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ORIGINAL ARTICLE

Influence of Various Pretreatments on Drying Time of Solar Dried Grapes

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ABSTRACT
Experiments were conducted on drying time for solar dried grapes. The fresh grapes were treated with potassium carbonate, olive oil, soy lecithin and sugar concentration. The drying time was observed to be comparatively minimum when treated in 7 % potassium carbonate with immersion time of 5 min followed by 2.98 % olive oil with 120 sec immersion time. Therefore, potassium carbonate may be recommended as one of the best pretreatment for grape drying, because it maintains the final product quality, which has practical importance for the food industry.
Keywords: Solar drying, Grapes, Pretreatment, Drying time, Immersion time

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INTRODUCTION

Grape (*Vitis Vinifera*) belongs to Vitaceae family. It is an important commercial fruit crop of India. It is cultivated in sub-tropical climate of peninsular India. Grapes are the refreshing fruit and these are the rich source for minerals like calcium, iron and vitamins A, C and B6 [5]. Grapes 2.56 % of the total production of fruits and 1.14 % of the total area of cultivation and share of India is 2.8 % in the global production of grapes. Grapes are cultivated under the area of 79.6 thousands hectares with an annual production of 1878.3 thousand MT in India. Grapes are cultivated in the states of Maharashtra, Andhra Pradesh, Karnataka and Tamil Nadu. It is also cultivated in North Indian states as temperate crop. Only in Punjab annual production of grapes is 22088 MT under an area of 777 hectares [4].

Grapes can be consumed raw or processed form. March-April months are the peak production duration for grapes. In this period, it is highly available in the market. But due to poor handling and tremendous post-harvest losses, quality of grapes deteriorates which limit profits. Growers need to be educated to minimize market risk and get better price for their produce. For this purpose solar drying method is the appropriate and economical alternative for small scale growers of grapes.

Solar drying is a promising substitute for sun drying or for standard dehydration process. In this method, air moves in enclosed chamber having higher temperature and lower humidity which helps to increase the rate of drying and protects the materials from dust, insect, birds and animals. It requires smaller drying area. The faster drying rate reduces the risk of spoilage by micro-organism and also gives a higher output of product [9].

In solar drying system, the solar energy promotes the heating of air and to dry any food substance. It is not only beneficial but also reduces wastage of agricultural commodities and helps in preservation of the products. Such drying process is very helpful for easy handling of dried goods during transportation as well as it promotes the health and welfare of the people [3].

Pretreatments methods such as blanching, chemical pretreatment and osmotic dehydration, improve the nutritional quality of the dried products as well as reduce the dehydration time of the drying process [1], [6]. Thus, the present study is aimed to determine the effects of various pretreatments on the drying time of grapes and to optimize the experimental data.

MATERIAL AND METHODS

Selection of raw materials

Fresh grapes were purchased from a local market of Jabalpur, (M.P.), India. The selected grapes were graded according to size and colour to obtain uniform quality. Then, they were washed with water and unwanted material like dust, dirt, and surface adhering were removed.

Preparation of sample and solution:

The cleaned and graded grapes were pretreated in different solution for different immersion time. The pretreatments were used for developing of cracks in waxy layer of grapes. Four types of solutions were used with different concentration: K_2CO_3 solution, soy lecithin solution, olive oil solution and sugar solution were prepared in distilled water and heated at 50 °C. Grapes were kept in these solutions under continuous agitation for specific immersion time. Finally the samples were weight**.**

Measurement of initial moisture content The moisture content of fresh samples was determined by using air oven method and calculated by using following equation [8]. Cool the dried sample in desiccators and weighed. The weight of sample before and after drying was taken and loss in weight was calculated. Moisture content (*wb*) of samples was calculated by the following formula:

$$Moisture\ Content\ (\%, w.b.) = \frac{(Initial\ mass\ of\ sample, g - final\ mass\ of\ sample, g\ )X100}{Initial\ mass\ of\ sample, g}$$

Measurement of total soluble solids

The total soluble solids of prepared solution were found out by using hand refractometer, which give the reading directly in Brix [8].

Drying procedure

The pretreated samples were dried in a solar dryer as described by [11]. Weight loss of the dried grapes was measured at various time intervals, ranging from 30 min at the beginning of drying. The experiments were replicated thrice, and the average of the drying time for each pretreatment was used for statically analysis.

Statistics Design

The influence of two independent variables i.e. solution concentration and immersion time on drying time for grapes were analyzed by using central composite rotatable design. All independent variables were controlled at three different levels discussed in Table 1. A second-order polynomial equation was then used to fit the measured, dependent variable (drying time) as a function of drying parameter. Response Surface Methodology (RSM) which explores the relationship between several explanatory variables and response variable was applied to the experimental data using Design expert version 11 (Stat-ease Inc., USA) (30 days trial pack). The process was optimized for minimum value of drying time conducting statistical analysis.

RESULTS AND DISCUSSIONS

Effect of different solution concentration and immersion time on drying time

The combined effect of different solution concentration and immersion time affected the drying time to achieve the final moisture content (14 %, wb) of the grapes is shown in Fig. 1 to 4. These figures show that drying time was reduced with increasing pre-treatment concentration and immersion time. This may be due to the fact that pretreatment accelerates drying rates because presence of the cuticular wax is the main barrier to the evaporation of water. Removal of the surface wax by pretreatments is effective in promoting evaporation. Dipping of grapes in pretreatment removes part of the wax and probably destroys the cuticular structure, whereby the drying rate is increased. Dipped grapes stay yellow green. This is due to inhibition of the action of the polyphenol oxidizes by quick drying. The waxy cuticule of grape skin controls the rate of moisture diffusion through the berries and accelerate drying. Chemical treatments are applied to remove or modified this cuticle and increase grape permeability to water [2], [7]. Statistical analysis revealed that drying time was significantly affected by different solution concentration and immersion time.

The variation of drying time was studied against the variation of solution concentration and immersion time. The variation is described by a polynomial equation of second order. The multiple regression model for the drying time showed regression coefficient R^2 i.e. 0.99 and p value: 0.0017, 0.0014, 0.0001 and 0.0008 were observed for potassium carbonate, olive oil, soy lecithin and sugar concentration respectively.

The polynomial equations generated by multiple regression analysis using CCRD for different combination of solution concentration and immersion time are as follows:

Drying time = 144.52 + 3.97 x (B) – 7.76 x (A) – 0.27 x (B) x (A) – 1.2 x $(B)^2$ + 0.45 x $(A)^2$
Drying time = 262 – 30.6 x (C) – 1.4 x (A) + 0.09 x (C) x (A) + 2.95 x $(C)^2$ + 0.002 x $(A)^2$
Drying time = 126.78 – 0.28 x (D) + 4.93 x (A) – 1.33 x (D) x (A) + 0.15 x $(D)^2$ – 1.95 x $(A)^2$
Drying time = 223.5 – 2.09 x (E) – 0.55 x (A) + 0.001 x (E) x (A) + 0.012 x $(E)^2$ – 0.01 x $(A)^2$
Where, A = Immersion time, B = Potassium Carbonate, C = Olive oil, D = Soy lecithin and E = Sugar concentration

In figure 1, optimum potassium carbonate concentration and immersion time for minimum drying time (77 h) was observed to be 7 % and 5 min respectively. Figure 2 shows that the sample of grapes treated with 2.98 % olive oil took minimum drying time of 91.6 h at min immersion time of 120 sec. This may be due to higher concentration of solution resulted in cracks development of waxy layer of grapes by which drying rate becomes faster.

From figure 3 it can be inferred that an increase in the percentage of soy lecithin results in lesser drying time. An optimum soy lecithin (3 %) and immersion time (4 min) for minimum drying time (99.9 h) was observed. The influence of sugar concentration and immersion time on the drying time for grapes is shown in Figure 4. The drying time for the grapes decreased from 131.3 h to 92.7 h when sugar concentration increased from 50 to 64 °Brix for any constant immersion time within the range of 24 to 48 h. An optimum sugar concentration and immersion time for minimum drying time of 93.5 h was observed to be 64 °Brix and 48 h respectively. Pretreated grapes with sugar solution before drying has been beneficial in retarding enzymatic browning reaction. Moreover the drying time of the grapes drops before drying because of the osmotic pressure, whereby reducing drying time [10].

Table 1: Independent variables with their range and levels for solar drying

Set of experiment	Independent variables	level		
		-1	0	+1
1st set: Effect of K_2CO_3 concentrations and immersion time	K_2CO_3 (%)	3	5	7
	Time (min)	1	3	5
2nd set: Effect of olive oil concentrations and immersion time	Olive oil (%)	1	2	3
	Time (s)	40	80	120
3rd set: Effect of soy lecithin concentrations and immersion time	Soy lecithin (%)	1	2	3
	Time (min)	2	3	4
4th set: Effect of sugar concentrations and immersion time	Sugar (%)	50	57	64
	Time (h)	24	36	48

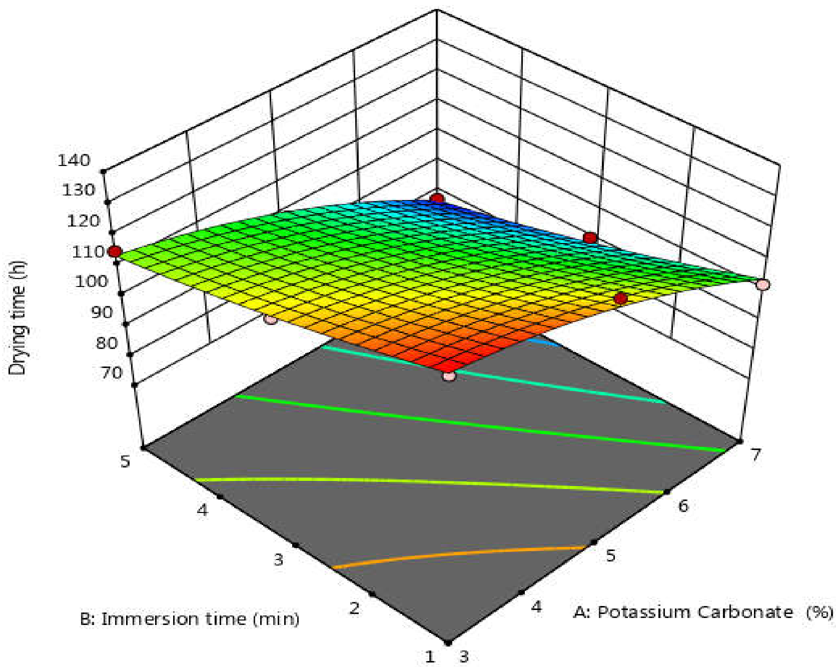

Fig. 1: Effect of potassium carbonate concentration and immersion time on drying time

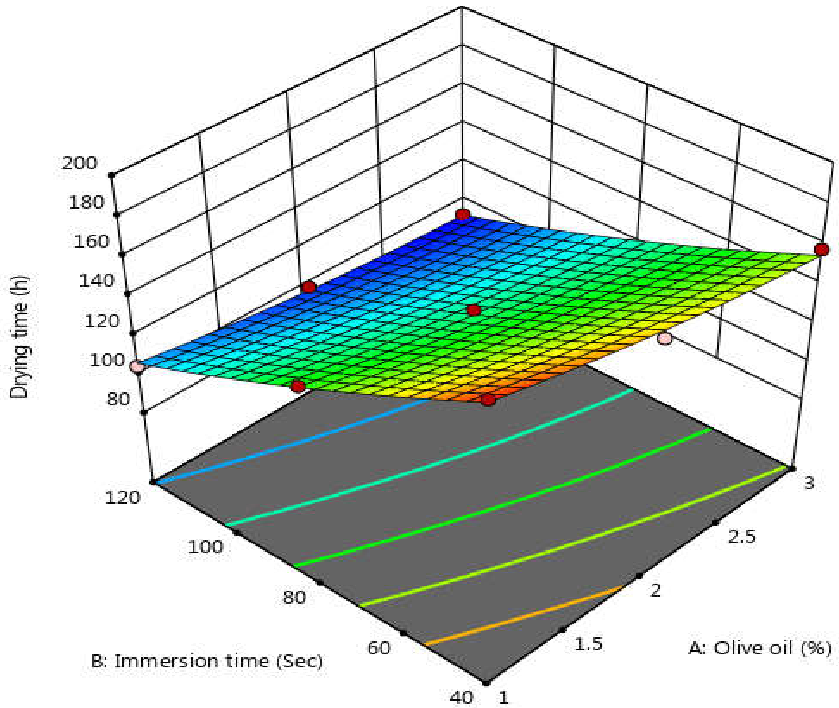

Fig. 2: Effect of olive oil concentration and immersion time on drying time

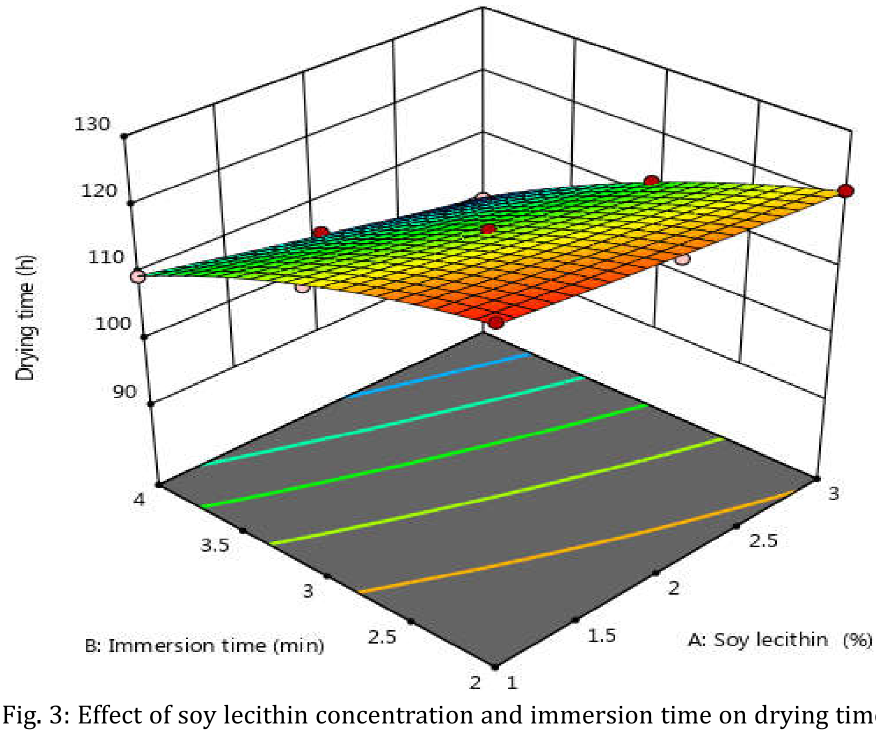

Fig. 3: Effect of soy lecithin concentration and immersion time on drying time on vacuum drying

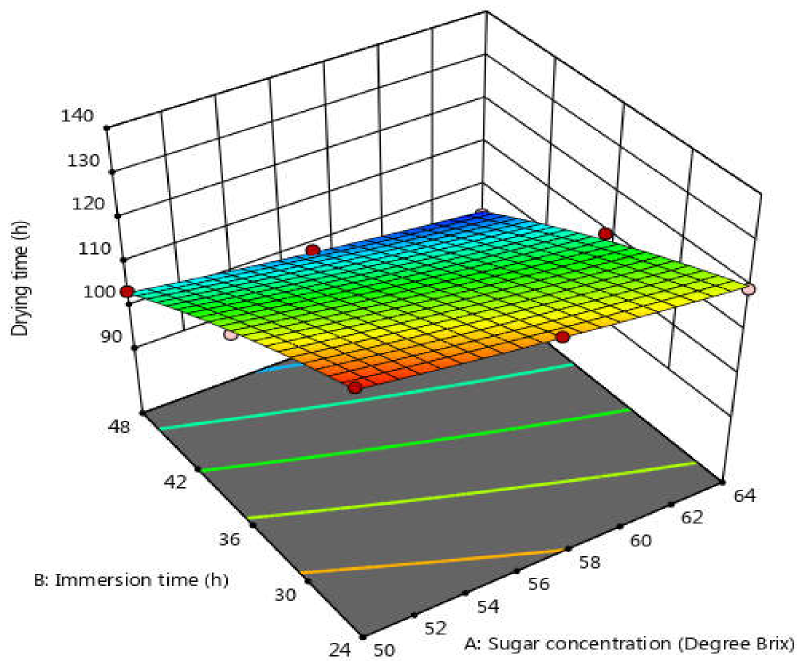

Fig. 4: Effect of sugar concentration and immersion time on drying time

CONCLUSION

Different pretreatments and immersion time for grapes were evaluated to find out the effect of these parameters on drying time of the dehydrated grapes. Drying time reduced with increase in solution concentration and immersion time. Optimization process was employed to find out the best combination of process parameters. The study was concluded that the minimum drying time of 77 h was found for the grapes treated with potassium carbonate concentration of 7 % and immersion time of 5 min whereas the optimum condition for olive oil concentration and immersion time for minimum drying time of 91.5 h was observed to be 2.98 % and 120 sec respectively.

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