Bhushan, L.S. (1978a). Distribution of erosion index and iso-erodent map of India. *Indian J. of Soil Conservation.* **6** : 1-12.

Ram Babu, Tejwani, K.G., Agarwal, M.C. and Chandra, Subhash (1978b). Rainfall erosion potential and Iso-erodent map of India. Bull. No.2, CS & WCR & T Institute, Dehradum : p. 47.

Wischmeier, W.H. (1958). Rainfall energy and its relationship to soil loss. *Trans. Am. Geophys. Union,* **39** : 285-291.

Wischmeier, W.H. (1959). A rainfall erosion index for universal soil loss equation. *Soil Sci. Soc. Amer. Proc.* **23** : 246-249.

Wischmeier, W.H. (1962). Rainfall erosion potential. *Agri. Engg.* **43** : 212-215.

Wischmeier, W.H. and Mannering, J.V. (1969). Relation of soil properties to its erodibility. *Soil Sci. Soc. Am. Proc.* **33** : 131-137.

Wischmeier, W.H. and Smith, D.D. (1978). Predicting rainfall erosion losses. A guide to conservation planning. USDA, Agricultural Hand Book No. 537 : p. 58.

(Received : August 2000 ; Revised : April 2001)

Madras Agric. J., 87(10-12): 571 - 574 October - December 2000

https://doi.org/10.29321/MAJ.10.A00508

Drying characteristics of grape varieties

R. RAGHUPATHY

Agricultural Engineering College, University of Agricultural Sciences, Dharwad, Raichur, Karnataka.

Abstract : The effect of direct sun-drying and solar drying of fourteen varieties of grapes were studied in terms of moisture content, drying rate, total soluble solids (TSS) and acidity. A saving in time of 40% could be achieved in a solar cabinet drier as compared to open sun drying. Appreciable change in TSS and no difference in citric acid were observed between the products dried under the two methods. The dehydration ratio, dehydration ratio, rehydration coefficient and the moisture content of rehydrated product were also determined. (***Key words :*** *Solar cabinet drier, Drying rate, Dehydration, Rehydration).*

Raisin constitutes an important item in the dried fruits consumed in India. While raisin made with white seedless grapes are used for a variety of table purposes, black grapes are generally used in bakery products. These grapes while drying undergo many changes and the drying behaviour of each of these vary according to their varietal difference. Moreover, drying need to be modernized to get good quality product at low processing cost. Though attempt were made earlier (EI Haggan and Kelwa, 1994) to dry the grapes continuously by using mechanical driers and solar driers, the effect of drying method on the drying characteristics of different varieties of grapes were not studied. Hence a study was made to dry fourteen varieties of grapes (both black and white) directly under sun and by using a solar cabinet drier and their drying characteristics were studied.

Materials and Methods

In order to improve the quality and increase the effect of the process, the drying was carried out in a solar cabinet drier and the results were compared with that of the sun-drying process.

The solar drier used consisted of a wooden rectangular base (2m x 1m) divided lenghwise into parallel channels of equal width. The box was glazed at the top to provide screening effect against Ultra-Violet light and to reduce photo-degradation of the drying product. The bottom and sides are well insulated and the interior surfaces are coated with black paint to absorb maximum solar radiation. Holes at the base and a chimney at the top were provided to permit natural convection of air.

Fourteen varieties of grapes, *viz.,* Sonaka1, Sonaka2, Thompson seedless, Phakdi, Arkahans, Anab-e-shahi, Manik chaman, Arkavati, Arka kiran, Gulabi, Bangalore blue 1, Bangalore blue 2, Arkashyam and Kiran were freshly harvested from the orchard of Raichur campus (UAS, Dharwad) at an average moisture content of 82 per cent (w.b) and

Table 1. TSS and acidity levels of grape varieties

Variety	Total Soluble Solids (°Brix)			Citric acid (%)		
	Before drying	After solar drying	After sun-drying	Before drying	After solar drying	After sun-drying
Sonaka 1	20.0	45.0	45.0	0.12	0.089	0.090
Sonaka 2	20.0	47.0	46.5	0.12	0.080	0.089
Thompson seedless	17.0	40.0	38.0	0.14	0.110	0.110
Phakdi	15.0	39.0	37.5	0.12	0.080	0.083
Anab-e-shahi	16.0	41.0	40.0	0.099	0.070	0.070
Manik-chaman	20.0	48.0	43.0	0.13	0.090	0.090
Arkavati	23.0	50.0	45.0	0.15	0.100	0.120
Arka kiran	15.0	36.0	34.0	0.14	0.110	0.110
Gulabi	21.0	50.0	48.0	0.12	0.080	0.080
Arkahans	16.0	40.0	39.0	0.06	0.050	0.050
Bangalore blue$_1$	20.0	42.0	41.0	0.13	0.110	0.110
Bangalore blue$_2$	20.0	43.0	42.0	0.14	0.090	0.096
Arkashyam	22.0	55.0	50.0	0.06	0.050	0.050
Kiran	20.0	44.0	42.0	0.15	0.120	0.130

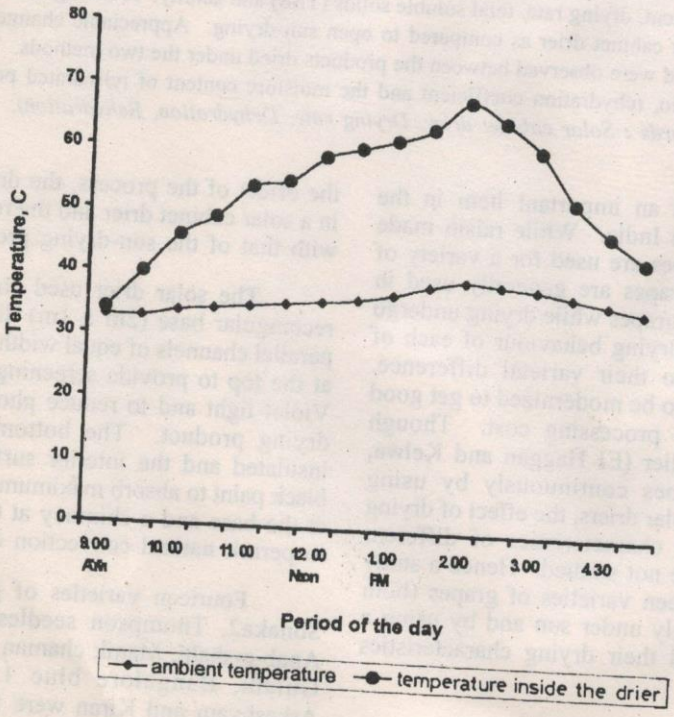

Fig.1 Ambient and Drier temperature curves

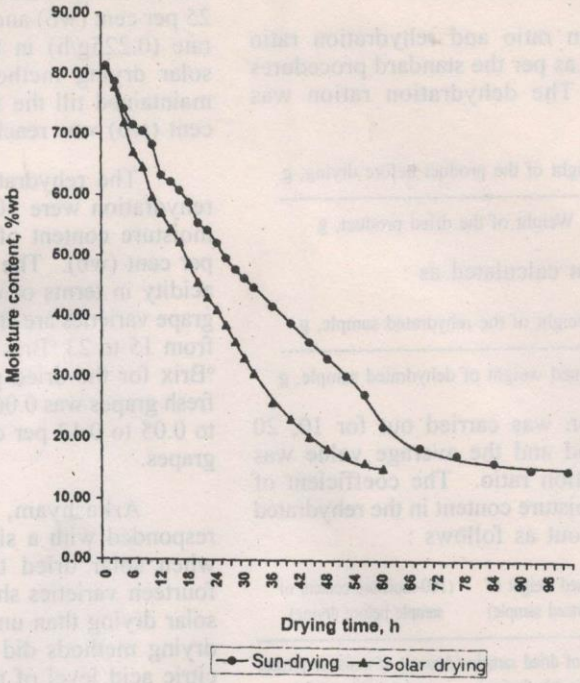

Fig. 2 Drying characteristic curves for grapes

used for the study. Fruits of equal sizes were selected for the study. They were washed thoroughly with tap water initially to remove adhering extraneous matter and then washed with distilled water. Three samples of 250 g each of the different varieties were taken for drying in the solar cabinet dryer as well as for drying under direct sun.

The selected samples of grapes were treated with boiling solution of 0.5 per cent sodium hydroxide for 3-5 seconds (Sharma *et al.* 1992). After draining, the samples were exposed to sulphur fumes by burning 3 g of sulphur per kg of berry bunches in an enclosed sulphur fumigation chamber for 3 hours. This was done to prevent fungal attack and to maintain the colour of the dried product.

The pretreated samples were kept on two trays of the solar cabinet drier and also kept outside the drier (control : sun-drying). The ambient temperature and the temperature unside the drier were measured with the help of themometers. The surface of the solar cabinet drier was placed north to south so that maximum sunlight could be absorbed from morning to evening. The drying was carried out in the drier and under open sun simultaneously. The initial weight and the physiological loss in weight were recorded at different time intervals. The drying was carried out until the grapes reached a final moisture content of 16 per cent. At the end of the day, the samples were packed in black polyethylene bags and kept in dark, cool chamber and the drying was continued on the following days.

After the drying, the samples were tested for their TSS and acidity by standard methods. The TSS determined by using a hand Abbey refractometer in °Brix. (Srivastava and Sanjeev Kumar, 1994). The acidity in terms of citric acid was also determined as per the method followed by Srivastava and Sanjeev kumar (1994). The pulp of different samples were removed and then crushed to extract juice. This juice was made up to 10ml with distilled water and titrated with Sodium hydroxide solution of 0.1 N using phenolphthalein as the indicator in volumetric analysis setup, until the dull white colour transformed into light pink (end point). The percentage titrable acidity was calculated using the equation.

$$\% \text{ acid} = \frac{\text{Titre value x Normality of alkali x m.eq.wt. of acid}}{\text{Volume of sample taken}} \times 100$$

where, m.eq.wt. of citric acid = 0.064

The dhydration ratio and rehydration ratio were also worked out as per the standard procedures (Ranganna, 1986). The dehydration ration was calculated as :

$$\text{Dehydration ratio} = \frac{\text{Weight of the product before drying, g}}{\text{Weight of the dried product, g}}$$

The rehydration ration calculated as :

$$\text{Rehydration ratio} = \frac{\text{Weight of the rehydrated sample, g}}{\text{Drained weight of dehydrated sample, g}}$$

The rehydration was carried out for 10, 20 and 30 minutes period and the average value was taken for the rehydration ratio. The coefficient of rehydration and the moisture content in the rehydrated sample were worked out as follows :

$$\text{Coefficient of rehydration} = \frac{\text{(Drained weight of rehydrated sample)} - \text{(100-moisture content of sample before drying)}}{\text{(Weight of dried sample taken for rehydration)} - \text{(Amount of moisture present in the dried sample)}}$$

$$\text{Moisture content in the rehydrated sample} = \frac{\text{(Drained weight of the rehydrated sample)} - \text{(Dry matter content present in the sample taken for rehydration)}}{\text{Drained weight of the rehydrated sample}}$$

Results and Discussion

The ambient temperature and the temperature inside the solar drier were recorded and plotted as in fig. 1. The ambient temperature during the drying period varied from as minimum of 33°C to a maximum of 40°C and the corresponding temperatures inside the drier were 34°C and 68°C respectively. The physiological loss in weight of different grape varieties was recorded and the average moisture content and drying rates were calculated at each of these intervals. The results are plotted as shown in fig. 2.

The grapes dried in the drier could reach the final moisture content of 16 per cent (wb) in 60 hours whereas the sun drying took more than 100 hours. Sun dried products could reach only 22 per cent (wb) at the end of 60 hours. The percentage saving in time by using a solar cabinet drier was found as 40 per cent. At the initial stages of drying, the moisture content of grapes reduced at a faster rate (0.916 g/h) until it reached a moisture content of 25 per cent (wb) and thereafter it reduced at a slower rate (0.225g/h) in the sun-drying method. In the solar drying method, the higher drying rate was maintained till the final moisture content of 16 per cent (wb) was reached.

The rehydration ratio and the coefficient of rehydration were 10:13 and 0.3 respectively. The moisture content of the rehydrated sample was 40 per cent (wb). The Total Soluble Solids (TSS) and acidity in terms of citric acid found for each of the grape varieties are shown in Table 1. The TSS varied from 15 to 23 °Brix for the fresh fruits and 35 to 55 °Brix for the dried products. The citric acid in the fresh grapes was 0.06 to 0.15 per cent and it decreased to 0.05 to 0.13 per cent for the different varieties of grapes.

Arkashyam, Arkavati and Manik chaman responded with a significantly higher level of TSS when solar dried than when sun-dried. All the fourteen varieties showed a higher TSS level under solar drying than under sun-drying but the different drying methods did not have any difference in the citric acid level of the dried products.

Acknowledgments

The material and manpower assistance provided by the University of Agricultural Sciences, Dharwad is gratefully acknowledged.

References

El Haggen, A.M. and Helwa, N.H. (1994). Continuous drying of grapes. *J. Institution of Engineers (India),* **75** : 6-11.

Ranganna, S. (1986). Handbook of analysis and quality control of fruit and vegetable products. Tata Mc-Graw Hill Publications, New Delhi.

Sharma, P.C., Sharma, K.D. and Prashar, R.S. (1992). Prospects of raisin production in tribal areas of Himachal Pradesh. *Indian Food Packer,* **46** : 3.

Srivastava, R.P. and Sanjeev Kumar (1994). Fruit and Vegetable Preservation, Principles and Practices. International Book Distributing Company, Lucknow.

(Received : May 2000 ; Revised : April 2001)