in term of fuel cost reduction to every user.

3.Health and Sanitation

Promotion of good health both to household and community members is another good and beneficial impact. The design and function of the claystove has inhibited the production of excess fire and smoke that would inflict people.

4. Environmental Impact

A remarkable contribution is the protection and preservation of sound environment by way of smoke emission reduction along cooking activities.

5.Waste Mitigation and waste conversion

The production and use of the double burner claystove dramatically converted untapped and waste materials such as termite mounds and rice hull as resource capital. Likewise, it mitigates the throwing and scattering of other agricultural wastes such as twigs, branches, corn hobs, rice straw, coconut husks and others which are used instead as fuel for cooking.

6.Discovery of Economic use of Untapped Resources

As part of the research, the termite mounds was subjected to soil-diffraction and plasticity tests. Result of the tests has revealed the presence of highly valuable minerals namely: Plagioclase, Amphibole, Mica, and quartz. Such minerals are with high utility in other fields and industry. Also, greater plasticity of termite mounds over the standard clay is recorded which is beneficial in other production and economic activities.

7.Intitutionalized Teaching activities both in theory and practice. It serve as an actual model for a more effective and applied teaching to students and community.

DRAWINGS AND TECHNICAL ASPECTS

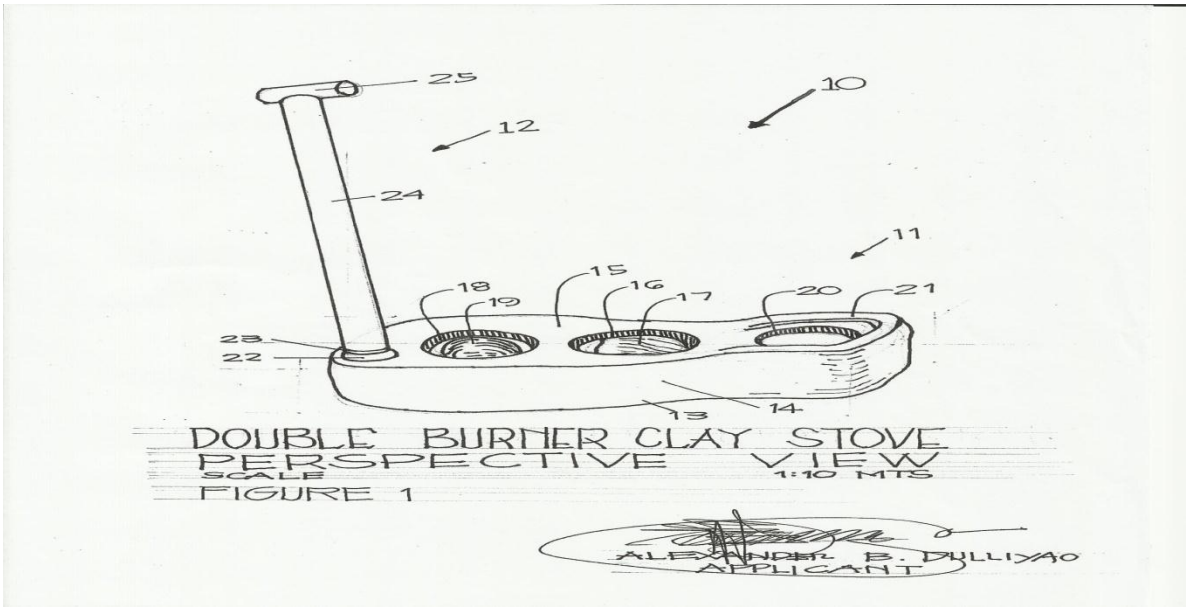
The accompanying drawings and technical descriptions are shown as follows:

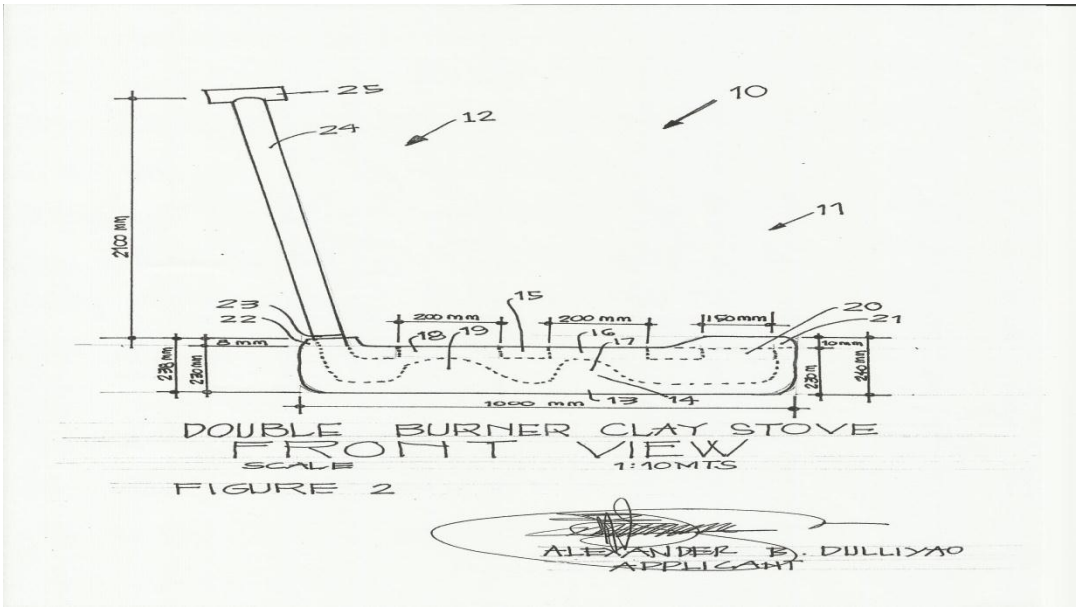
Fig. 1 is an perspective view of the double burner clay stove of a preferred embodiment;

Figure 2 is the front view of the preferred embodiment;

Figure 3 is the rear side view of the preferred embodiment of the utility model;

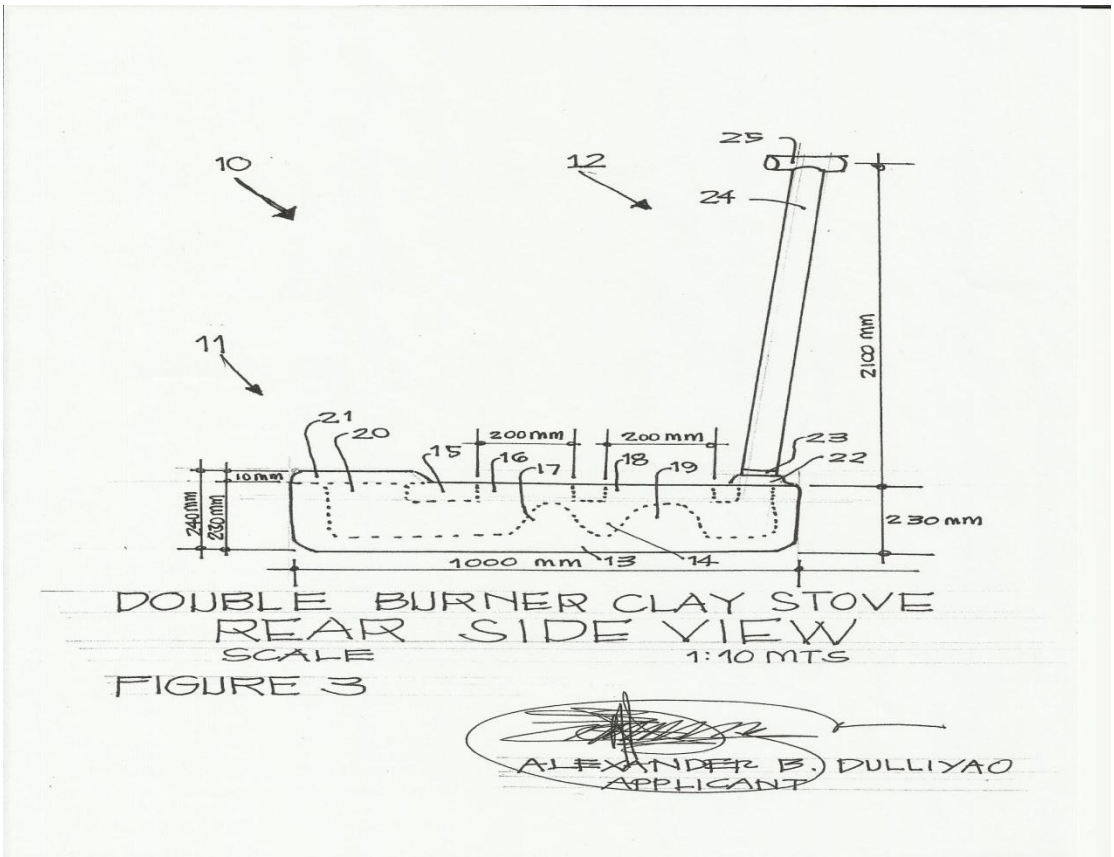
Figure 4 is the cross sectional view of the utility model in use for cooking.





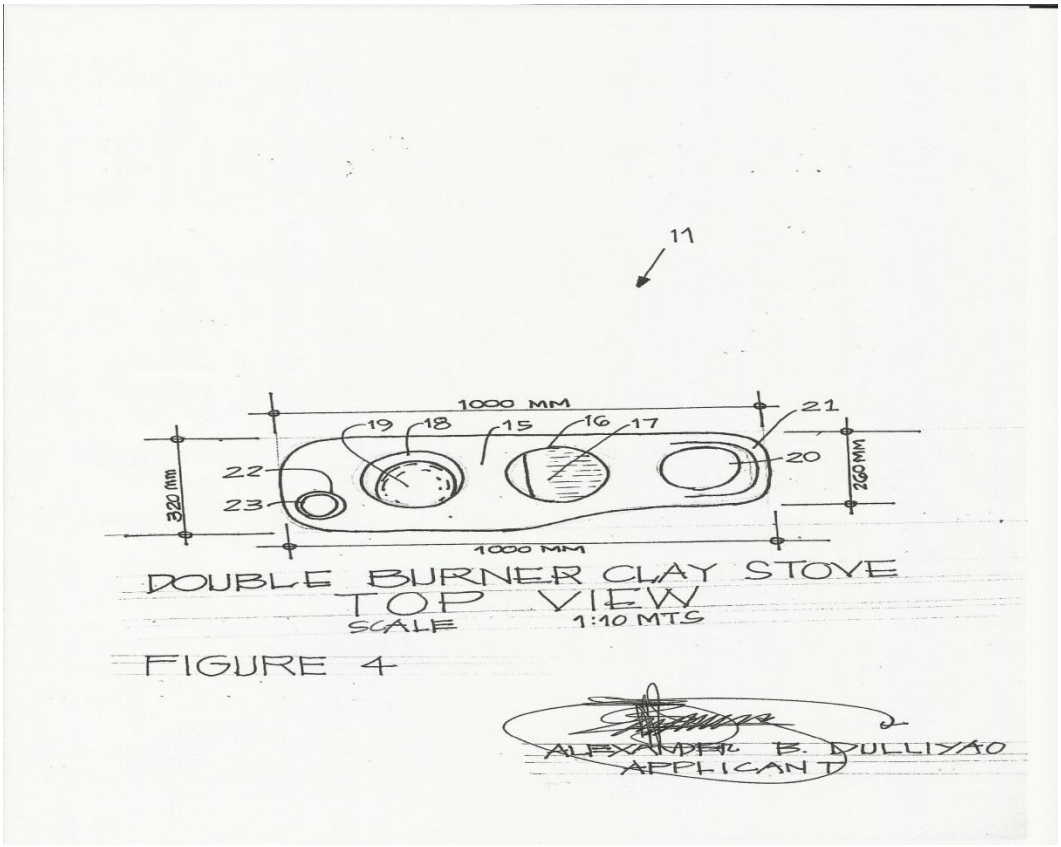
DOUBLE BURNER CLAY STOVE
FRONT VIEW
SCALE 1:10MTS

FIGURE 2



DOUBLE BURNER CLAY STOVE
REAR SIDE VIEW
SCALE 1:10 MTS

FIGURE 3



Detailed Description of the Preferred Embodiment

The preferred embodiment(**10**) as illustrated in Figure 1 is the perspective view of the monolithic double burner cookstove comprising the body(**11**) and a chimney(**12**). The body(**11**) is made up of its base(**13**), walls(**14**), and the top most surface that is the ceiling(**15**). The main pothole(**16**), subordinate pothole(**18**) and firehole(**20**) are carbed conically on the ceiling (**15**) inward or downward the base(**13**). A hump(**17**) is placed inside the body(**11**) that is fixed directly underneath the main pothole(**16**) that is monolithically fused with the base. The hump(**17**) which is semi-circular is inclined upward at 40 degrees with the ridge meeting at 2/3 point of the main pot hole(**16**) which is fixed barely at 15mm away from the ceiling(**15**). The 2/3 point is based at the main pothole(**16**) inorder for the fire to flow directly and hit the center of the pot's bottom to distribute the fire evenly. The subordinate hump(**19**) which is circular is fixed underneath the subordinate pothole(**18**) that is monolithically fused with the base. This is done to retain longer the draft in an evenly distribution of heat hitting the pot's bottom before finally flowing and rising up thru the chimney. An ear(**21**) behind the firehole is purposely formed to support the fuel.

The chimney base mount(**22**) which is located at the edge of the ceiling(**15**) opposite the firehole(**20**)holds securely in place the chimney base(**23)** upon which the chimney trunk(**24**)is being connected. The chimney hat(**25**) is placed on the upper tip of the chimney trunk(**24**). This is used to prevent the entry of the rain water and other foreign objects to the body(**11**) that would surely cause disturbance and malfunctioning of the stove. Likewise, the chimney hat(**25**) will likewise prevent the entry of strong wind that will tend to push the air inward that causes backfiring on the firehole(**20**). The body**11)** is made purely of termite mounds mixed with rice hull.

As shown in Figure 2, the front view of the preferred embodiment(**10**) resembles that of a man's foot where the main pothole(**16**), subordinate pothole(**18**) and the fire hole(**20**) are conically carbed on the ceiling(**15**) inward the body(**11**). The hump(**17**) is seen thru the main pothole(**16**), while the circular subordinate hump(**19**) is fixed underneath the subordinate pothole(**18**) that is monolitically fused with the base. The ear(**21**) is formed behind the firehole(**20**). The chimney base mount (**22**) anchored securely the chimney base (**23**) that is placed on the edge of the ceiling(**15**) opposite the fire hole(**20**).

Figure 3 shows the rear side view of the preferred embodiment(**10**). The main pothole(**16**), subordinate pothole(**18**) and the firehole(**20**) are conically carbed starting on the ceiling(**15**) inward. A semi-circular hump(**17**) is seen thru the main pothole(**16**), while the circular subordinate hump(**19**) is seen thru the subordinate pothole(**18**). The ear(**21**) is formed behind the firehole(**20**). The chimney base mount(**22**) is placed on the opposide edge of the firehole(**20**) to support the chimney base(**23**).

Figur**e** 4 shows the top view of the preferred embodiment(10.

CONCULUSIONS

The research work has successfully developed and produced a low-cost double burner stove that is efficient, convenient, health-wise, environmental-friendly, economical, durable, and made-up of indigenous and inexpensive materials such as termite mounds, rice hull and water which are locally abundant in the area.

Likewise, the research has developed a double-burner claystove that made possible the use and conversion of agricultural wastes in its construction such as rice hull(ipa), as well as the most dreaded termite mounds into capital resources that are useful in producing a very useful cooking stove with the preferred embodiment.