

Performance Determination of Shea Butter As Thermal Storage Material For Domestic Solar Oven

Precious Okwunakwe

*Department of Physics, Kebbi State University of Science and Technology, Aliero
Nigeria*

Isah Umar Bakara

*Renewable Energy Research Centre, Waziri Umaru Federal Polytechnic Birnin
Kebbi, Nigeria*

Abdullahi Bello Umar

*Centre of Excellence-Renewable and Sustainable Energy Studies, Suresh Gyan
Vihar University, Jaipur – India*

ABSTRACT

A solar baking oven was successfully constructed with cheap and locally sourced materials and during the testing data was collected and tabulated. The use of thermal storage material have become a major concern due to this limitation, this paper present the comparative performance of shea butter as thermal storage material for domestic solar oven. The Indian method of testing was adopted. The results reveals that the highest temperature of the oven with storage was 78.6⁰C at about 2:00pmand for without storage was 78.8⁰C around 11:00am it shows clearly that the shea butter help to preserve food stuff in order to keep it warm till the next day. Research on this study more alternative material for thermal storage should be investigated to come up with one that can give the most optimal system performance.

Keywords:*Solar oven, thermal storage, shea butter, efficiency*

INTRODUCTION

The use of kerosene for cooking is presently more common in the urban and suburban cities because of the declining production and poor management and distribution of electricity. The increasing cost of Liquefied Natural Gas due to the bad economic situation in the country also contributed to restriction of the use of liquefied natural gas by only the rich in the society (wood for cooking had also leads to soil erosion, deforestation, desert encroachment, health hazard Vieira de Silva, 2005).In this modern day civilization in environmental control, it has been realized that the use of wood fuel and other biomass, kerosene and liquefied natural gas for cookingintroduces Carbon II Oxide and other greenhouse gases in the household environments and this in great measure contributes to global warming and climate change.

Methodology

Materials

- Galvanized Sheet: will be use as the casing (housing) of some parts of the chamber (side and back of the drying chamber). A 0.9mm thickness of the galvanized sheet was also used for the absorber plate.
- Glass – will be use as the solar collector cover, the drying chamber and for the roofing. It Permits the solar radiation into the system but reduces the flow of heat energy out of the systems
- Net frame for the drying trays.
- Nails and glue as fasteners and adhesives.
- Hinges and handle for the dryer's door.
- Paint (black) and top gum
- Pyranometer is used to measure solar radiation
- Anemometer is used in measuring wind speed

Also, a thermometer was used to measure the ambient and dryer temperature and

- Wood is also use for the assembling of the entire dryer

Absorber Plate

There are many types of absorber plate but in this project a galvanized sheet which has a good thermal conductivity and a thickness of 0.9mm. The sheet was cut in form of a square shape and the inner surface of this sheet was painted black so that it will give high radiation and absorb large amount of heat into the baking chamber. There are two chambers in the absorber plate they are;

- (1) **The First Chamber** is the net carry the bread container and the net length is 59cm by 59cm and a frame was form for the net carry the bread container.
- (2) **The Storage Chamber** which consists of a tray carrying a Shea butter which is about 50cm by 50cm and also makes use of a hanger of about 5cm by 8cm with a width of 3.14cm. This chamber will help in baking bread in the evening because of it storage capacity.

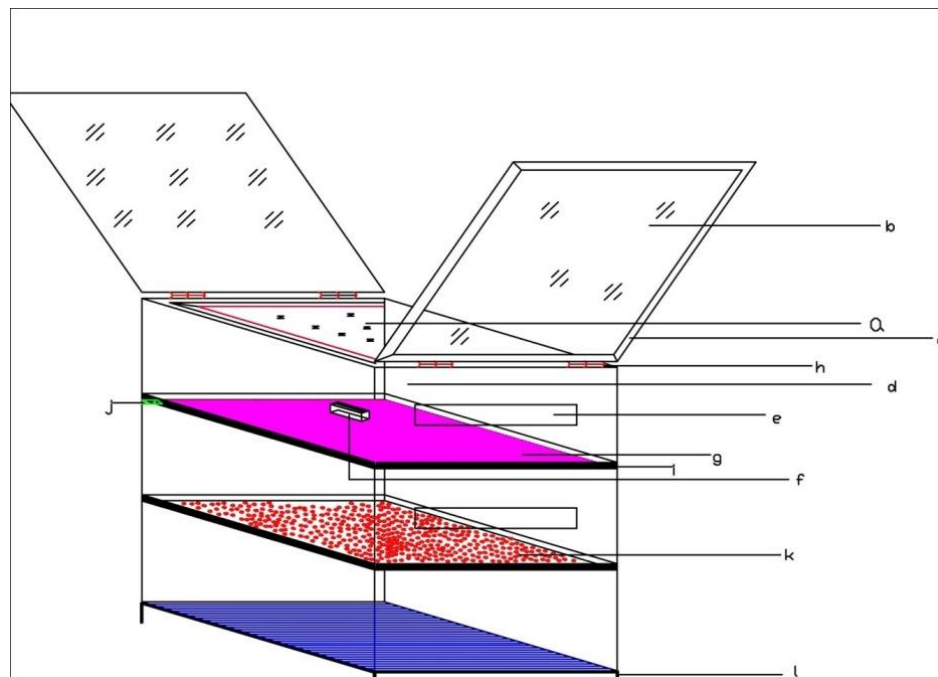


Fig. 1 Designed structure of the baking oven

Table 1:1Showing the system description

S/N	Description	Materials
a	Transparent glass	Glass
b	Reflective mirror	Mirror
c	Mirror frame	Wood
d	Absorber plate	Galvanize sheet
e	Opening	
f	Bread container	Galvanize sheet
g	Net	Iron
h	Hinges	Iron
i	Net Frame	Wood
J	Hanger	Iron
K	Shea butter	
L	Stand	Wood

DATA COLLECTION

In this study, India standard provides testing based on thermal test procedures for solar oven Ayoola *et al.*, (2014). The performance of the reflector based solar oven implemented in this study was done based on India standard, (IS 13429: 2000). The method involved two tests, the free-load test or stagnation test and a load test. Temperatures were measured with thermometer and to measure solar radiation, pyranometer was used. However, wind speed was measured by using digital Anemometer and also relative humidity was measured and recorded respectively. The test on solar oven was done on the month of October and it started at 8:00 am and ends at 6:00 pm. Every twenty (20) minutes data was collected and recorded at the end average hourly data was computed.

RESULTS

The plot shows the baking efficiency (A) and baking efficiency (B) with time. From the plot it was noticed that the efficiency of (B) which is the oven with storage has the highest peak value of 50.6% around 4pm before it finally dropped while baking efficiency of (A) has a peak value of 36.8% and dropped around 3pm.

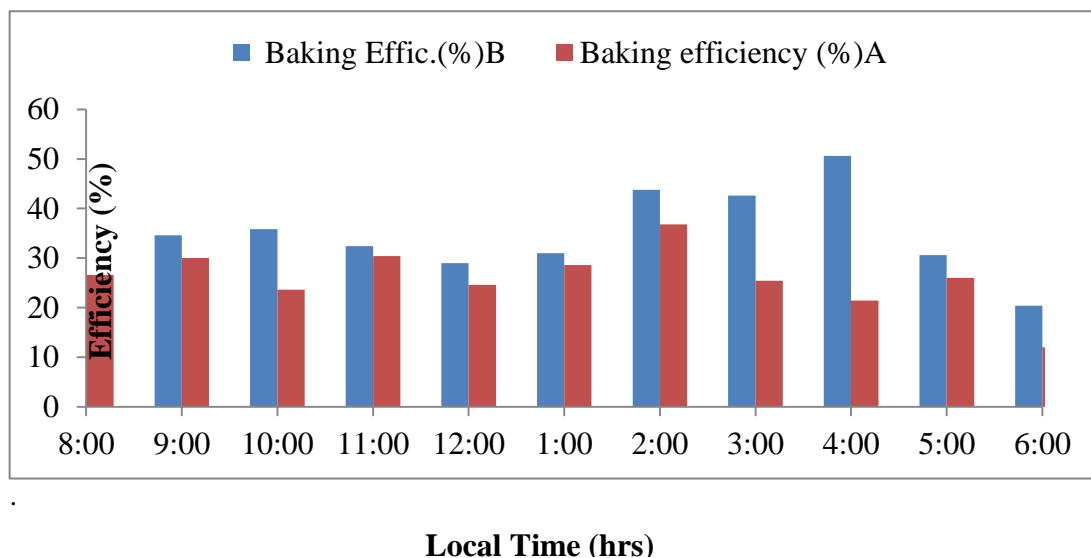


Figure 1.1: Bar chart of baking efficiencies of A and B.

Key: Baking efficiency A is oven without storage and efficiency B is with storage

The plot shows the oven temperature (A) and oven temperature (B) with time. From the plot it was noticed that the highest peak value was from oven temperature (A) which was 78.8°C and oven temperature (B) was 75.6°C it all started decreasing till it dropped.

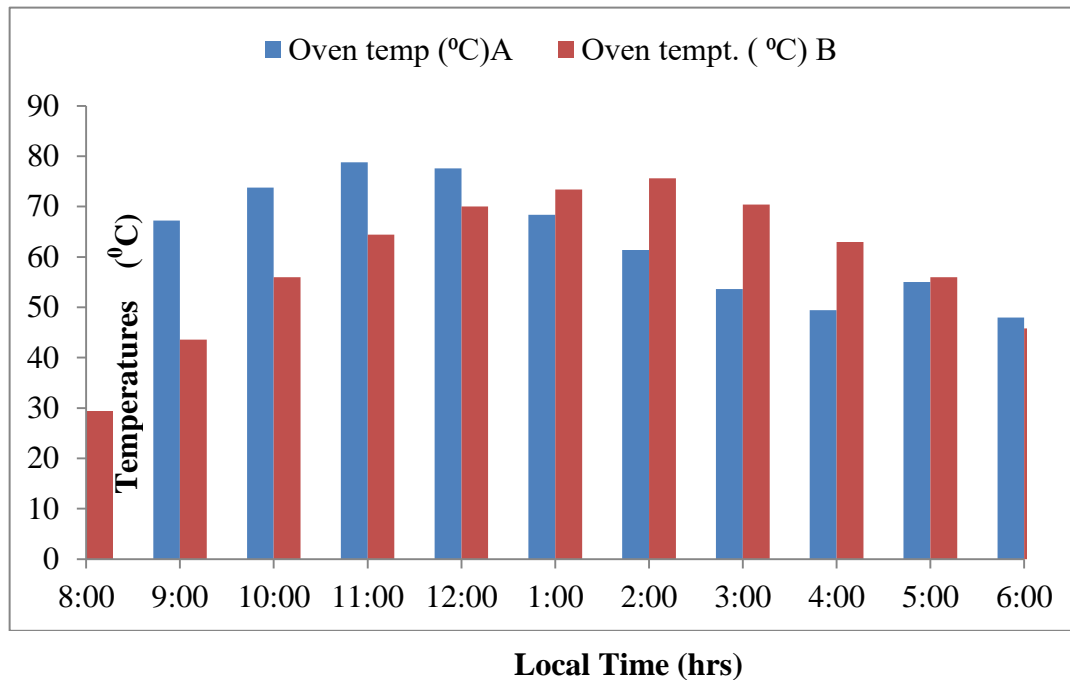


Figure 1.2: Bar chart of oven temperature A and B.

Key: oven temperature A is oven without storage and oven B is with storage.

DISCUSSION

The results of comparative performance of baking oven shows that baking efficiencies of A and B with time. From the plot it was observed that both efficiencies increased with time but baking efficiency A dropped and started fluctuating because of loss of heat from the system and efficiency B obtained the highest peak value 50.6% because the oven gained energy and solar radiation was high. Similarly the oven temperature A and B with time. From the plot it was noticed that both oven temperature A and B increased with time because solar radiation increased when the oven A obtained it highest peak to be 78.8°C because no cloud cover.

CONCLUSION

From the experiment that was carried out it was observed that the use of shea butter as thermal storage material worked perfectly well in order to increase the temperature of the oven to 75.6°C around 2:00 pm. However the use shea butter can also serve as preservative which can keep bread warm till the next day.

Recommendations

Although limitation was encountered during the execution of this research but it gives room for further research. Therefore the following recommendations are given for further researcher.

- ❖ To use aluminum sheet in constructions of solar oven instead of galvanized sheet to compare the oven efficiency of the two materials.
- ❖ Further tests should also be carried out during more sunny days or periods of the year.

- ❖ More alternative material for thermal storage should be investigated to come up with one that can give the most optimal system performance.
- ❖ The size of the reflectors can also be increased for additional solar radiation

REFERENCES

- [1] Ayoola, M. A., Sunmonu, L. A., Bashiru, M. I. and Jegede, O. O., Measurement of net all-wave radiation at a tropical location, Ile-Ife, Nigeria. *Atmosfera*27(3), 305-315, 2014.
- [2] Bald E. J., Ojosu, J. O and Umar, I. H., (2000) "Government Policies and Programmes on the Development of Solar PV Sub-Sector in Nigeria" *Nigeria Journal of Renewable Energy*, Vol. 8, No 1 & 2, Pp. 1 -6
- [3] Ugwoke N.T (1998) "Designed and Measured Performance of a Plane Reflector Augmented Box Type Solar Energy Cooker. M.Engr Project, Department of Mechanical Engineering, University of Nigeria Nsukka.
- [4] Vieira de Silva M.E., Santana L.L., Alves R.D., (2005) "Comparative Study of Two Solar Cooker: Parabolic Reflector and Flat Plate Collector Indirect Heating", *World Climate and Energy Event*, Rio de Janeiro, Brazil Pp.177-203.
- [5] Yusuf S.O, M. MGarba, M. Momoh and D.O Akpootu (2014) performance, evaluation of a box type solar oven with Reflector, the *International Journal of Engineering and Science*, Vol.3, issue 9, pp2-7