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Effect of Osmotic Agents on the Drying Behaviour and Product Quality in Raisin Processing

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The mass transfer during osmotic dehydration of grapes, to produce quality raisins, is investigated. The effect of some osmotic solutions (sucrose and honey) on water loss and solid gain is evaluated. It is found that the rate of moisture loss in the fruit varies with both the osmotic agents as well as their concentrations in the soak solutions at ambient temperature. The sensory scores indicate that the honey-treated samples have better flavour while sugar-treated ones have better colour (appearance) and overall acceptability.

Introduction

More than half a million tones of raisins are produced in the world by either sundrying or mechancal dehydration. Raisins can also be produced by the osmotic dehydration, which helps in reducing the cost of production. Nearly 6.53 lac tonnes of grapes are produced in India, accounting for about 2% of the national fruit production[1]. Osmotic dehydration is a useful technique for the partial removal of moisture from fruits and vegetables and it is achieved by keeping the solid food in hypertonic sugar or salt solutions. During osmosis water flows out of the food into the solution and the solute from the solution diffuses into the food. The simultaneous mass transfer phenomenon is due to the water and solute concentration gradients across the cell membrane.

The combination of osmotic dipping followed by air-drying has been reported by many authors[2-5] and has many advantages over the conventionally dried fruits. Sucrose is the best all round osmotic agent because of its effectiveness, convenience and desirable flavour[2]. In the present investigation, sucrose and honey were used as the osmotic agents to study their effect on the mass transfer during osmotic dehydration of grapes (Thompson seedless variety) to produce raisins.

Materials and Methods

Thompson seedless grapes were procured from the local market and graded according to the uniformity in size, freedom from damages and blemishes, and were stored in a refrigerator at $4^{o}C$. The grapes were lye-treated in hot ($80^{o}C$) 1^{o} sodium hydroxide solution for 15 seconds to crack the peel, cooled and soaked in 0.2% KMS solution. The osmotic dehydration was carried out in sugar/honey solutions of 40, 50, 60 and $70^{o}B$ concentrations for 1, 2, 3, 4 and 5 h. The fruit to soak solution ratio was maintained at 1:4 with agitation at a rate of 100 rpm using a stirrer[5]. During the process, the loss in weight and increase in ^{o}B of grapes were recorded at hourly intervals.

The osmotic dehydration of the samples was carried out by placing the lye-peeled and KMS-treated grapes in optimum ^{o}B (60) sugar/honey solution for 24h. After the osmosis, the grapes were momentarily rinsed under running water and dehydrated in cabinet drier (Narang Corporation, New Delhi) at $60 \pm 5^{o}C$. The control sample was also treated in a similar manner, except osmosis, and dried. The loading density was 2 kg/m^2 of tray. The dehydrated samples were packed and sealed in HDPE (250 gauge) pouches for futher studies. 10g samples of the dried material were placed in a beaker containing 200mL of hot water at $98^{o}C$. The rehydration was carried out for 15, 30, 45, 60, 75, 90, and 105 min. The samples were drained and weighed to determine the percent gain in moisture for comparing reconstitutability.

The samples were evaluated for their colour, flavour, texture and overall acceptability by a semi-trained panel

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consisting of ten judges, using a nine point hedonic scale with 1 as poor and 9 as excellent quality[6]. The statistical analysis of the sensory data was carried out using analysis of variance, according to Steel and Tortie[9].

The water activity (a_w) of the dehydrated samples was determined using static desiccator method. The samples were weighed (2g) in petrt dishes and placed in the desiccator containing sulphuric acid solutions maintained at 20, 40, 50, 80, 100% relative humidity (RH) at room temperature[8]. The samples were regularly weighed untill equilibrium or till there was no further appreciable change in weight. The equilibrium relative humidity (ERH) curves were drawn between RH and weight gain or loss to determine a_w of the raisins.

Results and Discussion

Figures 1 and 2 show the per cent weight loss in relation to immersion period. When the grapes were immersed in sugar or honey solutions of different °B values, weight loss was the slowest in 40°B solution in both the cases. The loss in weight of grapes was in the range 2 – 25° (Figure 2) when immersed in honey solutions of different concentrations for 1 to 5 h. The losses were consistent with the degree of brix and increased as the soaking period progressed, except in the case of 60°B solutions which gave higher values than its 70°B counterpart at all the time intervals, barring the 2 h period. The weight losses on soaking in sugar solution (Figure 1) were higher in the case of 60°B solution up to 3 h followed by a sudden increase in weight loss in the case of 70°B after 4 and 5 h, giving values greater than at 60°B. The losses in weight of grapes were in the range of 0.1 to 1.5% when soaked in sugar solutions of 40, 50 60, and 70°B for 1-5 h, while those in the case of honey ranged from 2 to 25%. Figures 3 and 4 depict the increase in the total soluble solids (TSS) of grapes when soaked in the sucrose/honey solutions of different °B (40, 50, 60, and 70) for 1-5h. The final value of °B of grapes after soaking was higher in the case of honey, as compared to that in sugar solution, which corresponded to the higher weight losses in the case of honey (Figure 2). The maximum of 28°B and 26°B TSS in grapes were achieved in the case of honey and sucrose solution soakings, respectively. The increases in the values of °B with duration of soaking were almost the same for 40 and 50, and 60 and 70°B solutions in the case of sucrose while for honey, these values were lower in the case of 40°B and almost the same for 50, 60 and 70 °B solutions.

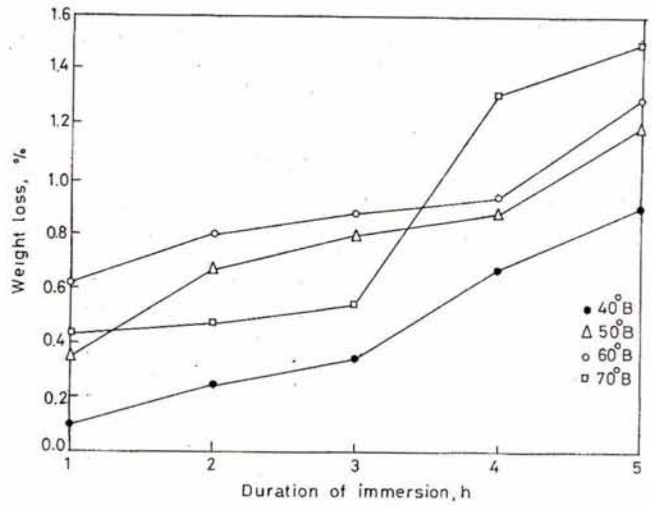

Figure 1 — Weight loss (per cent) with duration of immersion for osmostic dehydration in different sugar solutions

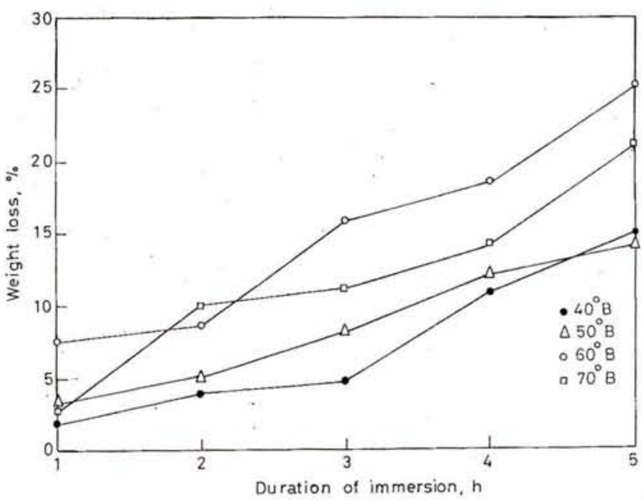

Figure 2 — Weight loss (per cent) with duration of immersion for osmostic dehydration in different honey solutions

Based on the above observations, the 60°B solution was selected for preparing the osmotically dehydrated grapes for further studies. Three samples, viz. control and soaked in 60°B honey/sugar solutions for 20 h were drained and dehydrated. Figure 5 shows the per cent moisture content of grapes as the dehydration progressed. The moisture content at the end of 15 h drying period was reduced from 80% to 12% in the case of control while this reduction in sugar/honey samples was from 60% to 8% and 10%, repsectively. Initially up to 2 h period, the moisture content (per cent) was almost the same for honey and sugar solution soaked samples, followed by a faster loss in the case of sugar-treated samples compared to honey-treated ones during 3rd to 7th h of

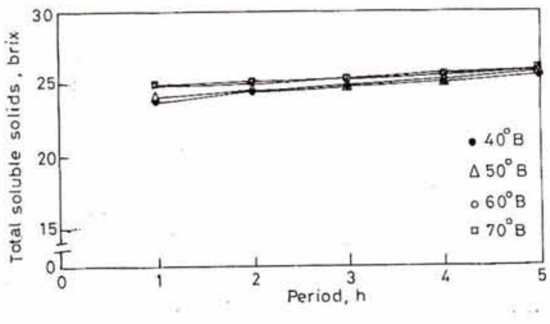

Figure 3 — Increase in total soluble solids of grapes in sugar solutions of different degree brix

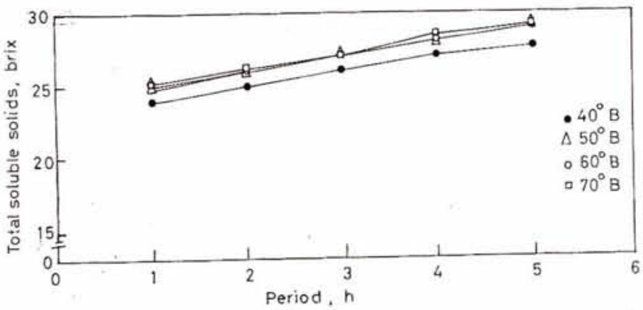

Figure 4 — Increase in total soluble solids of grapes in honey solutions of different degree brix

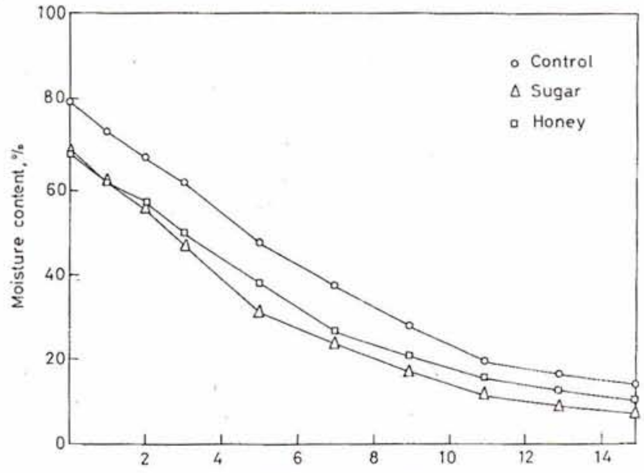

Figure 5 — Decrease in moisture content of grapes with duration of air drying

the drying. The higher final moisture content in the case of control could be attributed to higher initial moisture level, otherwise the rates of drying appeared to be almost the same.

The reconstitution of dehydrated samples in terms of gain in moisture (Figure 6) showed lower values for honey solutions-soaked samples as comapred to sugar

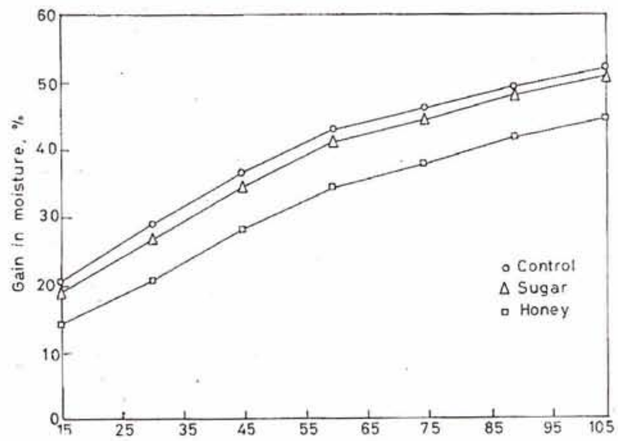

Figure 6 — Reconstitution of control, sugar and honey solutions-treated samples for different durations

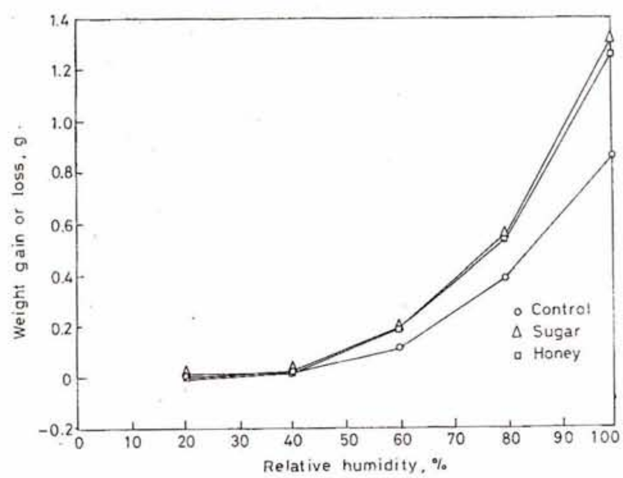

Figure 7 — The equilibrium relative humidity (ERH) curves for control, sugar and honey solutions-treated dehydrated samples

solutions-soaked and control ones, which showed more than 50% gain in moisture content in 105 min. The ERH curves (Figure 7) revealed that the control samples had a water activity of 0.25 i.e. (25% RH) while the value for sugar/honey solution soaked samples was approximately 0.20 (20% RH). At this RH value, the samples were fairly stable and had an excellent shelf-life. The sensory scores (Table 1) revealed that the honey solutions-treated samples had the best flavour but poor appearance while the control samples scored lower values for flavour, appearance as well as overall acceptability. The sugar solutions-treated samples were found much better, scoring maximum for appearance and overall ac-

Table 1— Mean* sensory scores of raisin samples treated in 60^{O}B osmotic solutions

Treatment	Texture	Flavour	Appearance	Overall acceptability
Control	7.5^{a}	6^{a}	4^{a}	6^{a}
Sugar	7.5^{a}	7^{b}	8^{b}	8^{b}
Honey	7.5^{a}	8^{c}	5^{c}	7^{c}

*Means superscripted with the same letter in a column are not significantly different ($P>0.05$)

ceptability. The texture scores were the same for all the three samples.

Conclusion

For the production of raisins through dehydration of grapes, the sugar (sucrose) at 60^{O}B is the most suitable osmotic agent. Honey solution could also be used as it improved the flavour considerably, provided the appearance could be improved through some other treatment.

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