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Solar Agricultural Dryer Design for Fruits and Vegetables

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Abstract

Drying is one of the oldest methods of preserving food. The solar drying system utilizes solar energy to heat air and to dry any food substance. It brings about a substantial reduction in weight, volume, minimizing packing, storage, and transportation costs, and enables storability of the product under ambient temperatures. This paper presents the design and construction of solar agricultural dryer which can be used for drying various products in rural areas under hygienic conditions. The solar dryer was constructed consisting of a solar collector cum drying chamber. The area of the solar agricultural dryer is $0.112m^2$ (0.556x0.435x0.465 m) and has been painted black to absorb maximum solar radiations. The air allowed in through inlet heats the dryer where it is utilized in drying (removing the moisture content from the food substance or agricultural produce loaded. Moreover, locally available materials were used for construction.

INTRODUCTION

Drying is an excellent way to preserve food, and solar food dryers are appropriate food preservation technology for sustainable development [1]. Drying was probably the first ever food preservation method used by man, even before cooking. It involves the removal of moisture and agricultural produce to provide a product that can be safely stored for a longer period. In rural areas drying of fruits and vegetables is carried by spreading the products on the ground or roofs with exposure to the sun in the open air. Sun drying method may be an efficient and cheap process but has disadvantages such as contamination by dirt, insects, birds, rodents, and bacteria and due to adverse climatic conditions like rain, wind, moist, etc. The process also requires a large area of land takes time, and highly labour intensive [2]. To protect the products from above mentioned disadvantages and also to accelerate the time of drying and control the final moisture of the product, with reducing wastages because of bacterial action, different types of solar dryers like direct or indirect solar dryers can be used. 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 [2]. Recently, efforts to improve sun drying have led to solar drying.

Solar dryers are specialized devices that control the drying process and protect agricultural produce from damage by birds, insects, rodents, dust, and harsh adverse climatic conditions. The most important advantage of the solar dryer is an economically feasible alternative to other available energy sources. This paper discusses the design of a low cost solar agricultural dryer that can be constructed in a rural area from locally available building materials.

Importance of Solar Food Dryer

For centuries, people of various nations have been preserving fruits, other crops, meat, and fish by drying. Drying is also beneficial for hay, copra, tea, and other income producing non-food crops [3]. With solar dryer being available everywhere, the availability of all these farm produce can be greatly increased. It is worth noting that until around the end of the 18th century when canning was developed, drying was one of the major methods of food preservation [3]. The energy input for drying is less than what is needed to for freezing or canning, and storage space is minimal compared with that needed for canning jars and freezer containers. Moreover, the nutritional value of food is minimally affected by drying [4]. Also, food spoilage is minimal by reducing the moisture content of food to 10 to 20%. Microorganisms are effectively killed when the internal temperature of the food reaches 145°F [4]. The flavour and most of the nutritional value of dried food is preserved and concentrated [1]. Dried food does not require any special storage equipment and is easy to transport [1]. Dehydration of vegetables and other food crops by traditional methods of open-air sun drying is not satisfactory, because the products deteriorate rapidly [3]. Studies showed that food items dried in a solar dryer were superior to those which are sun-dried when evaluated in terms of taste, colour, mold counts [5, 6]. Solar dried foods are quality products that can be stored for extensive periods, easily transported at less cost while still providing excellent nutritive value. This paper, therefore, presents the design and construction of solar agricultural dryer.

Solar dryers are a very useful device for:

- Agricultural crop drying.
- Food processing industries for dehydration of fruits and vegetables.
- Fish and meat drying.
- Dairy industries for the production of milk powder.

- Seasoning of wood and timber.
- Textile industries for drying of textile materials, etc.

Thus, the solar dryer is one of the many ways of making use of solar energy efficiently in meeting man’s demand for energy and food supply.

Design and construction of the dryer

The most commonly seen design types are of cabinet form (a wooden box with glass cover). For the design consideration, the greenhouse and thermosiphon principles are the theoretical basis. The simple solar food dryer consists of a solar collector cum drying chamber, which is accommodated with a tray made up of wire mesh on which the potato slices are placed for drying (figure 1). The average dimension of the dryer was 0.556 by 0.435, with a height of 0.555 m. The dryer was supported by four legs 0.1m each. The top side of the dryer has an angle of 43°. The transparent, 8mm thick glass was used. The glass used as a cover for the dryer was 0.535x0.43 m. There is an air vent (or inlet) on one side of the drying chamber where air enters and is heated up by the greenhouse effect by the direct sunlight and the air passes through tray around the food, removing the moisture content and exists through the air vent (or outlet) on the other side of the dryer. The hot air acts as a drying medium, and it extracts the moisture from the potato slices to the atmosphere under free (natural) convection. Thus the system is a simple solar dryer, and no mechanical device is required to control the intake of air into the dryer. The minimum temperature for drying potato slices is 29.1°C, and the maximum temperature is 74.6°C. Therefore 45.5°C and above is considered average for drying potato slices [3].

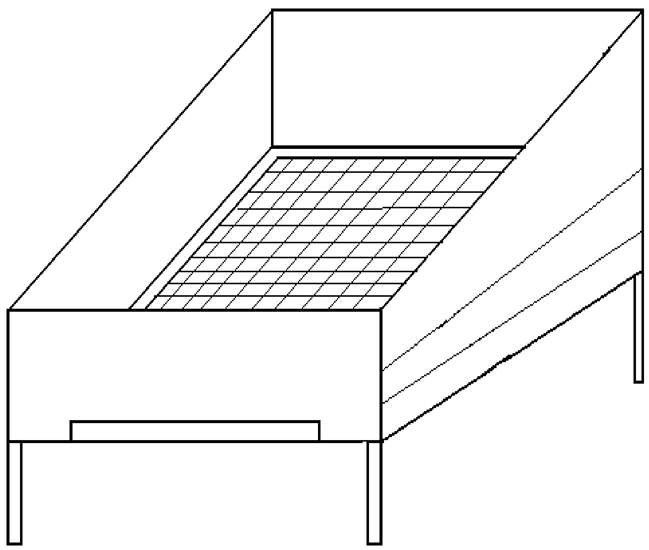

Figure 1. Solar agricultural dryer

Materials Used

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

Plywood: as the casing (housing) of the entire system; plywood was selected being the good insulator and relatively cheaper than metals.

Glass: as the cover for the collector cum drying chamber. It permits the solar radiation into the system but resists the flow of heat energy out of the systems.

Mild steel sheet of 1mm thickness painted black from inside for absorption of solar radiation.

Wire mesh - for constructing of the tray.

Design Calculations

The angle of tilt (β) of the solar collector cum dryer chamber was calculated based on the formula given below [7]:

$$\beta = 33.9° + \text{lat } \Phi \quad (43)$$

Where lat Φ is the latitude of the solar collector cum drying chamber. The latitude of Awantipora where the dryer was designed and used is 33.9 N.Hence, the suitable value of β use for collector cum drying chamber comes to 76.9^0

CONSTRUCTIONS

The solar food dryer was constructed making use of locally available and relatively cheap materials. Since the entire casing is made of plywood, and the cover is glass, the major construction work is carpentry works (joinery). The construction was made with simple butt joints using nails as fasteners and glue (adhesive) where necessary. The metal sheet used was mild steel of 1mm thickness. It is painted black for maximum absorption and radiation of heat energy. The glass was cut into 0.535x0.43 cm size to cover the dryer. The glass used was clear with 8mm thickness. The tray was made with wire mesh and nails to permit the free flow of air within the dryer. The interior of the simple solar dryer was painted black to promote absorption of heat energy while as the exterior was painted with black and white to minimize the adverse effects of weather and insect attack on the plywood and also for aesthetic appeal.

CONCLUSIONS

Solar radiations can be effectively and efficiently utilized for drying of agricultural produce in the environment if the proper design is carried out. The solar dryer designed and constructed exhibited sufficient ability to dry agricultural products to an appreciably reduced moisture level. Locally available cheap materials were used in construction, making it available and affordable to all rural people. This will go a long way in reducing food wastages and at the same time, food shortage since it can be used extensively for the majority of agricultural food crops. Apart from this, solar energy is required for its operation, which is readily available in the tropics, and it is also a clean form of energy. It protects the environment and saves cost and time spent on open sun drying of agricultural produce since it dries food items faster. The food items are also well protected in the solar dryer than in the open sun, thus minimizing the case of pest and insect attack and also contamination.

REFERENCES

[1] Scalin D., *The design, construction and use of an indirect, through-pass, solar food dryer*, Home Power Magazine, 1997, 57, p.62-72.

[2] GEDA-Gujarat Energy Development Agency, 2003, www.geda.com.

[3] Whitfield D.E., *Solar dryer systems and the internet: important resources to improve food preservation*, 2000, Proceedings of International Conference on solar cooking, Kimberly, South Africa.

[4] Herringshaw D., *All about Food Drying*, 1997, The Ohio State University Extension Factsheet-hyg-5347-97, www.ag.ohio-state.edu/.

[5] Nandi P., *Solar thermal energy utilization in food processing industry in India*, Pacific Journal of science and technology, 2009, 10(1), p.123-131.

[6] Ayensu A., *Dehydration of food crops using solar dryer with convective heat flow*, 2000, Research of Department of Physics, University of Cape Coast, Ghana.

[7] Sukhatme S.P., *Solar-Energy-Principles of thermal collection and storage*, Tata McGraw Hill Publishing Company Limited, 1996.