Development of a Low Cost Solar Dryer.

A.K. Ogunkoya, M.Eng.*; K.O. Ukoba, B.Sc.; and B.A. Olunlade, M.Eng.

Engineering Materials Development Institute, Akure, Ondo State, Nigeria

E-mail: tjoguns607@yahoo.com*

ABSTRACT

A low cost solar dryer was developed as part of major effort made to boost the acceptability of locally dried produce (e.g., pepper, tomatoes, okoro, etc.) against importation and the willingness of Nigerian government to encourage the adequate processing of home grown produce. It has been observed that food crises in most developing countries are due in part to the inability to preserve food surpluses rather than solely due to low production. In Africa, a majority of the farmers are subsistence farmers and affording hi-tech facilities and equipment has been a major problem. This work involves the development of an inexpensive point-of-use dryer that can dry perishable produce within few hours during the dry season. The materials used for the dryer development were locally sourced, therefore making it easily assessable and affordable. As of November, 2009, a unit of the dryer cost less than ₦ 6,000 Nigerian (approximately $40 U.S.).

(Keywords: development, low-cost solar dryer, produce, food storage, preservation)

INTRODUCTION

The food problem in most developing countries worldwide is due in large part to the inability to preserve food surpluses at the local level rather than low production. Food crops are usually for immediate consumption needs, resulting in wastage of food surpluses during the short harvest periods and scarcity during post harvest periods. Drying is one of the most efficient methods used to preserve food products for longer periods. It has been established as the most efficient preservation technique for most tropical crops (Tatedo, 2010).

Traditional Solar Drying

The traditional method of drying, known as 'sun drying', involves simply laying the product in the sun on mats, roofs, or drying floors. The major disadvantage of this method is contamination of the products by dust, birds, and insects (some percentage will usually be lost or damaged). The process is labor intensive, results in nutrient loss (such as vitamin A), and the method totally depends on good weather conditions. Because the energy requirements (Sun and wind) are readily available in the ambient environment, little capital is required. This type of drying is frequently the only commercially used and viable methods in which to dry agricultural products in developing countries.

The safer alternative to open sun drying is solar dryer. This is a more efficient method of drying that produces better quality products, but it also requires initial investments. If drying conditions such as weather and food supply are good, natural circulation solar energy, solar dryers appear to be increasingly attractive as commercial proposition.

Solar Dryer

A solar dryer is an enclosed unit, to keep the food safe from damage, birds, insects, and unexpected rainfall. The food is dried using solar thermal energy in a cleaner and healthier way. Basically, there are four types of solar dryers;

- Direct solar dryers – in these dryers the material to be dried are placed in a transparent enclosure of glass or plastic. The sun heats the material to be dried and the enclosure causes a heat build up due to the "green house effect" the drier chamber is usually painted black to absorb the maximum amount of heat.

•Indirect Solar Dryers – in these dryers, the Sun does not act directly on the material to be dried. The indirect nature of the solar heat makes these devices useful in the preparation of those crops whose vitamin content can be destroyed by sunlight; the products are dried by hot air heated by the sun.

•Mixed Mode Driers – in these dryers the combined action of solar radiation incident on the material to be dried and the air preheated in solar collector provide the heat required for the drying operation.

•Hybrid Solar Dryers – in these dryers, although the Sun is used to dry products, other technologies are used to cause air movement in the dryers. Examples include fans powered by solar PV.

In Nigeria, a majority of the farmers are subsistence farmers and affording hi-tech facilities and equipment has been a major problem. A majority of substance farmers farm perishable produces which if not preserved can lead to wastage. This has forced them in the past to either sell the produce at give-away prices or throw away the produce due to spoilage. The need for a dryer that can function effectively and efficiently with minimal maintenance, yet is inexpensive to purchase or construct, lead to this work.

METHODOLOGY

The Drying Process

The process of dehydration consists of removal of moisture from the food by heat, usually in the presence of a controlled flow of air. Water content of properly dried food varies from 5 to 25 percent depending on the food. Successful drying depends on:

•Enough heat to draw out moisture, without cooking the food;

•Dry air to absorb the released moisture; and

• Adequate air circulation to carry off the moisture.

When drying foods, the aim is to remove moisture as quickly as possible at a temperature that does not seriously affect the flavor, texture, and color of the food.

Materials

The major materials used for the development of the low cost solar dryer include, wood, transparent glass, black gloss paint, a hack saw, nails, zinc sheeting, wood glue, a glass cutter, abrasive paper, a measuring tape, and a tri-square.

Method

The direct solar method and the mixed mode were used in the construction of this unit. The working principle is shown below:

The solar rays enter the cabinet through the cover material. When reaching the solar collector or the tray surface, the solar energy is converted into heat raising the temperature inside. The heat energy is transferred to the food to be dried.

The heated food gives out water vapor and dries out. Gradually, the heated moist air rises and leaves the drying chamber through the air outlet at the high end of the drier as shown in the Figure 1.

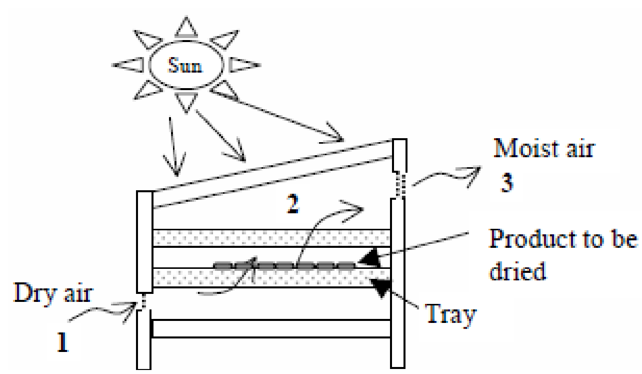

Figure 1: Principle of Direct Solar Dryer.

Steps Involved in the Construction

Step 1: The solar dryer was modeled and simulated using Pro/Engineering software. It was then analyzed using Ansys and Pro/Mechanica as shown in Figures 2 and 3.

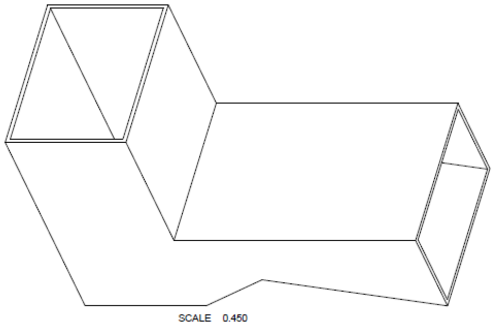

Figure 2: The Modeled Solar Dryer for Model 1.

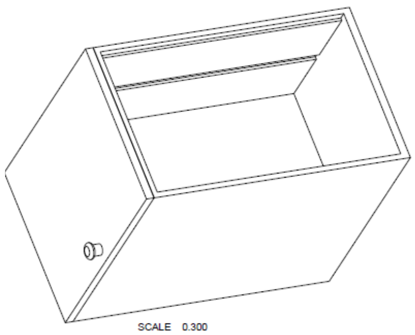

Figure 3: The Modeled Solar Dryer for Model 2.

Step 2: Measuring tape was used to measure the required dimension of the wood, zinc sheet, and glass and they were marked out and cut appropriately.

Step 3: The parts (starting with the wood and then the zinc sheet) were assembled and 4" nails were used to fasten them together.

Step 4: The inner part of the assembly was then painted black to be able to absorb the incident rays of the Sun.

Step 5: The cut out glass was then placed/added to the assembly as shown in Figure 4 and 5.

Step 6: Finishing operations was then done. The wood was sand-papered with abrasive paper, the zinc sheet was repainted for smoothness and other finishing operations were as well carried out.

Figure 4: Mixed Mode Solar Dryer.

Figure 5: Direct Mode Solar Dryer.

The dryer was tested in November, 2009 (with average sunshine for northern Nigeria). It took about 3 hours for fresh pepper, tomatoes, and okro, to be dried to a level suitable for long term food storage (Figure 6).

Figure 6: The Dried Produce.

CONCLUSION

This project has been able to establish that, the need for a dryer that can function effectively and efficiently with minimal maintenance, yet is inexpensive to construct, is both possible and achievable. The overall cost and choice of materials would promote mass production and hence, it can be a substitute to the expensive conventional dryers thereby making it assessable and affordable by local farmers.

REFERENCES

1. Ajayi, C., Sunil, K.S., and Deepak, D. 2009. "Design of Solar Dryer with Turboventilator and Fireplace". International Solar Food Processing Conference 2009.

2. Hankins, M. 1995. *Solar Electric System for Africa*. Commonwealth Science Council: Marlborough House, Pall Mall, London, UK.

3. Soboyejo, W.O. 2009. "Sustainable Design Workshop and Lecture". National Agency for Science and Engineering Infrastructure (NASENI) Abuja, Nigeria.

4. Tanzania Traditional Energy Development and Environment Organization (Tatedo). 2010. "Solar Drying Technology for Poverty Alleviation, Environment Conservation and Sustainable Rural Development". Tanzania.

ABOUT THE AUTHORS

Engr. A.K. Ogunkoya is a Research and Development Officer at the Engineering Materials Development Institute, Akure, Nigeria. He holds a Master of Engineering (M.Eng) in mechanical engineering (production option) and is also a registered Mechanical Engineer (R.17,140) with the Council for the Regulation of Engineering in Nigeria (COREN). His research interests are in the areas of operation research, design, modeling and simulation.

Mr. K.O. Ukoba is a Design and Simulation Engineer in the Manufacturing Department, Engineering Materials Development Institute, Akure, Nigeria. He holds a B.Eng. degree in Mechanical Engineering and is currently doing his M.Eng. in Mechanical Engineering. His research interests are in the areas of design/simulation, materials (testing and synthesis), corrosion, and ergonomics.

Engr. B.A. Olunlade is Deputy Director Engineering (currently, the Acting Director/CEO) of the Engineering Materials Development Institute, Akure, Nigeria. He holds a Master of Engineering (M.Eng) degree in mechanical engineering (production option) in mechanical engineering as well as a Masters degree in Business Administration and currently studying for his Ph.D. in Mechanical Engineering. He is a registered Mechanical Engineer (R6550) with the Council for the Regulation of Engineering in Nigeria (COREN). His research interests are in the areas of design, tools design, production/manufacturing and automation.

SUGGESTED CITATION

Ogunkoya, A.K, K.O. Ukoba, and B.A. Olunlade. 2011. "Development of a Low Cost Solar Dryer". *Pacific Journal of Science and Technology*. 12(1):98-101.

Pacific Journal of Science and Technology