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Research Article

COMPARATIVE STUDY OF SOLAR TUNNEL DRYER OF DIFFERENT COVER MATERIALS FOR DRYING MORINGA LEAVES

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Abstract: Solar tunnel dryers of 4' x 4' with polyethylene sheet (0.2 mm) and polycarbonate materials of 4 mm, 6mm and 8 mm thickness were developed. Performance of the solar tunnel dryers was evaluated at no load and full load conditions. Under no load condition, the temperature inside the solar tunnel dryers made of polyethylene, 4 mm, 6mm and 8 mm thickness polycarbonate are observed as 45°C, 49°C, 51°C and 50°C respectively. Dryers were evaluated under load conditions by drying moringa leaves. The time required for drying the leaves from 83% initial moisture content to 8% was observed to be 5 hours, 4.5 hours, 4 hours and 4.5 hours polyethylene, 4mm polycarbonate, 6mm polycarbonate and 8mm polycarbonate dryers. It took 6.5 hours to dry the moringa leaves in open sun drying. Dried products were analysed for the quality. It was observed that, Vitamin C, Protein content and Iron content of moringa leaves dried in 6 mm polycarbonate solar tunnel dryer were higher than that dried in other driers. From the colour analysis, it was observed that the "a" value of moringa leaves dried in 6 mm polycarbonate solar tunnel dryer fits with the standard value.

Keywords: *Solar tunnel dryer, Polyethylene, Polycarbonate, Quality, Colour*

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Introduction

Drying of agricultural products by solar energy plays an important role in processing and preservation of agricultural products. If drying is not completed fast enough, growth of microorganisms result which leads to the deterioration of the quality of the products. Proper utilization of solar energy for drying can easily be possible by choosing a proper solar dryer. Nowadays solar tunnel dryer is extensively used for drying agricultural products. In solar tunnel dryer, Drying parameters like temperature, mass flow rate of drying air, incident radiation and relative humidity of drying air are controlled for achieving better quality products. Solar tunnel dryer is a simple, efficient and low cost dryer for drying large quantity of agricultural products in less space. At the start, UV stabilized polyethylene sheets of 200 micron have been used for fabrication of solar tunnel dryers. Recently, UV stabilized polycarbonate sheet has become popular because of its long durability and better thermal efficiency. This paper presents the comparative study of solar tunnel dryers of different cover materials.

Materials and Methods

Solar tunnel dryers of 4' x 4' with polyethylene sheet (0.2 mm) and polycarbonate materials of 4 mm, 6mm and 8 mm thickness are developed for the study.
The performance of the solar tunnel dryer under no load and load conditions were studied. Dryers were evaluated under load conditions by drying moringa leaves. Temperature inside the dryers, drying rate and drying time were observed. From the observed data, efficiency of the dryer was also calculated.

Determination of Moisture Content

Moisture content of moringa leaves was determined using moisture meter at regular intervals.

Determination of drying Efficiency

Thermal efficiency of the solar tunnel drier was estimated using the formula,

$$\eta drying = [m \times h_{fg} / A \times I] \times 100$$

where, ηdrying= drying efficiency; m= the mass of water evaporated in time t; h_{fg}= latent heat of vaporization of water (kJ/kg), A= the area of solar tunnel dryer in m^2, I= the solar intensity in W/m^2.

Fig-1 Solar tunnel dryers (4' x 4')

Quality analysis

Quality parameters of dried products such as Protein, Crude fiber, Iron, Phenols and Vitamin C were analysed.

Colour analysis

Lovibond RT 200 Tintometer was used to measure the "L", "a" and "b" values of dried Moringa leaves.

Results and Discussion

The performance evaluation of solar tunnel dryer was carried out under no load and load conditions. Under no load condition, the temperature inside the solar tunnel dryers made of polyethylene, 4 mm, 6mm and 8 mm thickness polycarbonate were observed as 45, 49, 51 and 50ºC respectively. Dryers were evaluated under load conditions by drying moringa leaves. At the starting stage of drying moisture content was high and more moisture was evaporated from the outer surface. As the drying process continued the free moisture available on the surface decreased and less evaporation takes place and hence drying rate significantly decreased with drying time as well as moisture content. The drying efficiency of the 6mm polycarbonate dryer was found to be higher than other dryers and it was observed to be 26.75%.

Table-1 *Colour analysis of moringa leaves dried in different solar tunnel dryers*

Parameters	0.2 mm PE STD	4mm PC STD	6 mm PC STD	8mm PC STD
L	64.40	66.45	67.37	66.23
a	-2.37	-1.09	-.0.97	-1.19
b	23.54	20.07	23.43	23.51
a/b	-.1.006	-0.054	-0.04	-0.051

** STD – Solar Tunnel Dryer; PE – Polyethylene; PC – Polycarbonate*

0.2 mm polyethylene STD

4 mm Polycarbonate STD

6 mm Polycarbonate STD

8 mm Polycarbonate STD

Fig-2 Dried moringa leaves

The time required for drying moringa leaves from 83% initial moisture content to 8% was observed to be 5 hours, 4.5 hours, 4 hours and 4.5 hours polyethylene, 4mm polycarbonate, 6mm polycarbonate and 8mm polycarbonate dryers. It took 6.5 hours to dry the moringa leaves in open sun drying.

Lovibond RT 200 Tintometer was used to measure the "L", "a" and "b" values of dried Moringa leaves. The "a" value of moringa leaves dried in 6 mm polycarbonate solar tunnel dryer fits with the standard value. From the colour analysis, it was observed that "L" value decreases with drying temperature and drying time due to chlorophyll degradation. The lower a/b value and higher "L" value are preferred in dried moringa leaves.

Dried products were analysed for the quality. It was observed that, Vitamin C, Protein content and Iron content of moringa leaves dried in 6 mm polycarbonate solar tunnel dryer were higher than that dried in other dryers.

Table-2 *Quality analysis of moringa leaves dried in different solar tunnel dryers*

Parameters	0.2 mm PE STD	4mm PC STD	6 mm PC STD	8mm PC STD
Protein, %	30.10	31.85	32.35	31.03
Crude fiber, %	6.42	6.07	6.36	6.20
Iron (mg/100mg)	32.57	33.97	32.65	30.32
Phenols (mg/100mg)	999.37	954.2	1036.80	1062.99
Vitamin C (mg/100mg)	202.77	199.99	224.99	197.21

Conclusion

Solar tunnel dryers made of polyethylene, 4 mm, 6mm and 8 mm thickness polycarbonate were evaluated for their efficiency by drying moringa leaves. Moringa leaves dried in 6mm polycarbonate solar tunnel driers dried at a faster rate than other driers. The drying efficiency of the 6mm polycarbonate dryer was found to be 26.75%, higher than other dryers. Colour analysis showed that "a" value of moringa leaves dried in 6 mm polycarbonate solar tunnel dryer fits with the standard value. In the quality test conducted, it was observed that, Vitamin C, Protein content and Iron content of moringa leaves dried in 6 mm polycarbonate solar tunnel dryer were higher than that dried in other dryers. From the results obtained, it is concluded that the solar tunnel dryer will be best suited for drying agricultural products.

Application of research: Solar tunnel dryers are being used for drying agricultural and industrial products.

Research Category: Renewable Energy Engineering

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