DESIGN AND CONSTRUCTION OF A SOLAR DRYER FOR FOOD PRESERVATION

By

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A PROJECT REPORT SUBMITTED TO THE DEPARTMENT OF MECHANICAL ENGINEERING, FEDERAL UNIVERSITY OYE-EKITI, IKOLE EKITI CAMPUS

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OCTOBER, 2017.

DECLARATION

I declare that the work in this project is as a result of my findings and analysis in the process of designing the project. It has not been submitted in candidature of any student in any university. All works that has been benefited from are all duly acknowledged and referenced.

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CERTIFICATION

This is to certify that this project was carried out by IGWUIRO, DARLYNTON CHIKA, a student of Mechanical Engineering, Faculty of Engineering,Federal University Oye Ekiti, Ekiti State.

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DEDICATION

This project work is dedicated to the Almighty God who is my creator and guardian, without him this project won't be a success. He was with me through it all, financially, morally and physically. I also dedicate this work to my parents Mr. and Mrs. Igwuiro, after God, they are next in my life.

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My greatest appreciation goes to the Only Wise, Gracious and Merciful God for being my Pillar through thick and thin of this study. He is faithful indeed!

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ABSTRACT

This project presents the design, construction and performance of an indirect type solar dryer for food preservation. The solar dryer utilizes solar energy to heat up air and to dry any food substance loaded, which is beneficial in reducing wastage of agricultural product and helps in preservation of agricultural product. Based on the limitations of the natural sun drying (that is exposure to direct sunlight) liability to pests and rodents, lack of proper monitoring, and the escalated cost of the mechanical dryer, a solar dryer is therefore developed to cater for this limitation. In the dryer, the heated air from the solar collected is naturally convened through the cabinet and carries moisture from the item to be dried also, the drying cabinet absorbs solar energy directly through the transparent walls and roof.The performance evaluation was conducted using pepper.The results obtained during the test period revealed that the temperatures inside the dryer and solar collector were much higher than the ambient temperature during most hours of the day-light exhibiting sufficient ability to dry food items reasonably and rapidly to a safe moisture level. The results also indicate that moisture loss in solar dried vegetable was faster that the open dried sample and as such make the solar dried product of lesser tendency to mould and bacterial growth.

CHAPTER ONE

1.0 INTRODUCTION

1.1: Background of the Study

Agricultural produce like vegetables are of great nutritional and health importance since they make significant contribution in supplying essential vitamins, minerals, antioxidants, fibres and carbohydrates that improve the quality of the diet and also contains constituents that have health benefits and anti-disease factors, such as antioxidants and polyphenols. These components are known to scavenge harmful free radicals that are associated with incidence of cancer and heart diseases (Cao G., Sofic E., Prior R.L.1996).

Unfortunately, fresh fruits and vegetables are not only seasonal but highly perishable since the moisture content is more than 80%, they are classified as highly perishable commodities (Orsat, V., Changrue, V., Raghavan, G.S.V. 2006) As a result they deteriorate very fast few days after harvesting, losing almost all their required quality attributes and some could likely result to total waste. Drying is an excellent way to preserve food and solar food dryers are appropriate food preservation technology for sustainable development. Drying was probably the first ever food preserving method used by man, even before cooking. It involves the removal of moisture from agricultural produce so as to provide a product that can be safely stored for longer period of time (Scalin D. 1997). Fruits and vegetables are dried to enhance storage stability, minimize packaging requirement and reduce transport weight. Drying is a suitable alternative for post-harvest management especially in developing countries where exist poorly established low temperature distribution and handling facilities. It is noted that over 20% of the world perishable crops are dried to increase shelf-life and promote food security (Grabowski, S., Marcotte M., Ramaswamy, H.S. 2003)

Moreover, products with low moisture content can be stored at ambient temperatures for long period of time due to a considerable decrease in the water of the material, reduced microbiological activity and minimized physical and chemical changes. (Vlachos NA, Karapantsios TD, Balouktsis AI, Chassapis D. 2002). Dried vegetables are more concentrated than any other preserved form of foodstuffs and are tasty, nutritious, light weight and easy to prepare, store and use (Yaldyz, O and Ertekyn, C. 2001).

Sun drying is the earliest method of drying farm produce known to man and it involves simply laying the agricultural products in the sun on mats, roofs or drying floors. This has several disadvantages since the farm produce are laid on the open sky and there is greater risk of spoilage due to adverse climate conditions like rain, wind, moist and dust, loss of produce to birds, insects and rodents (pests); totally dependent on good weather and very slow drying rate with danger of mould thereby causing deterioration and decomposition of the produce. The process also requires large area of land takes time and highly labour intensive (GEDA, 2003). With cultural and industrial development, artificial mechanical drying came into practice, but this process is highly energy intensive and expensive which ultimately increases product cost (GEDA, 2003). Recently, efforts to improve sun drying have led to solar drying. Solar dryers are specialized devices that control the drying process and protect the agricultural produce from damage by insects, pests, dust and rain. In comparison to natural sun drying solar dryers generate higher temperatures, lower relative humidity, and lower product moisture content and reduce spoilage during the drying process. In addition, it takes less time to dry produce and is relatively inexpensive compared to artificial mechanical drying method. Thus, solar drying is a better alternative solution to all the drawbacks of natural drying and artificial mechanical drying (GEDA, 2003).

The Nigerian stored product Research Institute has developed techniques for the storage of fruits, vegetables and tubers. These methods are not strictly solar dependent, may in some cases require high-energy like refrigeration. It is believed that these inventions cannot be practically transferred to the rural-poor farmers in the society, since they may require financial inputs which are not within their reach.

The revival of solar drying of the more perishable agricultural products (like fruits and vegetables), appears to be a promising method of reducing post-harvest losses, improving rural incomes and contributing to self-sufficiency, even of reducing some imports through substitution products.

However, there is an objection over sun-drying as a preservative method that considerable amount of nutrients are lost during this process due to heat. Therefore, this study is aimed at evaluating the effect of the sun-drying on the nutritive properties of Tomatoes, Pepper.

1.2: Statement of the Problem

Most agricultural products such as fruits and vegetables are seasonal in Nigeria. The immediate effect of poor storage facilities is that farmers are robbed of benefits accruable from their hard labour, as they hurriedly disposes off their product at give-away prices, to save then the situation of helplessly watching their produce rot away. This serious lack of opportunity for adequate economic return reduces farmer's incentive and consequently their desires to produce more and as such there is need to device a measurement that could encourage and enhance the preservation and storage of agro-produce at least for some period of time before usage. Solar energy drying technology appears the best option for such measure.

However, the concept of solar drying to mitigate the above challenge is nonetheless without some major problems such as inability to undertake drying process over the night or during off sunshine hours. A solar dryer that could dry agricultural products during the off sunshine periods could have an advantage over an ordinary dryer and will be of great benefits. Its utilization could pose no burden to farmers.

1.3: Objectives of the Study

The present study is aimed to:

i. Design and construct a solar dryer for drying agricultural produce.

ii. Dry agricultural produce using the post-harvest heat storage solar energy crop dryer with pepper as test sample.

1.4: Justification of the Study

The small-medium scale solar dryer when developed and commercialized, will help the rural farmers by bridging the large scale industrial techniques and the traditional method of drying. The solar dryer can now dry large quantity of pepper and other vegetables with better quality and relatively better efficiency than the traditional method. The solar dried products were of high quality. Further processing of the dried crops will involve packaging for commercial purposes. This will also help in making these agricultural produce available in a relatively cheap prices in off season and also avert micronutrient deficiencies in diet especially among the low income groups in Nigeria.

1.5 Scope of the Project

In order to reach the project's objective, the following scopes are identified:

i. Designed a solar dryer according to the information obtained from the literature.

ii. Acquire materials needed is suitable for fabrication.

iii. Performance of solar dryer for collector efficiency, drying air temperature and weight loss will be compared with different types of drying method.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Concept of Solar drying

Solar drying is a simple process of removing excess water or moisture from a product in order to reach the requirement of standard specification moisture content that frees the product from damage. Reducing moisture content of food product down to a certain level slows down the action of enzymes, bacteria, yeasts and molds. Thus food can be stored and preserved for long time without spoilage. Dehydrated food, when ready to use, is re-watered and almost regains its initial conditions. Solar drying is one of the most important post-harvest processes for agriculture product. It can extend shelf life of the product, improve the quality and reduce post-harvest losses due to waste. The transportation cost is also reduced as the weight is less since the water is taken out from the product during the drying process. (Alamu, O.J; Nwaokocha, C.N and Adunola,O. 2010). Murthy in the year 2009 also defines the solar drying process as a process where the solar radiation is used to evaporate the moisture present in the product (Murthy, M.V. R. 2009). The solar energy is used to heat large volume of air and this air is allowed to flow over the product to remove and take away the moisture. Drying by solar energy is an economical procedure for agricultural products, especially for medium to small agriculture industry, to prevent excess of damage product after long storage. It is friendly to the environment. It used for domestic up to small size drying of crops, agricultural products and food product, such as fruits, vegetables and herbs where its contribute significantly to the economy of small agricultural communities and farms. Traditionally, direct sun drying was performed by spreading the product on the platform directly under the sun without any cover. However this method has many disadvantages including:

1) No scientific observations during long period of drying. The whole process depends on the experience of unskilled labor.

2) No standard control on the final quality of the final dried product, it is just based on observation and experience.

3) Very slow rate process, depending on the nature of the product and weather condition.

4) The product is exposed directly to all kinds of weather changes, such as rain and strong winds which can rot or destroy the material. Bad weather conditions on the other hand facilitate growing of bacteria and molds.

5) They have very large qualitative and quantitative losses due to natural attack conditions closely related to the open-air procedure such as dusting, rotting when weather conditions are not favorable, attacks by insects, rodents, birds and other unpredictable conditions. In other words, the quality of finished product is inconsistent and difficult to control.

To overcome these problems, solar dryer was developed. Solar dryer is an equipment which uses solar energy to heat up air and dry the food product. A solar dryer minimizes almost all the problems faced during conventional sun drying method, thus improving the quality of the dried product. In comparison to conventional sun drying, the use of appropriate solar dryers leads to a reduction of the drying time up to 50% and to a significant improvement of the product quality in terms of color, texture and taste. Furthermore, contamination by insects and micro-organisms can be prevented (Belessiotis, V. and E. Delyannis, 2010). The storage losses can be reduced to a minimum while the shelf life of the products can be increased significantly.

The conditions in tropical countries make the use of solar energy for drying food practically attractive and environmentally sound. Dryers have been developed and used to dry agricultural products in order to improve shelf life (Esper.A and Muhlbauer.W, 1996). Most of these either use an expensive source of energy such as electricity (El-Shiatry, M.A.; Muller, J. and Muhlbauer, W. 1991) or a combination of solar energy and some other form of energy (Sesay, K. and Stenning, B. C. 1997).

Most projects of these nature have not been adopted by the small farmers, either because the final design and data collection procedures are frequently inappropriate or the cost has remained inaccessible and the subsequent transfer of technology from researcher to the end user has been anything but effective (Berinyuy, J. E. 2004). The total cultivated area and production of mango in Sudan, year 2003, was estimated to be about 21,809 hectares and 442,330 tons respectively.

Mango falls into the group of fruit crops, used for food by both human being and animals. At harvest, this product usually contains too much moisture (about 25%-35%) which is a favorable environment for the growth of moulds (fungi) and insects that normally cause grain damage. In order to avoid this, drying of the mango must be done to reduce the moisture content to about (10 to 11%) for safe year-round.

A survey was carried out on ordinary sun drying method and it was found out that the existing method was very tedious, time wasting, wastage, in terms of produce and consequently having a very low hygienic level. The direct exposure to sunlight, or more precisely ultraviolet radiation, can greatly reduce the level of nutrients such as vitamins in the dried product. As a solution to these problems enumerated above, an idea was conceived and a Distribution Passive Solar Energy Maize Dryer was designed, fabricated, and tested. The aim of this research work therefore, is to design, construct and test a Simple Solar Dryer with roughened surface air heater to dry at least 1kg of mango slices.

The design consists of two major sections made in one unit:

1.The flat collector upon which solar energy is incident, transmitted and absorbed to heat air which is passed by natural convection to the drying chamber;

2. The drying chamber which contains the grains being dried.

The air having passed over the grains becomes saturated with water and is discharged through the chimney to avoid condensation of water vapor in the event that the system temperature falls.

Open air and uncontrolled sun drying is still the most common method used to preserve and process Agricultural product but uncontrolled drying suffers from serious problem of wind born dust, infestation by insect, product may be seriously degraded to the extent that sometimes become market valueless and resultant loss of and have to the food quality may have adverse economic effects on domestic and international market.

2.2. Classification of Solar dryer

Solar dryers are available in a range of size and design and are used for drying of various agricultural products. Various types of Dryers are available in the market as per requirement of farmers. Primarily all the drying systems are classified on the basis of their operating temperature ranges that is High Temperature solar dryer and Low Temperature Solar dryer. Following criteria's are required for the classification of solar dryer:-

1) Air movement mode
2) Insulation exposure
3) Air flow direction
4) Dryer arrangement
5) Solar contribution
6) Type of fruit to be dried

2.2.1Direct Solar Dryer

It is a type of dryer in which solar radiation is directly absorbed by the product to be dried. it is also called as natural convection cabinet dryer since the solar radiation is directly fall on the product, the quality of product is reduced. This dryer comprises of a drying chamber that is covered by a transparent cover made of glass or plastic. The drying chamber is usually a shallow, insulated box with air-holes in it to allow air to enter and exit the box.

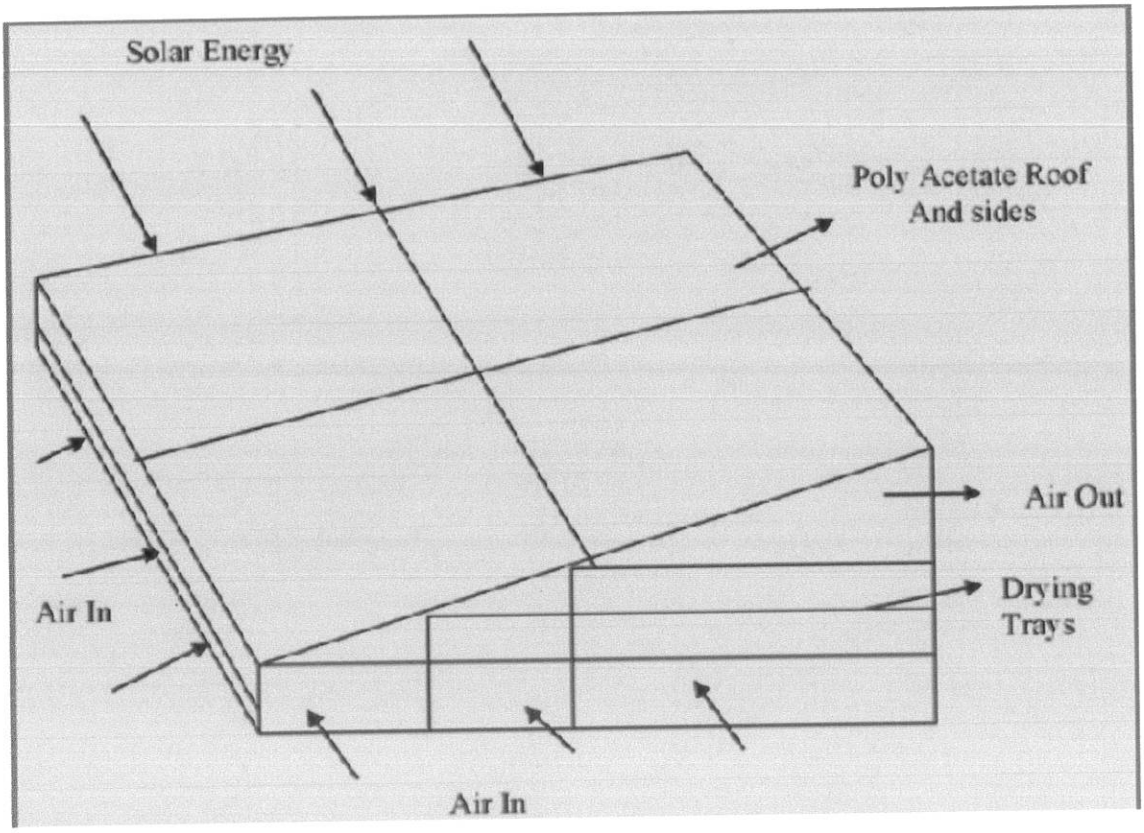

Fig1.A schematic of a simple direct dryer (Murthy, M.V. R. 2009).

2.2.2 Indirect Solar Dryer

The solar radiation gained by the system is utilized to heat the air which flows through the product to be dried in this dryer. In this of dryer quality of product improved though drying rate increased. Heated air is blown through the drying chamber. At the top of drying chamber vents are provide through which moisture is removed. In indirect type of solar drying systems a better control over drying is achieved.

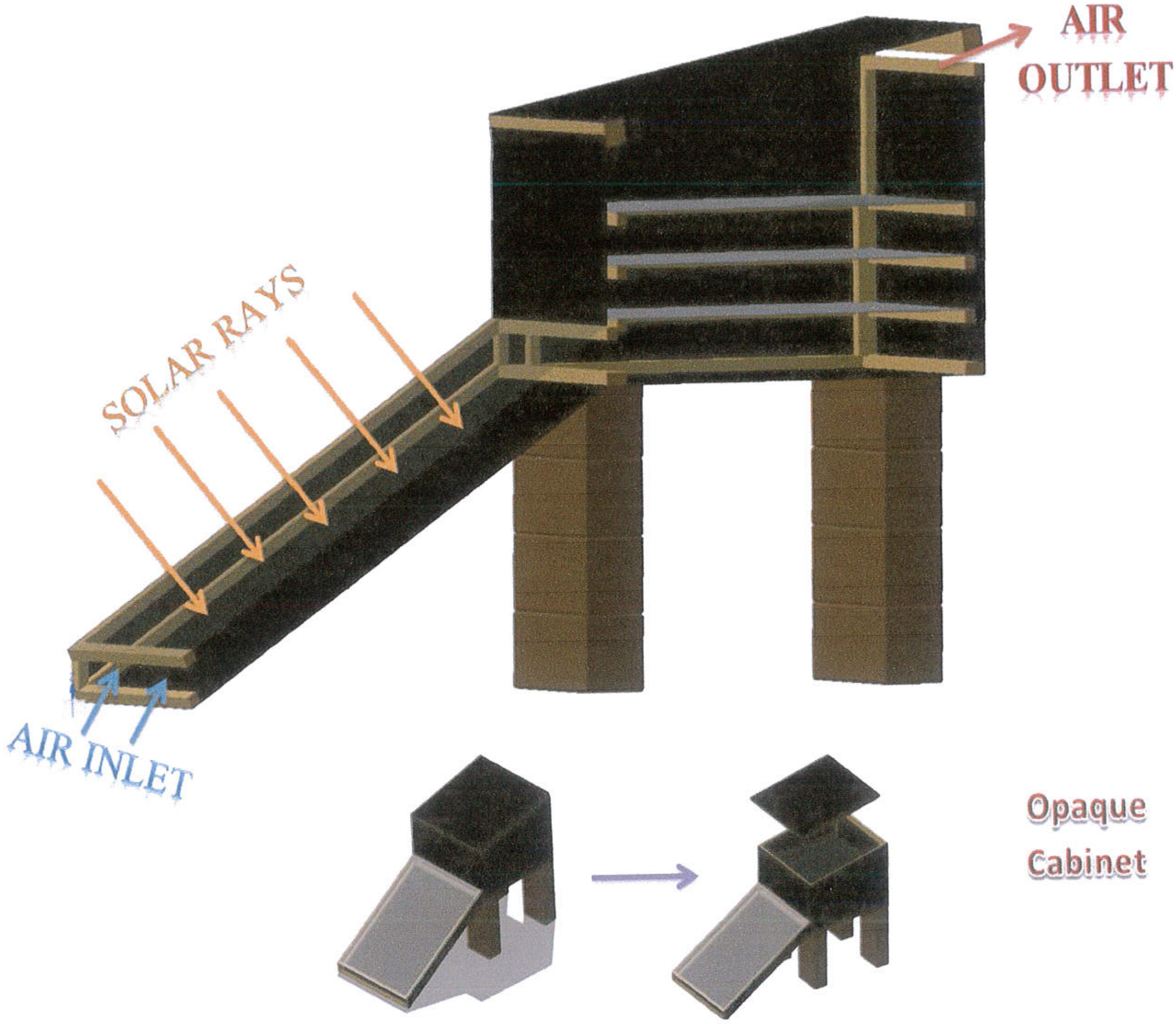

Fig2.indirect solar dryer (Scalin.D. 1997).

2.2.3 Forced Convection and Natural Convection Solar Dryer

Forced convection- In this type of dryer air is forced through a solar collector and the product bed by a fan or a blower, normally referred to as active dryer.

Natural convection – In this dryer natural movement of air takes place thus called as passive dryers. The heated air flow is induced by thermal gradient.

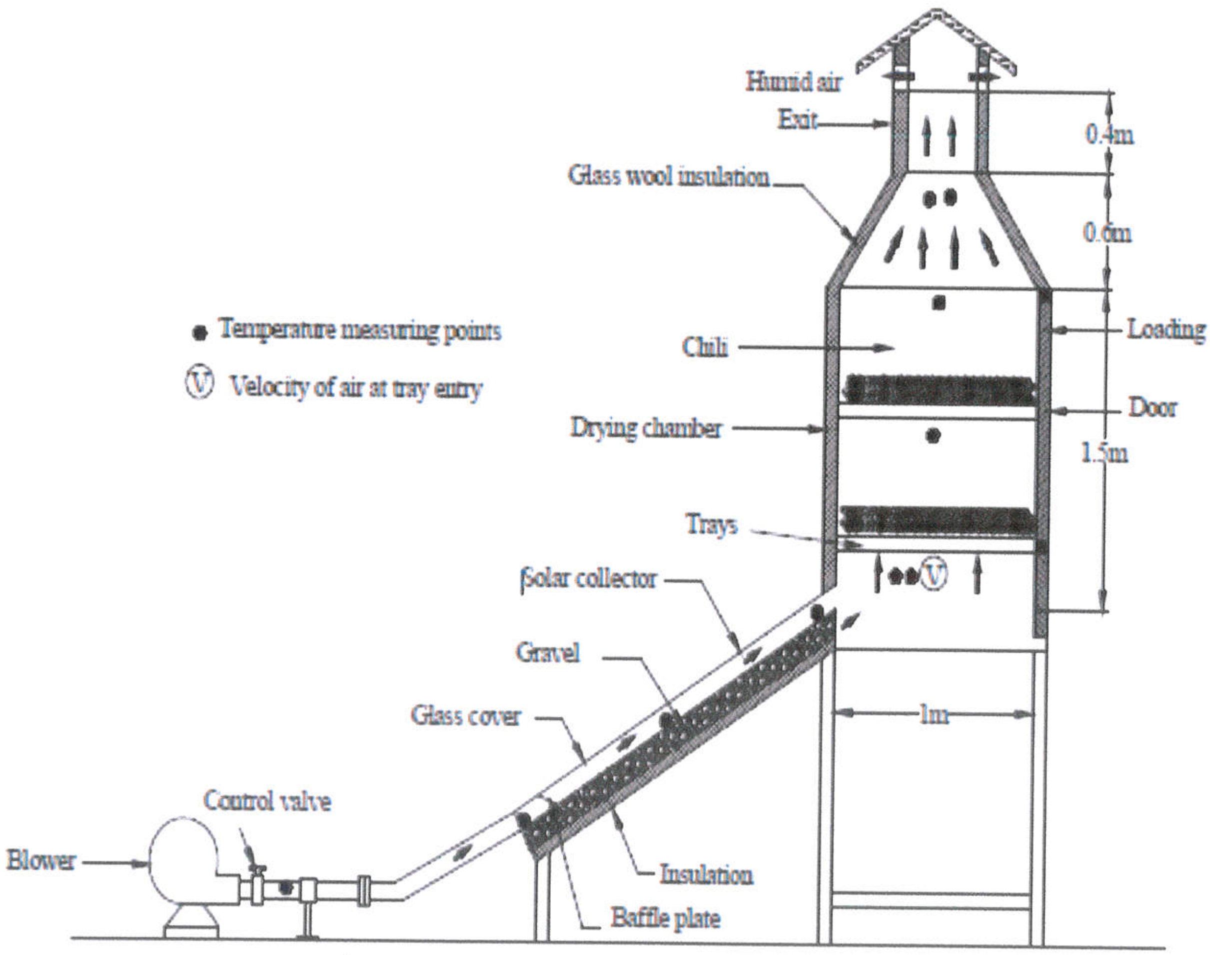

Fig3.A forced convention solar dryer (Ekechukwu, L and Norton, S.D. 1999).

2.3 A review of already design and developed solar dryer

Natural convection solar dryers which are suitable for the drying of most crops has been designed and developed, the design is a simplified design of the typical greenhouse type natural convection solar dryer. It consists of a cylindrical polyethylene-clad vertical chamber, supported structurally by a steel framework and draped internally with a selectively absorbing surface (Ekechukwu, L and Norton, S.D. 1999). They reported that performance of the dryer studied was dependent largely on the variations in ambient temperature and relative humidity.

The results obtained from experimental solar chimneys in this study, if designed properly could maintain chimney air temperatures consistently above the ambient temperature which would enhance the desired buoyancy induced airflow through the chimney and drying rate. Linear correlations have been obtained between the drying rate measured experimentally and a group of ambient and crop parameters. It has been reported that the large scale tunnel type solar dryer using polycarbonate cover have been tested and demonstrated potential of drying chili, coffee and banana (Janjaia, S; Srisittipokakuna, N; and Balab, B.K. 2011).. The black painted solar absorber surface raises the efficiencies of the dryers. In general, the solar dryer offers much superior quality product compares to open sun drying. Sethi and Arora (2009) in their work, designed a greenhouse drying system completely made of glass fiber as shown in the figure 2.4

Fig4. A greenhouse solar dryer (Sethi and Arora, 2009)

He made this with a glass fibre of thickness 1.2mm and he actually achieved a result well satisfactory. From this, I used glass to cover some parts of my solar dryer.

M. Mohanraj and P. Chandrasekar (2008) designed for the performance of an indirect forced convection solar drier integrated with heat storage material. They fabricated and investigated it for chili drying. The drier with heat storage material enables to maintain consistent air temperature inside the drier. The inclusion of heat storage material also increases the drying time by about four (4) hours per day. The chili was dried from initial moisture content 72.8% to the final moisture content about 9.2% and 9.7% (wet basis) in the bottom and top trays respectively. They concluded that, forced convection solar drier is more suitable for producing high quality dried chilli for small holders. Thermal efficiency of the solar drier was estimated to be about 21% with specific moisture extraction rate of about 0.87 kg/kW h.

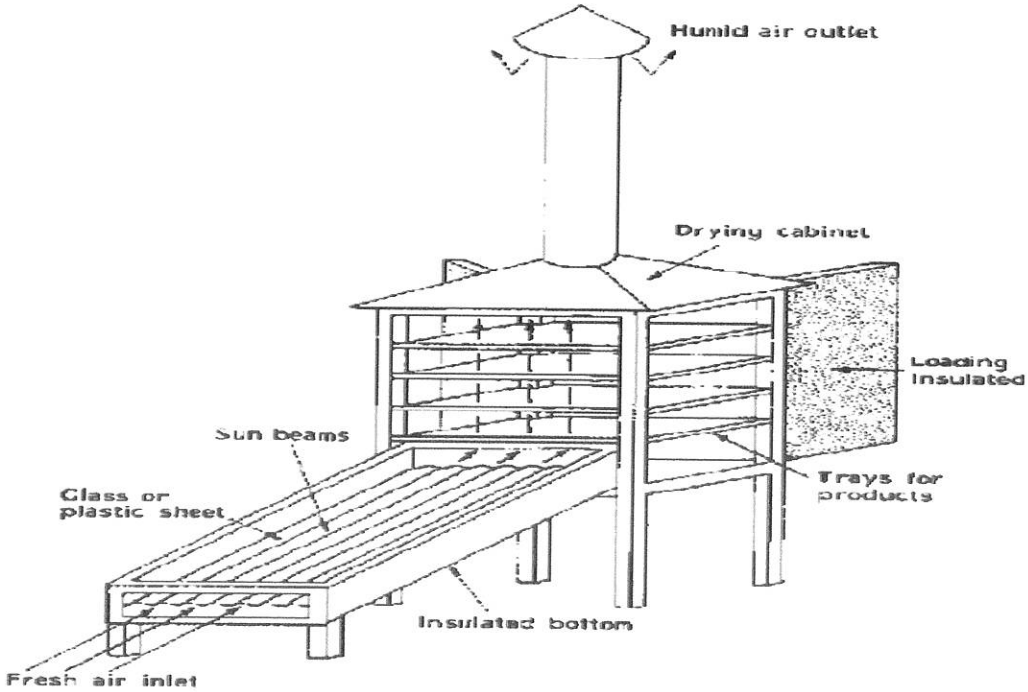

Fig5: indirect solar drier with forced convention (M. Mohanraj and P. Chandrasekar, 2008)

Bukola O. Bolaji and Ayoola P. Olalusi (2008) built a simple and inexpensive mixed mode solar dry locally source materials. The temperature rise inside the drying cabinet was up to 24°C (74%) for a hours immediately after 12.00(noon). The drying rate, collector efficiency and percentage of moist removed (dry basis) for drying yam chips were 0.62 kgh-1, 57.5 and 85.4% respectively. The dryer's sufficient ability to dry items rapidly was a quality designed with it. The drier is as shown below.

I put a roller at the stands of the drier to ease its mobility so that one does not necessary carry the drier but may just push with ease to any location for drying.

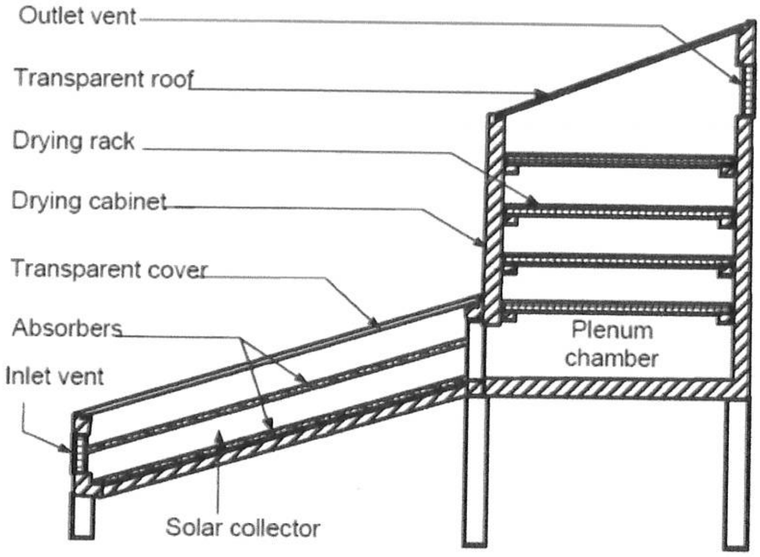

Fig6: Mixed solar dryer (Bukola O. Bolaji and Ayoola P.Olalusi, 2008)

Bukola O. Bolaji and Ayoola P. Olalusi (2008) Designed, constructed and tested the solar wind-ventilated cabinet dryer in Nigeria on latitude 7. 5oN.Comparatively, drying with the solar cabinet dryer showed better results than open air-drying. During the period of test, the average air velocity through the solar dryer was 1.62 m/s and the average daylight efficiency of the system was 46.7%. The maximum drying air temperatures was found to be 64°C inside the dryer. The average drying air temperature in the drying cabinet was higher than the ambient temperature in the range of 5°C in the early hours of the day to 31°C at mid-day.80% and 55% weight losses were obtained in the drying of pepper and yam chips, respectively, in the dryer. The design was equipped with wind ventilator which I did not put in my own design. This is because I want to reduce cost. I used only vent instead of ventilator.

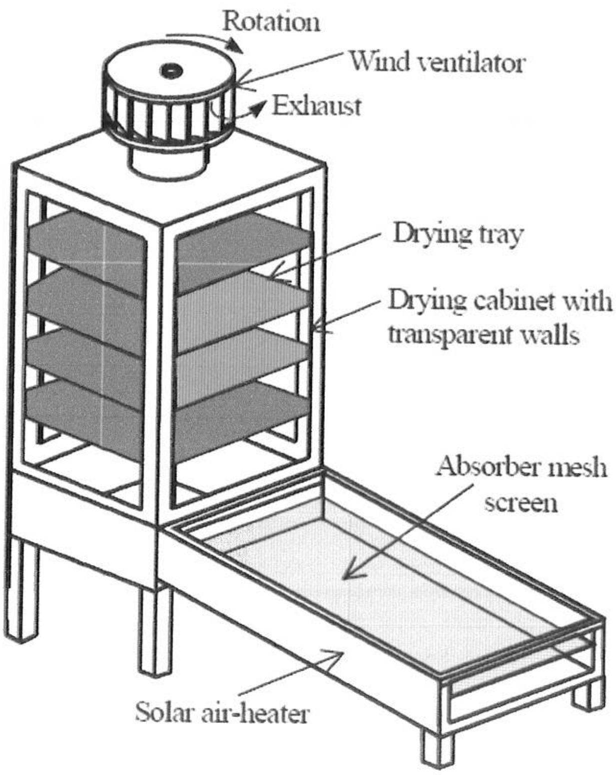

Fig7. An indirect solar dryer with ventilator (Bukola O. Bolaji and Ayoola P. Olalusi. 2008).

Ahmed AbedGatea (2010) designed and developed solar drying system for maize with V-groove collector of 2.04 m^2 area, drying chamber and blower. The thermal energy and heat losses from solar collector were calculated for each three tilt angles (30°, 45°, 60°). The results obtained during the test period denoted that the maximum gained energy occurred at 11 o'clock hour and then gradually declined since the maximum solar radiation occurred at this time.

CHAPTER THREE

3.1 MATERIALS AND METHOD

3.1: Materials Used for the Solar Dryer Construction

The following materials were used for construction of the passive solar dryer:

- Mild Steel Sheet: was used as the casing (housing) of some parts of the chamber (side and back of the drying chamber). A thick mild steel sheet was also used for the absorber
- Glass – was used 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.
- Galvanized iron frames for the drying trays (wire mesh).
- Nails and glue as fasteners and adhesives.
- Insect net at air inlet and outlet - to prevent insects from entering into the dryer.
- Hinges and handle for the dryer's door.
- Paint (black)
- A thermometer was used to measure the ambient and dryer temperature.

3.2: Sample Preparation

The vegetables (pepper) used for this work was purchased barely two days after harvest. The samples were then divided into two parts; one part was subjected into open sun drying whereas the other one was loaded into the passive solar.

3.3: Design Considerations

1. Temperature

The minimum temperature for drying food is 30°C and the maximum temperature is 60°C, therefore. 45°C and above is considered average and normal for drying vegetables, fruits, crop seeds and some other crops.

2. Design

The design was made for the optimum temperature for the dryer. T_0 of 60°C and the air inlet temperature or the ambient temperature T_1 = 30°C (approximately outdoor temperature).

3. Air gap

It is suggested that for hot climate passive solar dryers, a gap of 5 cm should be created as air vent (inlet) and air passage.

4. Glass or flat plate collector

It suggested that the glass covering should be 4-5 m thickness. In this work, 4mm thick transparent glass was used. It is also suggested that the metal sheet thickness should be of 0.8 – 1.0 m thickness; here a Galvanized steel of 1.0mm thickness was used. The glass used as cover for the collector was 103 × 100cm2.

5. Dimension

It is recommended that a constant exchange of air and a roomy drying chamber should be attained in solar food dryer design, thus the design of the drying chamber was made as spacious as possible of average dimension of 100 ×103 × 76 cm3 with air passage (air vent) out of the cabinet of 90 × 10cm2. The drying chamber was roofed with glass of 100 × 103 cm2. This is to keep the temperature within the drying chamber fairly constant due to the greenhouse effect of the glass.

6. **Dryer Trays**

1cm^2 mesh wire was selected as the dryer screen or trays to aid air circulation within the drying chamber. Two trays were made having wooden edges. The tray dimension is 96 × 98 cm of 2.5cm × 2.5cm wooden sticks used as frame.

3.4: Description of the Solar Dryer

The solar dryer consists of a solar collector (air heater), a drying chamber, heat storage unit and drying trays. The solar crop dryer is constructed of framed angle iron and transparent glass cover. Figures below shows the various parts and the sectional view of the solar dryer

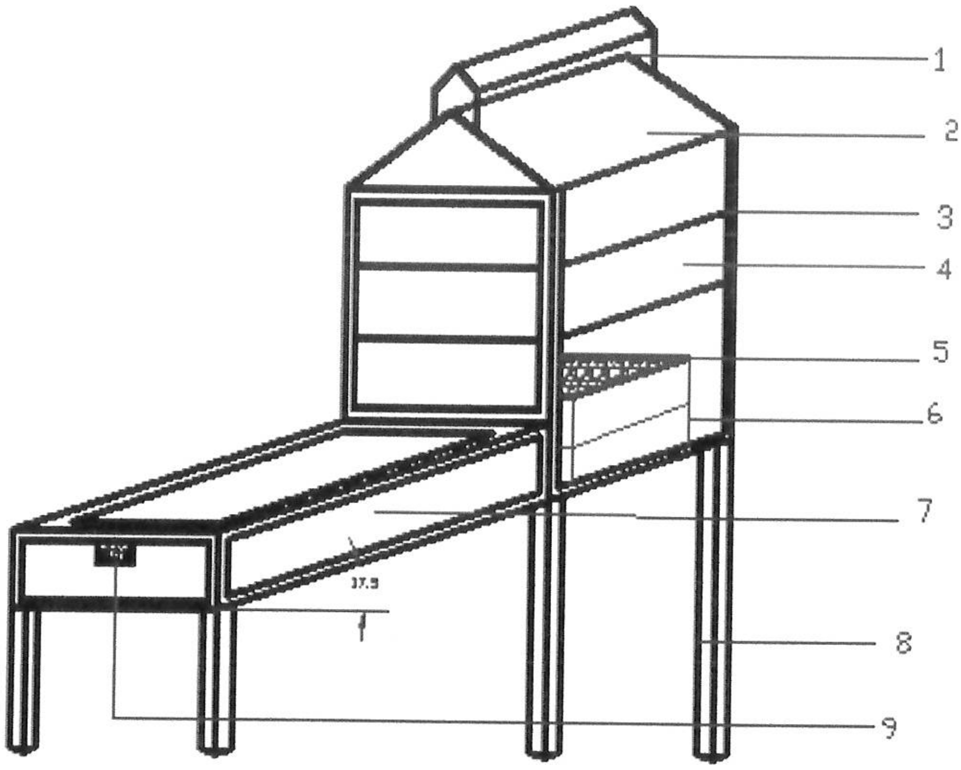

Fig 8: isometric view of the Passive Solar dryer with various parts

1: Chimney 2: Glass roof 3: Drying tray 4: Drying chamber 5: Heat Storage unit 6: Heat storage support 7: Collector 8: Support 9. Air inlet

Fig9.The constructed solar dryer

CHAPTER FOUR

4.0 RESULT AND DISCUSSION

4.1 Drying with solar dryer vs open sun drying

Chili was dried with the solar dryer and the same quantity was also exposed to open sun drying at the same time in Ikole campus, the result of drying is as shown below

Table 1: Difference in drying with solar drier and conventional drier of 200g of chili

No. of hours Drying	Drying with Solar Drying (g)	Open sun Drying(g)	Moisture removed by Solar Dryer(g)	Moisture removed by conventional drying(g)
2	190.8	195.3	9.2	4.7
4	171.3	182.5	19.5	12.8
6	155.5	173.4	15.8	9.1
8	127.8	159.1	27.7	14.3

The relative efficiency of the dryer after eight (8) hours of drying is calculated below:

4.1.1 Parameters for Conventional drying gotten from the above table

Initial mass of chili = 200g

Final mass of chili = 159.1g

Efficiency of Conventional drying is therefore calculated as the initial mass of the chili used for testing conventional drying subtracted from the final mass after drying and then divided by the initial mass for testing, that is;

Efficiency of conventional drying $= \frac{\text{initial mass} - \text{final mass}}{\text{initial mass}} = \frac{200-159.1}{200} = 0.2040$

4.1.2 Parameters for solar dryer gotten from the above table

Initial mass of chili = 200g

Final mass of chili = 127.8g

Efficiency of Solar drying is therefore calculated as the initial mass of the chili used for testing in the Solar dryer subtracted from the final mass after drying and then divided by the initial mass for testing, that is;

Efficiency of Solar drying $= \frac{\text{initial mass} - \text{final mass}}{\text{initial mass}} = \frac{200-127.8}{200} = 0.361$

Relative efficiency is derived by dividing the efficiency gotten from conventional drying by the efficiency gotten from the Solar dryer that is;

Relative efficiency $= \frac{0.2047}{0.361} = 0.574$

4.2 Ambient temperature vs. temperature of the dryer

The plot below shows the variation in the ambient temperature compared to the temperature of the solar dryer under the same atmospheric condition, it was found that temperature in the solar dryer is about 25% more than the ambient temperature as calculated below:

Table 2. Temperature variation in the drier

Time (hours)	Ambient Temperature (°c)	Temperature of dryer (°c)	Percentage Increase (%)
10:00 am	27	29	7%
12:00 pm	33	55	66%
2:00 pm	44	72	63.6%
4:00 pm	40	56	40%

The above table shows that there is an increase in temperature in the solar dryer compared to the ambient temperature in the environment. Furthermore the table above also shows that the best time to get the best efficiency from the dryer is around 2.00pm as there is the highest increase in temperature.

The results obtained shows that the relative efficiency of the solar is satisfactory because some other designs have less efficiency.

CHAPTER FIVE

5.0 CONCLUSION AND RECOMMENDATION

5.1 CONCLUSION

With reference to the results obtained in chapter four above, the solar dryer constructed has proved to be an efficient and effective means of drying agricultural products. To save time, the solar dryer is an indispensable means of drying products. The results further show that the solar dryer makes the product dried very safe from wind borne diseases and this means that the overall health safety of any product dried with this dryer is high.

Monitoring convectional drying during drying time from animals such as goats and fowls are waste of time, this solar dryer has the advantage of drying even when one is not there.

The product so dried is also kept in an enclosed chamber and dried with the door locked and this means the product is saved from burglars and this makes the overall advantage over the convectional drying.

5.2 RECOMMENDATION

The use of solar drying system should be made compulsory in this country and as such, eating dried foods will be safer.

The solar dryer can be improved on in other to come up to a way of regulating the amount of heating/drying effect of the dryer. This will make drying in the cabinet to be a controlled one.

Finally, I recommend to the federal government especially the federal ministry of agriculture, to supply a large quantity of solar dryer to the local farmers to make agricultural product safe from spoilage and from health threat and risk of wind borne diseases.

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