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Influence of pre-treatment on total soluble solids, titratable acidity and sugars of raisin

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Abstract
Drying or dehydration is one of the oldest and most important methods for preserving food. The basic problem in grape dehydration has been the slow rate of moisture removal during the drying process. Pre-treatment is a necessary step in raisin production. Increase in temperature of the alkaline dipping solution was further capable of loosening and widening the waxy plates that resulting in higher level of outer skin permeability of grapes and in higher mass transfer without affecting physico-chemical and organoleptic properties of raisin. In present study, grape bunches pre-treatment with 1% ethyl oleate and 1% potassium carbonate**,** 1.5% ethyl oleate + 2.5% potassium carbonate dipping solution at 45˚C and 55˚C had no effect on total soluble solids (TSS), titratable acidity and sugars (total, reducing and non-reducing sugar).

Keywords: raisins, TSS, acidity, sugars

1. Introduction
Grape (*Vitis vinifera* L.) is a leading fruit with world annual production of 75.80 million metric tons (Anon, 2017a) [1]. Grape is an important commercial fruit crop of India, which contributes to the maximum share among the fresh fruits and vegetables exported from India to Europe and other parts of the world. According to the estimate of NHB, the total area and production of grapes in the year 2016-17 was 136.0 thousand hectares and 2683.3 thousand MT respectively. Major grapes growing states are Maharashtra, Karnataka, Andhra Pradesh, Tamil Nadu, and the North-Western region covering Punjab, Haryana, western Uttar Pradesh, Rajasthan and Madhya Pradesh. Maharashtra ranks first in terms of production accounting for more than 82.56 per cent of total production and highest productivity in the country. The total grape exported from India during the year 2016-17 was 232.9 thousand tonnes worth Rs. 2088.35 crores (Anon, 2017b) [2].

Fresh grapes, a seasonal fruit having relatively high sugar and moisture content, are very sensitive to microbial spoilage during storage even under refrigerated condition (Xiao *et al.*, 2010; Xiao and Mujumdar, 2014) [3, 4]. Therefore, after harvest grapes must be consumed or processed into various products in a few weeks in order to reduce economic losses. Drying or dehydration is one of the oldest and most important methods for preserving food, including grapes (Defraeye, 2017) [5]. Grapes are processed into raisins for longer shelf-life as well as into dehydrated grapes, for use in wine or juice production.

Pre-treatment is a necessary step in raisin production which includes chemical, physical and blanching in order to ensure the increased rate of water removal during the drying process. A faster water removal rate decreases the rate of browning and helps to produce more desirable raisins. Food products generally undergo some pre-treatment before drying with intention of some changes either physical or chemical – which help to enhance mass the transport and hence the drying rate as well as quality of the dried products. Pre-treating helps to keep light-coloured fruits from darkening during drying and storage and it speeds up the drying of fruits with tough skins (Lokhande and Sahoo, 2016) [6].

Various chemical pre-treatments (hot and cold) have been used to increase the drying rate of grapes (Grncarevic, 1969; Winkeler *et al.*, 1974) [7, 8]. Wax compounds present on surface of grape berry have high molecular weight and they are insoluble in water and a melting point between 40 and 100˚C (Glenn *et al.*, 2005) [9]. According to some investigators, dipping in hot chemical solutions and in boiling water have resulted in poor quality raisins that were sticky in

nature with micro-cracks on their outer surface (Esmaiili *et al.*, 2007; Pangavhane *et al*., 1999) [10, 11].
Increase in temperature of the alkaline dipping solution was further capable of loosening and widening the waxy plates that resulting in higher level of outer skin permeability of grapes and in higher mass transfer without affecting physico-chemical and organoleptic properties of raisin (Singh *et al*., 2014; Bingol *et al*., 2012) [12, 13]. Therefore, the study was conducted to study the effect of pre-treatments on total soluble solids (TSS), titratable acidity and sugars (total, reducing and non-reducing sugar) of raisins.

2. Material and Methods

Fresh grapes bunches (variety Thompson seedless) used in the present investigation were procured from a well maintained grapes orchard in Vijayapura (District).

Preparation of fruits

Grape bunches harvested at full maturity (22˚B) were brought to the commercial raisin making shed in the farmers' field. Grapes were sorted to remove dead, diseased and under developed berries. Later, the grapes were washed with normal water before subjecting to pre-treatments.

Pre-treatments (3 Treatments with 7 replications)

1. Control (Farmers' practice) 1.0 per cent ethyl oleate + 1.0 per cent K_2CO_3 in normal water (100 litre of chemical solution for 2 tonnes of grapes) for 5 minutes
2. 1.5 per cent ethyl oleate + 2.5 per cent K_2CO_3 dipping solution at 45ºC for 5 minutes
3. 1.5 per cent ethyl oleate + 2.5 per cent K_2CO_3 dipping solution at 55ºC

Drying

Pre-treated grape bunches were dried under raisin making shed till reaching a safe moisture level of 17-20 per cent. The average ambient temperature in the drying shed during the study period was 36±2˚C. The time required for drying in treatments to reach the safe and optimum moisture level of 18-19 per cent.

Separation of dried grapes

Separation of dried grapes (raisins) from its stalks and rachis in bunches was done manually. The raisins were then brought to laboratory of Dept. of Post Harvest Technology, College of Horticulture, Bagalkot for further studies.

Washing

Raisins were washed with hot water at a temperature of 85±2˚C in laboratory in order to remove chemical residue present on the surface of raisins.

Drying

Washed raisins were shade dried in the laboratory to remove excess surface moisture.

2.1 Observation recorded are titratable acidity (%), total soluble solids (˚B), total sugar (%), reducing sugar (%) and non-reducing sugar (%)

Titratable acidity (%)

The titratable acidity of raisin was calculated by titration method. A known quantity of sample (2g) was taken and titrated against standard 0.1N NaOH using phenolphthalein as an indicator. The end point of the titration was determined by taking the amount of NaOH required to reach pH 8.1 (appearance of pink colour). The value was expressed in terms of tartaric acid as per cent titratable acidity (Srivastava and Sanjeevkumar, 1998) [14].

Total soluble solids (ºBrix)

Total soluble solids in raisin were measured using digital refractometer. A known quantity of sample was crushed with a known volume of distilled water at 1:1 ratio. TSS of juice obtained was read in a refractometer in ˚Brix.

Total sugar (%)

The total sugar content of the raisin was estimated by Anthrone reagent method. One gram of sample was taken and the volume was made up to 5 ml using 2.5 N HCl. The samples were subjected to hot water bath (at 95˚C) for 2-3 hours. After cooling it to room temperature, a pinch of sodium carbonate was added to neutralize the remaining acid in the sample after extraction. The sample was filtered and the volume was made up to 100 ml using distilled water. From that, 0.5 ml was taken and 0.5 ml distilled water was added followed by addition of 4 ml Anthrone reagent and it was heated (50-60˚C) for 5-8 minutes. The sample was cooled down and the intensity of dark green colour (absorbance) was read using spectrophotometer at 630 nm. A graph was drawn by plotting concentration of the standard on the x-axis and absorbance on the y-axis. From the graph, the amount of total sugar present in the sample was calculated. The values obtained were expressed as percentage.

Reducing sugars (%)

Reducing sugar in the sample was estimated by di-nitrosalicylic acid method (Miller, 1972) [15]. One gram of sample was ground in 10 ml water to extract the biomolecule. Centrifuging was done at 2700 rotation per minute for 10 minutes. The supernatant was separated and one ml of the same (or one ml sample directly after grinding with water) was taken and 2 ml di-nitrosalicylic acid was added. The samples were then kept in hot water bath for 5 min at 80-90˚C. After cooling the samples to room temperature, the absorbance value at 510 nm were taken using spectrophotometer. A graph was drawn by plotting concentration of the standard on the x-axis and absorbance on the y-axis. From the graph, the amount of reducing sugars present in the sample was calculated. The values obtained were expressed as percentage.

Non-reducing sugars (%)

The per cent non-reducing sugar was obtained by subtracting the value of reducing sugar from that of total sugar as given by Miller (1972) [15].

2.2 Statistical analysis

Statistical analysis was performed using Web Agri Stat Package (WASP) Version 2.0 (Jangam and Thali, 2010) [10]. All data the collected were analysed by one-way analysis of variance (ANOVA). Significant differences among means at $P \leq 0.05$ were determined by post hoc tests using Duncan's multiple range test.

3. Results and Discussion

The observations on changes in total soluble solids (TSS), titratable acidity (%) and sugars (total, reducing sugar and non-reducing sugar) as influenced by pre-treatments are given in Table 1. The data revealed no significant differences among the treatments. However, numerically maximum TSS

was recorded in T_2 (43.70˚B) followed by T_3 (43.55˚B**)**. Minimum TSS was in observed in T_1 (43.39˚B). Minimum titratable acidity was noticed in T_3 (0.70%) followed by T_2 (0.76%). Maximum titratable acidity was recorded in T_1 (0.77%). Maximum total sugar was recorded in T_2 (63.37%) followed by T_1 (63.34%) and minimum total sugar was observed in T_3 (63.32%). Maximum reducing sugar was recorded in T_2 (62.46%) followed by T_3 (62.40%) and minimum was noted in T_1 (62.25%). Minimum non-reducing sugar was recorded in T_2 (0.90%) and was recorded in T_3 (0.93%). Maximum was recorded in T_1 (1.09%).

Table 1: Effect of pre-treatment on total soluble solids (TSS) (ºB) and titratable acidity (%) and sugars (total sugar, reducing sugar and non-reducing sugar) of raisins

Treatments	TSS (ºB)	Titratable acidity (%)	Total sugar (%)	Reducing sugar (%)	Non-reducing sugar (%)
T_1	43.39	0.77	63.34	62.25	1.09
T_2	43.70	0.76	63.37	62.46	0.90
T_3	43.55	0.70	63.32	62.40	0.93
Mean	43.55	0.74	63.34	62.37	0.97
S.Em±	0.43	0.03	0.12	0.07	0.13
CD@5%	NS	NS	NS	NS	NS

As the intial quality of raw material used was similar with respect to variety and maturity stage, the TSS, sugars and titratable acidity of raisins is not expected to vary. Further, pre-treatments employed in this study influenced drying time but not the biomolecule levels. This may probably be due to the fact that grapes were subjected to dry to the same dryness irrespective of the pre-treatments. However, adapting different drying techniques may possibly affect sugars, TSS, acidity *etc*. Microwave drying of grapes resulted maximum retention of sugars (glucose 34 mg/100g, fructose 41.3 mg/100g) and titratable acidity (1847 mg/100g of sample) and hot air drying resulted minimum sugars (glucose 22 mg/100g, fructose 34 mg/100g) (974 mg/100g of sample) as reported by Carranza-Concha *et al.* (2012) [16]. According to Adiletta *et al*. (2015) [17], physical abrasive treatment and chemical treatment of grape bunches had no much impact on sugars and titratable acidity of raisin as it was affected by drying process. A reduction of sugar content was observed during drying, probably caused by non-enzymatic browning reactions. Lokhande and Sahoo (2016) [6] also did not observe much variation with respect to TSS, sugars and acidity in raisin between control and pre-treated grapes. In the present study, maximum TSS was recorded in T_2 (43.70˚B) followed by T_3 (43.55˚B**)**. Maximum total sugars, reducing sugars and minimum non-reducing sugars were recorded in T_2 (63.37, 62.46 and 0.90%). Minimum TSS was in recorded in T_1 (43.39˚B). Minimum titratable acidity was recorded in T_3 (0.70%) followed by T_2 (0.76%) and maximum acidity was recorded in T_1 (0.77%).

4. Conclusion

Grape bunches pre-treatment with hot water (45 and 55˚C) containing 1.5% ethyle oleate and 2.5% potassium carbonate) had no effect on total soluble solids (B), titratable acidity (%) and sugars (total sugar, reducing sugar and reducing sugars) (%) of raisin.

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