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Research Paper

Process Technology for Raisins

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ABSTRACT

The process of osmotic dehydration followed by tray drying was studied on grapes for raisin preparation. Grapes were dried out by osmosis using sugar syrup at grapes to sugar syrup ratio of 1:4, which were than dried in a commercial tray dryer maintained at 60°C temperature to obtained raisin. The grapes were dipped in sugar syrup of 40°Brix, 50°Brix, 60°Brix and 70°Brix concentration in beakers having fruit to syrup ratio 1:4 at 60°C temperature and time of immersion was 30 minutes and one hour for osmotic dehydration. From this it was concluded that, acidity and ascorbic acid decreases with increase in syrup concentration, temperature of solution and time of concentration and total, reducing and non-reducing sugar increases with increase in syrup concentration, temperature of solution and time of concentration.

HIGHLIGHTS

- Highest moisture loss was occurred on 4th day, after 180 min, 12.80% (60°Bx) and minimum moisture loss was recorded on 1st day after 30 min (1st observation) i.e.; 0.61% (50° Bri) of Osmotic dehydrated grapes
- The raisins are having nice texture, appearance as well as good flavor.

Keywords: Osmotic dehydration, Chemical composition, Raisins, Reducing and non-reducing sugars.

India has been a predominantly agrarian economy since time immemorial. Raisins are formed from grapes made by osmotic dehydration followed by drying. The affinity of water to pass through a semi-permeable membrane into a solution where the solvent concentration is higher to equalize the concentration of materials on either side of the membrane is known as osmosis. The dehydration means loss or removal of water. Osmotic dehydration (OD) is a technique used to reduce water activity (a_w) in foods in order to improve nutritional, sensorial and functional properties of food. It consists of an immersion of the product into concentrated solution A grape is a small, sweet fruit that grows in clusters on a vine and botanically it is termed as 'berry'. It can be eaten fresh as table grapes or they can be used for making wine, grape juice, jam, jelly, raisins etc. Grapes contain 81% water, 18% carbohydrates, 1% protein and have negligible amount of fat.

Raisins originated in the Middle East before making their way to Europe, where they were especially popular among the Greeks and Romans. A 100g of raisins contains, 108 calories of energy, 1 gram of protein, 0 of gram fat, 29 grams of carbohydrates, 1 gram of fibres, 21 grams of sugar and these are a good source of iron (14%), potassium (16%), copper (14%) and vitamin B6 (13%). Raisins also contain boron this mineral helps maintain good bone and joint health, can improve wound healing, and may improve cognitive performance. So, the present

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study taken up to find out the dehydration of grapes for raisins. Anonymous *et al.* (2003) reported that in conventional raisin preparatinon includes the pre-treatment of the grapes followed by shed drying in order to bring the moisture content of the final product up to 15-18 per cent from initial moisture content of grapes i.e. 70-85 per cent. This process requires very long period for drying that is about 15-21 days depending upon different weather condition.

Diletta *et al.* (2016) Conducted experiments without air drying is also known as tray drying, which uses hot air as a medium to make temperature gradient between grapes and air with simultaneous removal of moisture. The temperature of air decides not only the drying rate but also the quality of the end product. However, the part closer to the fruit surface dries up earlier, and the interior part is still left with some moisture. Caglar *et al.* (2009) found that the thermal energy consumes more time to reach that part and the vapour generated in the process also takes more time to reach the surface, resulting in higher drying time. Lokhande *et al.* (2007) reported hot air drying took 180 min to remove 65% of moisture from grapes. The quality characteristics of grapes, such phenolic content, anthocyanins, and antioxidant activity, also reduced during hot air drying treatment compared to non-conventional treatment. Collar *et al.* (2007) reroted hot air is considered to be a good alternative compared to sun drying of grapes, due to higher retention of phenolic content, anthocyanins, antioxidant activity, and other quality attributes along with less drying time. Tiara *et al.* (2005) Found that the osmotic dehydration is the phenomenon of removal of water from lower concentration of solute to higher concentration through semi permeable membrane results in the equilibrium condition in both sides of membrane.

MATERIALS AND METHODS

Grapes were collected from the local market and then washed properly, Clean grapes were dipped in the different concentrations of sugar solutions and then kept for drying in the tray dryer for formation of raisins.

Raw Materials

Fresh green grapes (Thompson seedless) were collected from the local market. These table grapes were mainly grow for preparation of raisins and wine.

Quality of raw materials: The Thompson seedless grapes were neither fully ripen nor raw they were perfectly ripened which was good for this experiment.

Shape and size of the fruits: The shape of the grapes was round and oval they were not distributed uniformly, the size was varying from 3-5 cm and whole grapes were used.

Equipments

(i) Tray dryer – It was a convectional drying equipment with enclosed insulated chambers and trays placed on top of each other in a trolley. Grapes were dried using tray dryer.

(ii) Hot air oven – It was an electrical device used for rapid evaporation, rapid drying. By using this equipment moisture in grapes were determined.

(iii) Weighing machine – It was a measuring instrument used to measure samples.

Other materials required to conduct the experiment

(i) Beaker – It was used for soaking of grapes in sugar solution.

(ii) Sugar – It was used for making sugar solution.

(iii) Water – It act as solvent in sugar solution.

(iv) Petridish – It was used for keeping grapes in it for weighing.

(v) Tray – Grapes were placed on it and kept for drying in tray dryer.

(vi) Spatula – It was used for mixing the sugar solution.

(vii) Tissue paper – It was used to remove water from surface of grapes.

Experimental procedures

Grapes were collected from the market
↓
Cleaned
↓
Grapes were wiped off by tissue paper
↓
Sugar solutions of different concentrations were prepared
↓
Grapes were dipped in the sugar solutions
↓
Temperature was fixed in tray dryer
↓
Grapes were kept inside the tray dryer for moisture loss
↓
After 4 days of subsequent drying
↓
Final product (raisins) was formed

Fig. 1: Flow chart for processing of grapes to make raisins

1. Sample preparation

Green grapes were washed thoroughly in tap water to remove pesticides like carbaryl, pyre thin etc that were spread on grapes to protect it from pests and other organisms those cause damage to the fruit. After thorough washing of the grapes, they were dried by the help of tissue paper which remove water from the surface of the grapes.

Plate 1: Fresh grapes after cleaning

Plate 2: Grapes were laid on the tissue paper to dry

Preparation of brix solution

For preparation of 4 brix solution of different concentration we took 4 beakers and labelled them as 40°Bx, 50°Bx, 60°Bx and 70°Bx. As we know every solution had a solute and solvent so here the solute was sugar and the solvent was water. 120ml of water was taken in 4 beakers. The weight of sugar was differed in each of the brix solution (Plate 3).

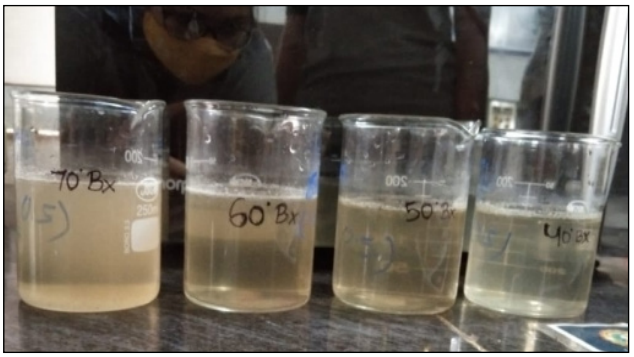

Plate 3: Prepared sugar solution of different concentrations of sugar

For 40°Bx solution, the weight of sugar was 40/100* 120 = 48g. So, in 1st beaker 48g of sugar which was measured by weighing machine was added to 120 ml of water and stirred well by spatula to make a solution.

For 50°Bx solution, the weight of sugar was 50/100*120 = 60g.

For 60°Bx solution, the weight of sugar was 60/100*120 = 72g.

For 70°Bx solution, the weight of sugar was 70/100*120 = 84 g. Simultaneously 60 g, 72 g, and 84g of sugar was added to 120 ml of water present in 2nd, 3rd and 4th beaker for preparation of a solution. After the preparation of all 4 brix solutions 100g of green grapes which were washed thoroughly and dried by tissue paper was added to each of the brix solutions for soaking in sugar water (Plate 4).

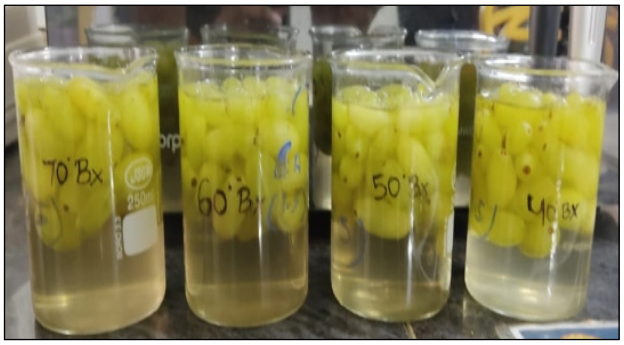

Plate 4: Grapes were dipped in the prepared solutions of 40°, 50°, 60° and 70° Bx

These were kept aside for 41 hour for the process of osmosis. Grapes were placed in sugar solution i.e., hypertonic solution due to which exosmosis occurred in which outward movement of the water molecules from the lower solute concentration to higher solute concentrations takes place through grapes covering resulted in shrinkage.

Measurement of initial and final moisture content of grapes:

The standard method to determine moisture in fruits and seeds were bone drying by hot air oven. Moisture present in grapes was also determined by this method. Two petridishes were taken and its empty weight was noted down then few fresh grapes samples cut in to slices were taken along the petridishes and the weight was noted down. The initial weight was noted and then it was placed in a preheated hot air oven. After 24 hour the petridishes were taken out from the oven and final weight was noted down.

Weight of Petridis 1 = 28.2g

Weight of grapes in Petridis 1 = 9.4g

Weight of Petridis 2 = 28g

Weight of grapes in Petridis 2 = 9g

Petridis	Initial Weight	Final Weight	Moisture Loss
1	37.6	30.2	7.4
2	37	30	7

% of peridish 1 = 7.4/9.4*100 = 78.72%

% of Petridish 2 = 7/9*100 = 77.77%

Total percentage = 78.72+77.77/2 = 78.25

After 41 hour soaked grapes present in different brix solution was taken out from the beaker and spreaded over 4 trays named as 40°Bx, 50°Bx, 60°Bx and 70°Bx. The tray dryer was pre-heated to reach the temperature of 60°C and then these 4 trays were kept inside it (Plate 5).

Plate 5: Grapes were kept inside the tray dryer for drying for 8h

On 1st day, few readings were taken in 30 minutes interval and after that the readings were taken in 1 hour interval to know the moisture loss in grapes. On 2nd day (after 16 hour) readings were taken in 1 hour interval. On 3rd day (after 16 hour 20 minutes) readings were taken in 1hour interval (Plate 6).

Plate 6: Final product obtained as raisins

On 4th day (after 16 hour 30 minutes) readings were taken in 1 hour interval and then final products i.e., raisins were formed.

RESULTS AND DISCUSSION

When grapes were immersed in sugar solution of different ^{0}Bx values, weight loss of grapes was minimum in 50^{0}Bx solution i.e., 66.11% whereas weight loss of grapes was maximum in 40^{0}Bx solution i.e. 70.65 %. 100g of grapes were immersed

in sugar solution of different ^{0}Bx i.e., 40^{0}Bx, 50^{0}Bx, 60^{0}Bx, 70^{0}Bx for about 41 hours. After 41 hours, the grapes which were immersed in 50^{0}Bx, 60^{0}Bx and 70^{0}Bx have lost some weight whereas the grapes which were immersed in 40^{0}Bx gained 0.2g of weight. Table 1 shows the percentage of total weight loss of grapes after osmotic dehydration.

Table 1: The percentage of moisture loss of grapes after osmotic dehydration.

Sl no.	Sugar conc.	Initial weight of grapes (g)	Final weight of grapes (g)	Moistureloss (%)	Moisture loss (%)
1.	40°Bx	100.2	29.4	70.8	70.65%
2	50°Bx	97.4	33	64.4	66.11%
3	60°Bx	95.8	28.6	67.2	70.14%
4	70°Bx	99.2	33.4	65.8	66.33%

Initially, the readings were taken at the interval of 30 min. According to 1st reading, the highest moisture loss was occurred in the grapes which were immersed in 70^{0}Bx i.e., 1 % whereas lowest moisture loss was occurred in grapes which were immersed in 50^{0}Bx i.e., 0.61%. Five readings were taken at 30 min of interval in 1st day. After that four readings were taken at 60 min of interval in that day. In 1st day, highest moisture loss was observed after 150 min of tray drying i.e., 3.55% (40^{0}Bx) whereas lowest moisture loss was observed after 30 min of interval i.e., 0.61 % (50^{0}Bx).Table 2 shows the percentage of weight loss occurred in 1st day after tray drying. Table 2 shows the percentage of moisture loss of grapes after tray drying in day 1.

Table 2: Percentage of moisture loss of grapes after tray drying (1st day)

1st day						
Sl No.	Temp °C	Time (min)	°Bx	Initial wt. (W_1)	Final wt. (W_2)	Moisture loss (%)
			40°Bx	100.2	99.4	0.79
			50°Bx	97.4	96.8	0.61
1	50°C	30 min	60°Bx	95.8	95.2	0.62
			70°Bx	99.2	98.2	1.00
			40°Bx	99.4	98	1.40
			50°Bx	96.8	95.4	1.44
2	50°C	60 min	60°Bx	95.2	93.8	1.47
			70°Bx	98.2	97.2	1.01
			40°Bx	98	97	1.02
3	50°C	90 min	50°Bx	95.4	94.2	1.25
			60°Bx	93.8	92.6	1.27
			70°Bx	97.2	95.8	1.44
			40°Bx	97	95.6	1.44
4	50°C	120 min	50°Bx	94.2	93.2	1.06
			60°Bx	92.6	91.6	1.07
			70°Bx	95.8	94.8	1.04
			40°Bx	95.6	92.2	3.55
			50°Bx	93.2	92	1.28
5	50°C	150 min	60°Bx	91.6	90.8	0.87
			70°Bx	94.8	93.6	1.26
			40°Bx	92.2	90	2.38
6	50°C	210 min	50°Bx	92	90	2.17
			60°Bx	90.8	88.2	2.86
			70°Bx	93.6	91.4	2.35
			40°Bx	90	88	2.22
			50°Bx	90	87.8	2.44
7	50°C	270 min	60°Bx	88.2	86	2.49
			70°Bx	91.4	89.4	2.18
			40°Bx	88	86.2	2.04
			50°Bx	87.8	86	2.05
8	50°C	330 min	60°Bx	86	84	2.82
			70°Bx	89.4	87.6	2.01
			40°Bx	86.2	84.4	2.08
			50°Bx	86	84.4	1.86
9	50°C	390 min	60°Bx	84	82.4	1.90
			70°Bx	87.6	86.2	1.59

On 2nd day, it was observed that the colour of grapes was changed from green to brownish colour . On 2nd day, grapes were observed at the interval of each 60 min of tray drying. 1st observation indicated that the highest and lowest moisture loss was 5.01% (70^{0}Bx) and 4.48% (60^{0}Bx) respectively. Seven readings were taken in 2nd day at the interval of 60 min. In 2nd day the highest moisture loss was observed after 60 min of drying operation i.e., 5.01% (70^{0}Bx) and the lowest moisture loss was recorded after 240 min of tray drying i.e., 1.43% (40^{0}Bx). Table 3 shows the percentage of weight loss occurred in day 2.

Table 3: Percentage of moisture loss of grapes after tray drying (2nd day)

2nd day						
Sl no.	Temp °C	Time (min)	°Bx	Initial wt. (W_1)	Final wt. (W_2)	Moisture loss (%)
			40°Bx	79	75.2	4.81
			50°Bx	78.2	74.4	4.85
1	60°C	60min	60°Bx	75.8	72.4	4.48
			70°Bx	79.8	75.8	5.01
			40°Bx	75.2	71.6	4.78
			50°Bx	74.4	71.2	4.30
2	60°C	120min	60°Bx	72.4	69.4	4.14
			70°Bx	75.8	72.8	3.95
			40°Bx	71.6	69.8	2.51
			50°Bx	71.2	69.2	2.80
3	60°C	180min	60°Bx	69.4	67.8	2.30
			70°Bx	72.8	71.2	2.19
			40°Bx	69.8	68.8	1.43
			50°Bx	69.2	68.0	1.73
4	60°C	240min	60°Bx	67.8	66.6	1.76
			70°Bx	71.2	70.0	1.68
			40°Bx	68.8	65.6	4.65
			50°Bx	68.0	65.8	3.23
5	60°C	300min	60°Bx	66.6	64.2	3.60
			70°Bx	70.0	67.2	4.00
			40°Bx	65.6	62.6	4.57
			50°Bx	65.8	63.8	3.03
6	60°C	360min	60°Bx	64.2	61.8	3.73
			70°Bx	67.2	65.2	2.97
			40°Bx	62.6	59.6	4.79
			50°Bx	63.8	61	4.38
7	60°C	420min	60°Bx	61.8	59.2	4.20
			70°Bx	65.2	62.6	3.98

On 3rd day, it was observed that the colour of grapes was changed from brownish to dark brown. Table 4 represents the percentage of moisture loss occurred in 3rd day with respect to time. On 3rd day, 7 observations were taken. Among them highest moisture loss was observed after 360 min of drying operation i.e., 5.91% (40^0Brix) whereas lowest moisture loss was observed after 180 min of drying operation i.e., 0.39% (50^0Brix). On that same day, after 300 min of drying operation, it was observed that there are some changes occurred in the shape and size of the grapes. The grapes were quizzed a little and there was reduction of the length of its diameter. Table 4 shows the osmotic dehydration of grapes after tray drying in day 3.

Table 4: Osmotic dehydration of grapes after tray drying (3rd day)

3rd day						
Sl no.	Temp °C	Time (min)	°Bx	Initial wt. (W_1)	Final wt (W_2)	Moisture loss (%)
			40°Bx	53.4	51	4.49
			50°Bx	55.8	53.4	4.30
1	60°C	60min	60°Bx	53.8	52.2	2.97
			70°Bx	57.2	55.4	3.14
			40°Bx	51	48.4	5.09
			50°Bx	53.4	50.8	4.86
2	60°C	120min	60°Bx	52.2	50	4.21
			70°Bx	55.4	53.4	3.61
			40°Bx	48.4	46	4.95
			50°Bx	50.8	50.6	0.39
3	60°C	180min	60°Bx	50.0	47.8	4.40
			70°Bx	53.4	48.8	8.61
			40°Bx	46.0	43	6.52
			50°Bx	50.6	47.8	5.53
4	60°C	240min	60°Bx	47.8	45	5.85
			70°Bx	48.8	46.6	4.50
			40°Bx	43.0	40.6	5.58
			50°Bx	47.8	45.6	4.60
5	60°C	300min	60°Bx	45.0	43.2	4.0
			70°Bx	46.6	44.4	4.72
			40°Bx	40.6	38.2	5.91
6	60°C	360min	50°Bx	45.6	43.4	4.82
			60°Bx	43.2	41.4	4.16
			70°Bx	44.4	42.6	4.05
			40°Bx	38.2	36.4	4.71
			50°Bx	43.4	41.2	5.06
7	60°C	420min	60°Bx	41.4	39.6	4.34
			70°Bx	42.6	40.8	4.22

On 4th day it was observed that the grapes were dark brown in colour and some changes in the shape and size of the grapes were clearly observed. On 4th day, four observations were recorded at the interval of 60 min. Table 5 represents the percentage of moisture loss on 4th day. It was the last day of our experimentation. On that day three observations were taken at the interval of each 60 min. On that day highest moisture loss was observed after 180 min of drying operation (3rd observation) i.e., 12.80 %(60^0Bx) whereas lowest moisture loss was observed after 180 min of drying operation i.e., 2.0% (40^0Bx). On 4th day, after 180 min of drying operations, finally grapes are converted into raisins. Plate no. 8 and 9 represent the picture of raisins. The raisins had nice texture, appearance and good

flavor. Table 5 : Osmotic dehydration of grapes after tray drying in day 4.

Table 5: Osmotic dehydration of grapes after tray drying (4th day)

			4th day			
Sl no.	**Temp °C**	**Time (min)**	**°Bx**	**Initial wt (W1)**	**Final wt (w2)**	**Moisture loss (%)**
			40°Bx	33	31.4	4.84
1	60°C	60min	50°Bx	36.8	35.8	2.71
			60°Bx	35	33.8	3.42
			70°Bx	37.2	36.2	2.68
			40°Bx	31.4	30.0	4.45
			50°Bx	35.4	34.4	3.91
2	60°C	120min	60°Bx	33.8	32.8	2.95
			70°Bx	36.2	35.2	2.76
			40°Bx	30	29.4	2.0
			50°Bx	34.4	33.0	4.06
3	60°C	180min	60°Bx	32.8	28.6	12.80
			70°Bx	35.2	33.4	5.11

Calculation

Percentage of total moisture loss =

$$\frac{\left(\begin{array}{c}\text{Initial weight of grapes} - \\ \text{Final weight of grapes}\end{array}\right)}{\text{Initial weight of grapes}} * 100$$

Percentage of total moisture loss(40^0Bx) =

$$\frac{(100.2 - 29.4)}{100.2} * 100 = 70.65\%$$

Percentage of total moisture loss (50^0Bx) =

$$\frac{(97.4 - 33)}{97.4} * 100 = 66.11\%$$

Percentage of total moisture loss (60^0Bx) =

$$\frac{(95.8 - 28.6)}{95.8} * 100 = 70.14\%$$

Percentage of total moisture loss (70^0Bx) =

$$\frac{(99.2 - 33.4)}{99} * 100 = 66.33\%$$

Based on the above calculations, highest moisture loss occurred from those grapes which were immersed in 40^0Bx sugar solution; i.e., 70.65 % whereas lowest moisture loss occurred from those grapes which were emmersed in 50^0Bx sugar solution; i.e., 66.11 %.

CONCLUSION

The process of osmotic dehydration was followed by tray drying was studied on grapes for raisin preparation. Raisins are basically grapes which are dried. Here, the grapes were immersed in different concentration of sugar solution i.e.; 40^0Bx, 50^0Bx, 60^0Bx, 70^0Bx for 41 hours. After 41 hours, the grapes were taken out from the sugar solution and spreaded over 4 trays. The tray dryer was pre-heated to reach the temperature at 60^0C and then these trays were kept inside.

On 1st day five readings were taken at the interval of 30 min. and four readings were taken at the interval of 60 min.

On 2nd and 3rd day, subsequently 7 readings were taken at the interval of 60 min.

On 4th day, three readings were taken at the interval of 60 min. Among them highest moisture loss was occurred on 4th day, after 180 min (3rd observation) i.e.; 12.80% (60^0Bx) and minimum moisture loss was recorded on 1st day after 30 min (1st observation) i.e.; 0.61% (50^0Bx).

After 4 days of drying operation, it was recorded that maximum moisture loss was occurred from the grapes which were immersed in 40^0B sugar solution i.e.; 70.65% whereas minimum moisture loss was occurred from the grapes which were immersed in 50^0B sugar solution i.e.; 66.11%.

On 2nd day, it was noticed that the color of the grapes was changed from green to brownish. On 3rd day, it was observed that the color of the grapes was changed from brownish to dark brown and a little shrinkage was noticed on the grapes.

On 4th day, after 180 min of drying operation, it was observed that the grapes are converted into dark brown color as well as changes had been noticed in the shape and size of the grapes. There was huge reduction of the length of their diameter. Those dried grapes are so called raisins. Those raisins had nice texture, nice appearance as well as good flavor.

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