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Development of Transparent Glass Heat Absorber Device for Moisture Removal of Farm Produce

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Abstract— *The farm produce dryer uses renewable energy to dehumidify freshly picked vegetables in the farm yard. This apparatus uses clear glass to capture solar energy. The transparent glass within the airtight box absorbed the Sun's rays and the box is directly exposed to the Sun at an of about sixty degrees. An aperture to the drying chamber directed the concentrated warm air produced inside the box to eliminate moisture from the harvested farm products. There are two parts in this renewable farm dryer; the drying chamber and heat generating box. The heat generating box included a rectangular wooden box, reflector foil and transparent glass. Sunlight is converted into thermal energy in this chamber. Convection is the method used to move the heat inside the box to the drying chamber. Lastly, the drying chamber is made up of cuboids, isolating material and wire gauze. This is where the dried harvested plants are located which have an opening which allows heated air to flow from the heat generating chamber.*

Keywords— *Moisture, Closed system, Heat energy, Solar energy, Transparent glass, Convection.*

I. Introduction

Ninety-five percent of the food that a nation's citizens consume comes from Agriculture. These farm produce are not durable and not available all through the seasons. At the time when the raw farm produce eventually reaches the consumer, it is render unfit for ingestion. The majority of the harvested produce is processed and consumed in urban areas, which are distant from the rural areas where farming is practiced. Moreover, agricultural products are unappealing to the consumers during the off-season. This makes farmers to cultivate for themselves to avoid waste of harvested produce. Hence, there is an urgent need to design and construct a renewable farm dryer with local source materials to enable farmers dry the farm produce.

II. Concept of energy

The sun directly produces solar energy through a thermonuclear process. This process generates electromagnetic radiation and thermal energy. The heat remains in the sun and the electromagnetic radiation in the form of visible light, infrared light, and ultra-violet radiation streams out into space in all directions (Umukoro *et al.*, 2021). Only a small portion of the radiation generated reaches the Earth's surface. Solar radiation that reaches the earth is an indirect source of almost all energy used today. To store and transform solar energy into a form that can be used for energy, two crucial elements are required; namely the storage and collector unit. The collector gathers all radiation that hits the surface and transform it into necessary energy form (Veerakumar, *et al.*, 2014). The transparent glass allows rays to pass through it and transforms solar radiant energy to some useful form of energy.

III. Drying principle

Heat is needed during the drying process to remove moisture from agricultural produce, and air circulation is needed to remove the moisture that have been evaporated (Selvaraj, *et al.*, 2017). The moisture in the harvested vegetables is removed when hot air is circulated over it until the hot air is completely saturated (Akachukwu, 2014). The rate of moisture removal depends on the temperature. The higher the temperature, the higher the heat generated and the increase in the moisture removal from the sample. High drying rates and intense heat are necessary for a better dried produce which does not deteriorates with time (Hitesh, *et al.*, 2011).

IV. Transparent glass

The glass used to make the solar collector has a diameter and thickness of 5.0 mm^2. This is a transparent glass material which absorb all the radiation falling on it surface. The glass is made of an area of 48 x 22 inches. The higher the diameter or thickness of the glass, the better its heat absorption. The glass was framed with an aluminum and a rubber isolator. See fig.1 below.

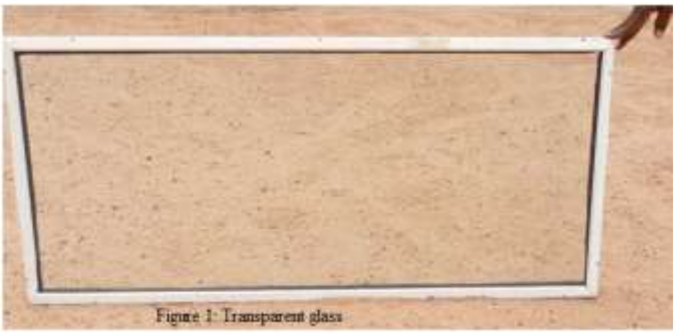

Figure 1: Transparent glass

V. Heat generating chamber

The region of the heat generating chamber is composed of wooden materials of area 46 inches x 22 inches x 8 inches. As shown in fig. 2, the interior of the box was coated in black paint and covered in aluminum foil. The upper end of the heat generating chamber is covered with a transparent glass of area 21 inches x 44 inches x 0.197 inches. The heat box chamber is tilted at an angle of 60^o to the vertical. The glass is aligned

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horizontally across the East and West latitude to allow direct rays on the surface of the collector. The trapped air closed to the aluminum region.

Figure 2: Heat chamber

VI. CHAMBER FOR DRYING

A well-seasoned woods was used to construct the drying chamber and dryer's can withstand termite and atmospheric wind attack. The cuboids chamber is made up of area of 33 inches x 22 inches x 35 inches. The interior of the dryer is covered with aluminum foil, which distributes the heated air evenly among the agricultural products. The lower end of the drying chamber contains an opening area of 22 inches x 10 inches. This is the portion where the heat generating box is inserted interlocked to the drying chamber. An access door was made on the drying chamber at the back view of the cuboids. The door will enable the farmer inserts the farm produce's samples into the dryer. The door is lagged with an isolating material to prevent the system from heat loss to the environment. The front and back views of the drying chamber box are shown in fig.3(a-b) below.

Figure 3a: Drying chamber

Figure 3b: Completed dryer system

VII. WEIGHING

Utilizing an electronic scale, the moisture content of the collected plants was ascertained as shown in figure (a-b). The weight of the harvested crops' moisture content was measured using the weighing device both before and after drying.

Figure 4a: Yam sample

Figure 4b: Plantain sample

Evaluation;

$$M_C = \frac{W_f - W_d}{W_f} \times 100$$

where

M_c = moisture content of dried farm produce (%)

W_f = weight of fresh farm produce (g)

W_d = weight of dried produce (g)

Moisture loss from yam and plantain in the month of May, 2022.

$$M_{yam} = \frac{8885 - 1342}{8885} \times 100$$

$$= \frac{7543}{8885} \times 100$$

$$= 0.8489 \times 100$$

$$= 85\ \%$$

$$M_{plantain} = \frac{1084 - 459}{1084} \times 100$$

$$= \frac{625}{1084} \times 100$$

$$= 0.5766 \times 100$$

$$= 58\ \%$$

Moisture loss from yam and plantain in the month of November, 2022.

$$M_{yam} = \frac{8885 - 620}{8885} \times 100$$

$$= \frac{8265}{8885} \times 100$$

$$= 0.9302 \times 100$$

$$= 93\,\%$$

$$M_{plantain} = \frac{1084 - 234}{1084} \times 100$$

$$= \frac{850}{1084} \times 100$$

$$= 0.7841 \times 100$$

$$= 78\,\%$$

Table1: Analyzed proximate compositions and minerals content of dried yam and plantain in month of May, 2022

Minerals	Yam (%) per 100g	Plantain (%) per 100g
MC	9.52	10.80
Fat	0.35	2.90
CP	4.10	13.60
Ash	2.70	1.80
C Fiber	1.00	3.80
NFE	83.35	67.90
K(mg/kg)	0.33	256.00
Ca(mg/kg)	0.05	136.00
Mg(mg/kg)	0.20	389.00
P(mg/kg)	0.10	214.00
Fe(mg/kg)	1.00	3.63
N_a(mg/kg)	0.02	239.00

Table2: Analyzed proximate compositions and minerals content of dried yam and plantain in month of November, 2022

Minerals	Yam (%) per 100g	Plantain (%) per 100g
MC	8.10	9.21
Fat	0.35	2.90
CP	4.10	12.60
Ash	2.70	1.80
C Fiber	1.00	3.80
NFE	82.35	67.90
K(mg/kg)	0.33	256.00
Ca(mg/kg)	0.05	136.00
Mg(mg/kg)	0.20	379.00
P(mg/kg)	0.10	214.00
Fe(mg/kg)	1.00	3.63
N_a(mg/kg)	0.02	236.00

VIII. Conclusion

The glass absorber dryer device have high performance for heat generation and absorption when exposed to sun rays. The moisture content of the farm produce were determined freshly and after the drying. The results from the dryer system as depicted in Table 1 have moisture content of 9.52 % for yam and 10.80 % for plantain during the wet season. Also, table 2 showed moisture content of 8.10 % and 9.21 % for yam and plantain during dry season. From this values, the amount of water lost from farm produce is high during the dry season compared to the rainy season. Hence, farm produce with high percentage of moisture cannot be preserved for long period. All the same, the proximate composition analyzed indicates that no nutrients and mineral were lost when the device was employed for the harvested plants.

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