*Pak. J. Agri. Sci.*
*24(3)200, 1987*

# FABRICATION OF A HOT BOX TYPE SOLAR DRYER FOR DEYHDRATION OF AGRICULTURAL PRODUCTS

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## ABSTRACT

A hot box type solar dryer was fabricated for the dehydration of agricultural products. This dryer made use of the absorption of solar radiation by the product itself as well as by the internal surface of the drying chamber to achieve the drying process. Differen tfruits and vegetables were dried in this dryer and data regarding initial weight, dehydrated weight, and drying time etc., were recorded.

## INTRODUCTION

A traditional method of drying of agricultural products is to dry them in the open sun. This technique usually leads to inferior quality products because of contamination by dirt, insects etc. Effectiveness of solar energy and quality of dried products may be improved considerably by using a solar agricultural dryer. Solar dryers are classified by Lawand (1978) as follows:

a) *Natural dryers*: These make use of natural action of solar radiations, ambient air temperature, humidity and wind speed to achieve the drying process.

b) *Solar dryers-direct*: In these dryers, heat is generated by the absorption of solar radiations on the product itself as well as on the internal surfaces of the drying chamber. This heat evaporates the moisture from the product.

c) *Solar dryers-indirect*: In these dryers, air is heated in a solar collector and then ducted to the drying chamber to dehydrate the produce.

There are also some mixed mode dryers in which the combined action of the solar radiations incident directly on the material to be dried and air preheated in a solar air heater furnishes the heat required to complete the drying operation.

This research pertains to the fabrication of a "Solar dryer-direct" type for the dehydration of fruit and vegetables on a small scale. This dryer has been fabricated with indigenous material and tested under the climatic conditions of Faisalabad. The solar energy was used directly for drying fruit and vegetables.

## MATERIAL AND METHODS

This solar dryer had a double-walled rectangular container whose outer wall was made of 2.5 cm thick wood and inner wall of galvanized iron sheet (24 guage). Two walls were separated by 2.5 cm thick insulation. The container was covered with a double-layered transparent glass roof. The inclination of wooden box and glass roof was equal to the latitude of the location (i.e. 32$^{0}$ for Faisalabad). The material to be dried was placed on the perforated trays inside the inner chamber of the dehydrator. The solar radiations were transmitted through the glass roof and the heat was generated by the absorption of solar radiations on the product itself as well as on the blackend interior surface of the chamber. Fresh air entered into the chamber through the holes at the base of the dryer. As the temperature of the enclosure was incressed, the air inside the chamber was heated. The warm air passed out of the upper apertures by natural convection and made room for the fresh air to enter into the chamber. As a result, there was a constant circulation of the air through the chamber and thus flow of hot air over the drying matter removed the moisture from the product. Performance of the dryer was tested by drying different fruits and vegetables. Various parameters used in the study were:

i) Absorber plate temperature i.e., the temperature of inner blackened surface,
ii) inner space temperature of the drying chamber,
iii) ambient air temperature,
iv) drying times of various products, and
v) quality of the dried product.

## RESULTS AND DISCUSSION

This dryer made use of direct solar radiations, therefore, its effectiveness depended upon the availability of sunshine. The data regarding the average ambient temperature, absorber plate temperature and inner space temperature of the dryer for the period from June 26 to July 29, 1985 are shown in Table 1. The maximum plate temperature attained was 102°C. The plate temperature of solar dryer designed by Walter and Alvardo (1984) was in the range of 66 to 78°C which was definitely inconvenient. The plate temperature of solar dryer under study was in the range of 80 to 102°C which made it more suitable for raising

Table 1. *Performance of solar dryer*

| Fruits or vegetables | Preparation | Pre-drying treatment i.e. blanching or sulfiting | Prepared wt. (g) | Initial time (A.M.) | Initial and ambient temp. $T_a$ | Final temperatures (C) plate temp. $T_p$ | Inner space temp. $T_s$ | Dried Wt. | Final time | Total drying time (hours) |
|---|---|---|---|---|---|---|---|---|---|---|
| Mushroom | Whole, stalk | — | 200 | 8.00 | 32-43 | 40-100 | 35-82 | 26 | 11.30 A.M. | 3.30 |
| Potatoes | Peeled, sliced | Blanching & sulfiting | 1400 | 8.00 | 32-38 | 40-86 | 38-82 | 200 | 1.30 P.M. | 5.30 |
| Onion | Cut into | Blanching & sulfiting | 1000 | 8.00 | 33-42 | 38-100 | 37-83 | 90 | 12.00 P.M. | 4.00 |
| | strips with | | | | 32-37 | 45-96 | 42-78 | 75 | 10.30 A.M. | 2.30 |
| | hand | | | | 31-38 | 38-75 | 30-65 | 100 | 5.30 P.M. | 9.30 |
| Mint | Trimmed leaves | — | 500 | 8.00 | 32-38 | 35-86 | 33-72 | 1060 | 5.00 P.M. | 9.00 |
| Tomatoes | Cut into slices | — | 9000 | 8.00 | 34-40 | 40-92 | 38-82 | 130 | 1.30 P.M. | 5.30 |
| Garlic | Peeled | — | 2500 | 8.00 | 33-36 | 40-90 | 38-83 | 376 | 1.00 P.M. | 5.00 |
| Bitter gourd | Peeled & cut | Blaching & sulfiting | 1700 | 8.00 | 31-38 | 39-85 | 38-75 | 260 | 5.00 P.M. | 9.00 |
| | into slices | | | | 33-39 | 38-100 | 36-86 | 210 | 3.30 P.M. | 7.30 |
| Pease | Shalled | Blanching & sulfiting | 1000 | 8.00 | 33-40 | 40-100 | 36-85 | 450 | 7.00 P.M. | 7.00 |
| Apricots | Halved un- | | 1400 | 8.00 | 33-39 | 28-96 | 35-85 | 160 | 12.00 P.M. | 4.00 |
| | peeled | | | | 35-42 | 45-95 | 43-82 | 600 | 1.30 P.M. | 5.30 |
| Peaches | Unpeeled halved. | — | 1400 | 8.00 | | | | | | |
| Pears | Peeled, sliced | Sulfiting | 2800 | 8.00 | | | | | | |
| Apples | Peeled, sliced | Sulfing | 1300 | 8.00 | | | | | | |
| Pomegranate | Peeled & shelled | — | 2000 | 8.00 | | | | | | |

inner air temperature. The inner space temperature ranged from 80 to 85°C, being optimum for drying. Wrublesh and Catania (1978) recorded maximum temperature rise of 16°C above the ambient temperature, whereas this dryer showed maximum temperature rise of 50°C above the ambient temperature. Figure 1 shows mean variations in ambient temperature, inner space temperature and plate temperature during the day time.

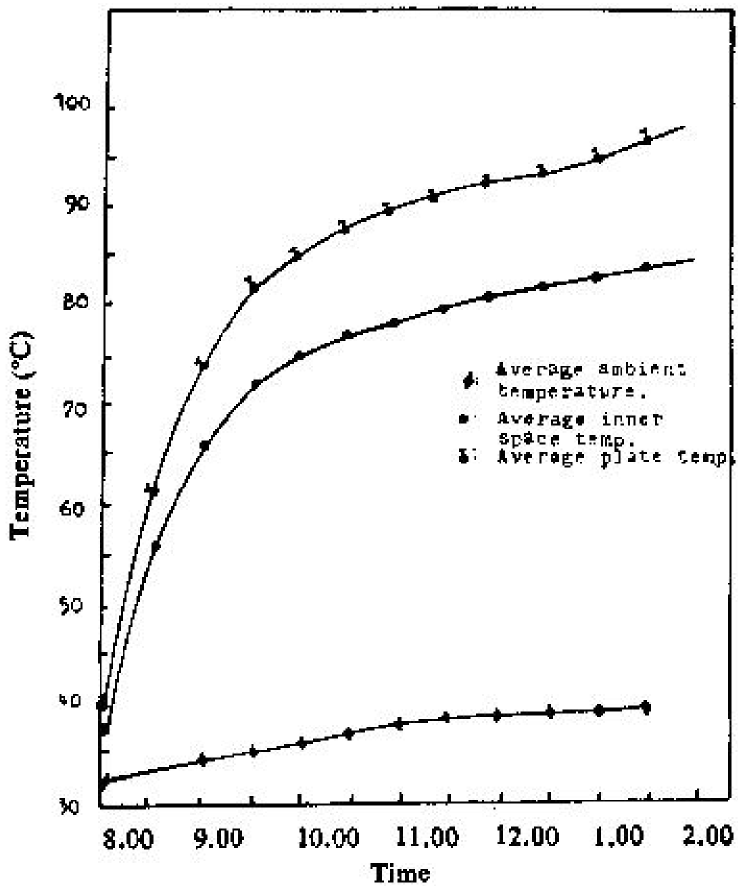


Figure 1. Variation in average ambient temp., inner space temperature and plate temperature, during day time.

Different fruits and vegetables such as apples, apricots, pears, pomegranate, garlic, mushroom, onion etc., were dried in this dryer. Table 1 shows the time for the dehydration of these products. Nejat and Tayeb (1983) fabricated and tested a solar dryer. It was observed that 500g of potatoes took seven hours to dry and the dehydrated weight was 100g. It could be seen from Table 1 that 1400g of potatoes were dried only in five and a half hours and weight after drying was 200g which meant a loss of 1200g of water. Similarly, the performance of the dryer for other fruits and vegetables was quite remarkable. This dryer reduced the drying time considerably in comparison with conventional sun drying and produced a good quality of dried products. For example, drying time of 200g of mushroom was 3 to 4 hours in this dryer, whereas the same quantity of mushroom took almost three days when it was dried under open sun conditions. Further, in this dryer, the dried products remained free from contamination caused by dirt, dust, wind, insects etc. Therefore, this dryer seems to have proved an effective and useful device for the preservation of agricultural products economically and hygienically.

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