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Production of Raisin from Pre-treated Grapes by Tray Drying

Jain Priti*

Department of Post Harvest Process and Food Engineering, College of Agricultural Engineering, JNKVV, Jabalpur, 482004, Madhya Pradesh, India

**Corresponding author*

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A B S T R A C T

In this study, raisin was produced from pre-treated grapes by tray drying method. Grapes were cleaned and soaked in a different type of solutions such as potassium carbonate, olive oil, soy lecithin, and sugar concentration for different immersion time. The pre-treated grapes were then dried in a hot air tray drier at 50°C and airflow 1.0 m/s. Results showed that drying time was varied for pre-treated grapes. The shortest drying time of 61 h) was obtained for those grapes which were dipped in 6.7 % potassium carbonate solution for immersion time of 5 min.

Introduction

Grape (*Vitis vinifera*) is one of the oldest fruit crops in India. In India, among growing commercial fruit crops grape is most important. Dried grapes (raisins) can be eaten raw or used in baking. It has high sugar content (about 20 ºBrix), crunchy pulp and thin skin. A good raisin variety should have a soft texture and delightful flavor. Two popular varieties of raisins are *Kishmish* and *Munnakka.*

In India, produced fruits are wasted nearly 30% due to improper post-harvest processing, transportation, and storage (Kumari, 2016). Drying is an important method of food preservation, which provides longer shelf life, lighter weight for transportation and small space for storage (Doymaz, 2007). Though, various methods of drying are adopted by food processors such as vacuum drying, tray drying, tunnel drying, conventional drying process (solar drying), etc. Since grapes contain about 70- 80% water and are perishable in nature. Therefore its shelf life can be increased by drying.

Food products can be treated before processing by several methods viz: blanching, chemical pre treatment, and osmotic dehydration to improve the nutritional quality of the dried products as well as reduce the dehydration time of the drying process (Akanbi *et al.*, 2003; Kingsly *et al.*, 2007). The pre-treated samples dry faster than

untreated samples and had lower values of the total energy needed and specific energy requirement Pretreatments process removes the wax barrier on fruits or vegetables and thus reduce drying time. It also helps to minimize the nutritional losses in the samples before drying. (Tunde-Akintunde *et al.,* 2014; Doymaz, 2007)

Although there are several studies on drying of grapes was done. But the effect of different concentrations of solution and immersion time for pre-treated grapes on drying time and optimized parameters have been limited. Hence, the objective of this study was to study the production of raisin using tray drying from pre-treated grapes.

Materials 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 pre-treated in a different solution for different immersion time. The pretreatment was used to develop cracks in the waxy layer of the grapes. Four types of solutions were used with different concentrations: K_2CO_3 solution, soy lecithin solution, olive oil solution and sugar solution, which were prepared in distilled water and heated at 50 °C. Then, grapes were soaked in these solutions under continuous agitation for specific immersion time. The total soluble solids of sugar solution were found out by using a hand refractometer, which gives the reading directly in Brix. (Patil *et al.,*2015; Ranganna, 2000). Finally, the ready samples were weight before drying**.**

Measurement of Initial Moisture Content

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

$$\text{Moisture content (\%, w. b.)} = \frac{\text{(Initial mass of sample, g – final mass of the sample, g)}}{\text{Initial mass of the sample, g}} \times 100$$

Drying Procedure

The pre-treated grapes were dried in a hot air tray dryer at 50ºC with an air velocity of 1m/s. The weighed samples were spread in the form of a thin layer of perforated sieves made of steel mesh. Weight loss of the dried grapes was measured at various time intervals, ranging from 30 min to achieve a moisture content of 14% (wb), and then the drying process was stopped. The experiments were replicated thrice, and the average of the drying time for each pre-treatment was used for statically analysis.

Statistical Design

The influence of two independent variables i.e. solution concentration and immersion time on drying time for grapes was 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 the drying parameter. Response Surface Methodology (RSM) which explores the relationship between several explanatory variables and

response variable was applied to the experimental data using the trial package, Design expert version 11 (Stat-ease Inc., USA). The process was optimized for the minimum value of drying time conducting statistical analysis.

Results and Discussion

During pre-treatment of grapes, attention was drawn to the necessary concentration of solution and immersion time to increase water vapour permeability through the waxy layer of grapes. The initial moisture content of 84% (wb) for fresh samples was determined by using an air oven method.

Effect of Different Solution Concentration and Immersion Time on Drying Time

The variation of drying time was studied against the variation of solution concentration and immersion time to achieve the final moisture content of 14 % (wb) for the grapes is shown in Figure 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 the presence of the cuticular wax is the main barrier to the evaporation of water. Removal of the surface wax by pretreatment is effective in promoting evaporation. Gabas *et al.,* 1999 and Pangavhane *et al.,* 1999 also reported that 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 the inhibition of the action of the polyphenol oxidizes by quick drying. The waxy cuticle of grape skin controls the rate of moisture diffusion through the berries and accelerates drying. Chemical treatments are applied to remove or modify this cuticle and increase grape permeability to water.

Statistical analysis revealed that drying time was significantly affected by different solution concentration and immersion time. Regression coefficient (R^2) and p value were observed with the range of 0.97 to 0.99 and 0.0001 to 0.0117 respectively.

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

Drying time = 146.44 - 2.75 x (B) - 10.96 x (A) + 0.06 x (B) x (A) - 0.1 x (B) ^{2} - 0.48 x (A) ^{2}
Drying time = 213.7 - 25.15 x (C) - 0.48 x (A) + 0.13 x (C) x (A) + 1.4 x (C) ^{2} - 0.004 x (A) ^{2}
Drying time = 144.56 - 4.14 x (D) - 16.9 x (A) - 0.075 x (D) x (A) + 0.33 x (D) ^{2} + 1.58 x (A) ^{2}
Drying time = 200.9 - 1.76 x (E) – 0.93 x (A) - 0.015 x (E) x (A) + 0.014 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

As per figure 1, optimum potassium carbonate concentration and immersion time for minimum drying time of 61 h was observed to be 6.7 % and 5min respectively. Figure 2 shows that the sample of grapes treated with 2.79 % olive oil took minimum drying time of 83.3 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. Optimum soy lecithin (3 %) and immersion time (4 min) for minimum drying time (92 h) were observed. The influence of sugar concentration and immersion time on the drying time for grapes is shown in Figure 4.

Table.1 Independent variables with their range and levels for vacuum 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

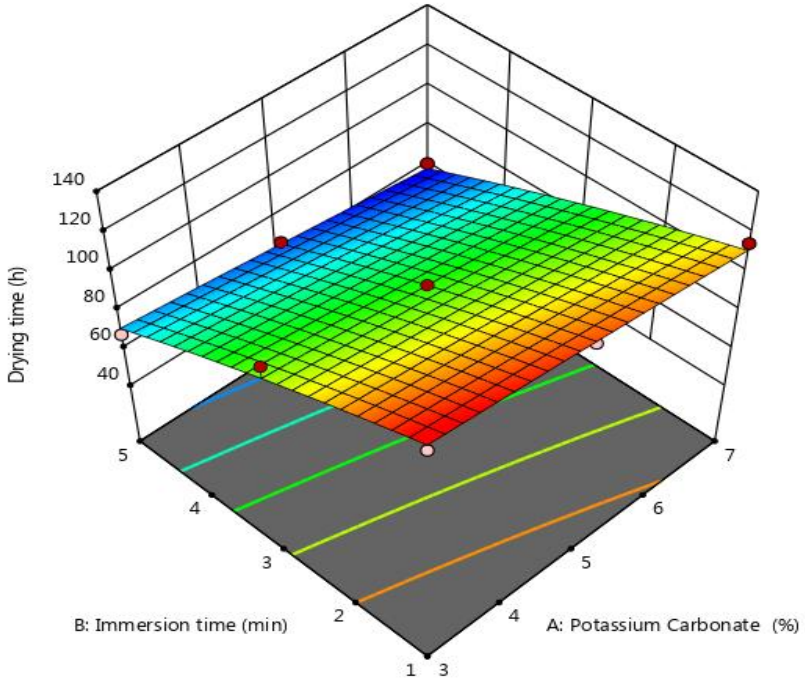


Fig.2 Effect of olive oil concentration and immersion time on drying time

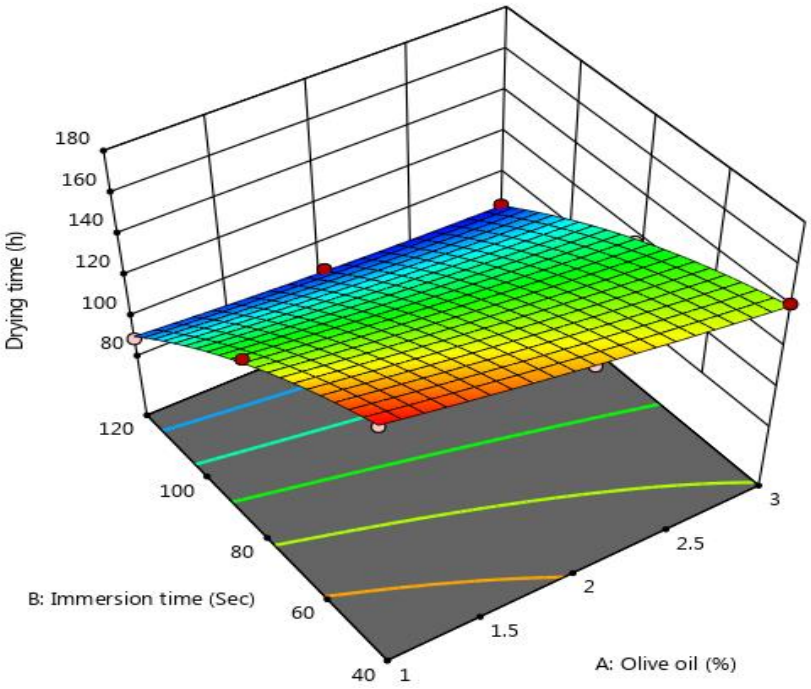


Fig.3 Effect of soy lecithin concentration and immersion time on drying time

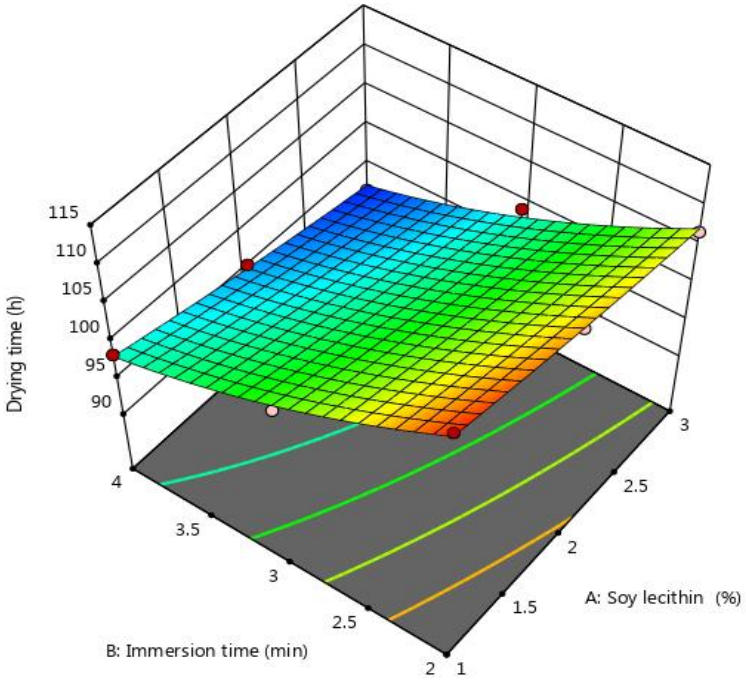
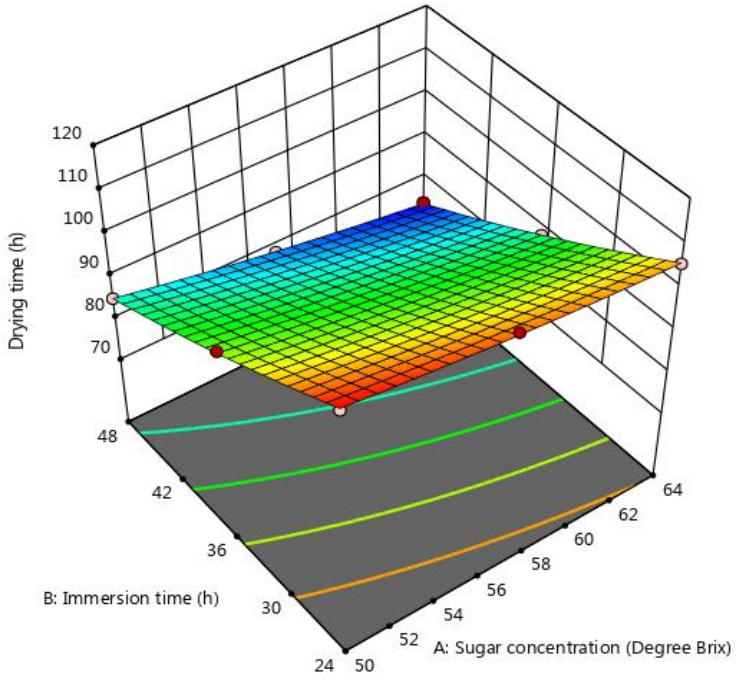


Fig.4 Effect of sugar concentration and immersion time on drying time



The drying time for the pretreated grapes decreased from 112.3 h to 73.5 h when sugar concentration increased from 50 to 64 °Brix for immersion time ranging from 24 to 48 h. An optimum sugar concentration and immersion time for the minimum drying time of 73.4 h was observed to be 64 °Brix and 48 h respectively. Due to osmotic pressure in grapes, partial water was transferred to the sugar solution. Therefore, the drying time was lower due to partially dried grapes. The reason was also explained by Yongsawatdigul and Gunasekaran, 1996.

The Optimization process was employed to find out the best combination of process parameters i.e. concentration and immersion time of the different type of solution for the reduction of drying time of pre-treated grapes. They were dried in a hot air tray dryer at 50ºC with an air velocity of 1m/s. It was concluded that drying time reduced with an increase in solution concentration and immersion time. The minimum drying time of 61 h was found for the grapes treated with potassium carbonate concentration of 6.7 % and immersion time of 5min.

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