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Harvest Date and Post Harvest Alkaline Treatment Effects on Quantity and Quality of Kashmar, Iran, Green Raisin

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ABSTRACT

The yield and quality features of raisin are affected by various factors especially harvest date and dipping solutions. Combinations of different harvest date (four harvest dates) and post harvest alkaline emulsion (three alkaline solutions) were tested in *Vitis vinifera* L. cv 'Paycamy' green raisin production in Kashmar, Khorasan Province of Iran. Such raisin quantitative and qualitative characteristics as: yield, drying ratio (fresh: raisin yield), raisin wastes, sugar content, price, color, homogeneity of color, raisin size, alkaline solution residues and surface texture of raisin (shrinkage) were assessed. Harvest date results showed that grape °Brix and raisin sugar content increased from 15.5 to 21 and 53% to 62% respectively. In addition, fourth harvest yield increased raisin yield up to 30% as compared to the first harvest. The amount of wastes resulted from decayed berry in the fourth harvest was higher than those for the other harvest dates, but such qualitative traits as color, size and texture softness improved through further fruit ripening. Interaction effect of alkaline solution and harvest date on price and raisin size (number of raisins per 100 g) were significant ($P< 0.01$). Alkaline solution affected raisin waste, the differences among post harvest treatments being significant. The color of raisin was not affected by alkaline solution but it was steadily improved with each succeeding harvest date.

Keywords: Grape (*Vitis vinifera* L. cv. Paycamy), Green raisin, Harvest time, Post harvest treatments, Raisin quality.

INTRODUCTION

Drying is probably the oldest method of preserving fruits. It was initially used as a way of storing foods for the low supply season (Ramos *et al*., 2003). Dried grapes, commonly known as raisins, are of a great economic importance for many countries (Pangavhane and Sawhney, 2002). Turkey, USA, Greece, Iran and Australia are the main raisin producers in the world (Strzelecki, 1994; Thompson and Kirby, 1994). Different grape cultivars are consumed as table grape, raisin and in processed forms (Salunkhe and Desai, 2001). In addition, there are many factors affecting the quality as well as yield of raisins. The physical characteristics of raisins from different countries are quite different, while chemical characteristics being fairly consistent. The physical characteristics found out are probably the result of cultivars, cultural, and processing differences (Bongers *et al*., 1990). The quality of raisin was affected by such preharvest operations as irrigation, nutrition, pruning, crop per vine, bunch growth condition, pest and disease control methods and the proper harvest time as well as such postharvest factors as proper handling of bunches, applying a suitable method for raisin production, environmental conditions

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and the duration of drying time (Jalili Marandi, 1996).

The fresh and dried fruit factors which influence raisin yield and quality are important to the harvesting, processing and marketing decisions of raisin producers and packers (Christensen *et al.*, 1995 b). Several studies have been carried out on changes in grape fruit characteristics and in composition during ripening (Peter *et al.*, 1995 a). Sugar accumulation increases rapidly after veraision (Christensen *et al.,* 1995 a) and is accompanied by a decrease in Titratable Acidity (TA) (Nunan *et al.*, 1998; Arzani and Koushesh saba, 2006). It is well recognized that raisin quality is greatly influenced by the sugar (expressed as Soluble Solid, SS) at harvest. The recommended minimum level of fruit maturation for drying `Thompson seedless' (*Sultana*) is about 19 °Brix.

In grape drying, the rate of moisture diffusion through the berries is controlled by the waxy cuticle of the grapes (Pangavhane *et al.*, 1999). A number of authors have reported the effects of pre-treatments on the drying rates and quality parameters of various foodstuffs. Some experimental results on grape drying are reported in the literature (Raouzeos and Saravacos, 1986; Aguilera *et al.*, 1987; Tulasidas *et al.*, 1996; Karathanos and Belessiotis, 1997). Dipping in hot water or the use of such chemicals as alkaline, sulphur, caustic and ethyl or methyl oleate emulsions are some of the pre-treatments widely used for grape drying (Doymaz and Pala, 2002). Different alkaline solutions are such as simple soda solution, potassium carbonate with olive oil, carbonate with olive oil as well as "alkaline rock" are used (Salunkhe and Desai, 2000). "Alkaline rock" is extracted from *Salsola soda* (a plant species locally called '*Shoran'* or '*Eshnabian*') which has been historically used for raisin production in some regions in Iran.

Iran is the origin of grape *Vitis vinifera* (Winkler, 1970), thus there is a wide diversity of cultivars around the country. Cultivar `*Paycamy*' is a late ripening cultivar with strong vigor, hermaphrodite flowers, bunch length of about 12.5 cm and berry of a low density (Mokhtarian, 1997). It has been used for experiments carried out here because of its good horticultural traits as well as its commercial value.

Quality is one of the main concerns in raisin production. By that reason, extensive research projects are necessary to enhance the quantity and quality of raisins. Accurate grape harvest date (Bongers, *et al.*, 1990) and the suitable solution as a pre-treatment for producing raisins (Doymaz and Pala, 2002; Tafazzoli, 1995) are two main factors affecting raisin quality. Therefore, the main objective of this research was to explore the best harvest date for '*Paycamy*' cultivar as well as to determine the optimum alkaline solution for green raisin production.

MATERIALS AND METHODS

Farm experiments were carried out in the Kashmar Agricultural Research Station vineyard, (Khorasan Province, Iran). Laboratory work was carried out in the Department of Horticultural Sciences, Tarbiat Modares University (TMU), Tehran, Iran. Evaluation of raisins were made according to the standards of the Institute of Standard and Industrial Research of Iran (ISIRI).

The experiment was designed as a factorial (Four harvest dates×Three postharvest applied alkaline solutions) based on a Randomized Complete Block Design (RCBD) with 3 replications. First harvest date was chosen as simultaneous with the beginning of the local harvest date. Succeeding harvests were performed with 10 days interval following the first harvest date. At any harvest, about 9 kg of fruit were collected. Then 7 kg of the fruit were taken for alkaline treatments after the decayed berries being trimmed from the clusters. A 100-berry sub sample was macerated in a food blender and the clear juice assessed for SS as °Brix using a hand-held temperature compensating Atago N-20 refractometer as described previously by Saini *et al.* (2001). Harvested grapes were mixed and divided into three portions, each one being treated with a dif-

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ferent solution. The three alkaline solutions (B) employed were: 2% alkaline solution (temperature of solution adjusted to 27°C) derived from alkaline rock (B_1); 2% alkaline solution (temperature of solution adjusted to 50°C) derived from alkaline rock (B_2) and 2% alkaline solution (temperature of solution adjusted to 27°C) derived from potassium carbonate and olive oil (B_3).

The treated bunches were hung on wires in special rooms with netted (reticulated) walls and at room temperature. Then after drying, raisin characteristics were recorded as for quantitative and qualitative evaluations. Quantitative traits were: yield (kg of raisins obtained from 7 kg of grapes), drying ratio (fresh grape to obtained raisins), raisin wastes (g decayed raisin per 7 kg of grape), sugar content (%) and price (U. S. $) per kg (based on the market price). Also some such qualitative traits as color, color homogeneity, raisin size, alkaline solution residues and raisin surface texture (shrinkage) were recorded. Five color classes were applied for color ranking: A, B, C, D, and E which respectively stand for pale green, yellow, amber yellow, dark amber yellow, and mixed yellow (the mixture in which the percentage of dominant color did not exceed 60%). Numbers obtained as bellow were assigned for identifying color homogeneity: 100 g of raisin was weighed, the separation of which was done according to the mentioned color classifications. Number of raisins in each color class was written down as color class number denoted by A. Then the total number of raisins in 100 g (N) was counted. The percentage of each color class was obtained based upon the following formula: $(A/N) \times 100$ (Anonymous, 1996). Considering the number of raisins per 100 g, three classes ranked were: big (210-240 raisins per 100 g), medium (240-270 raisins per 100 g) and small (270-300 raisins per 100 g), to determine raisin size. Fehling solution was used for sugar content determination. Raisin water content was determined through vacuum drying method (Hosseini, 1995). The residue of alkaline solutions and covering surface texture (shrinkage) were determined through visual observation. Grape in the early harvest stage is of a high level of moisture content so that after drying, surface texture of raisin becomes shrinked and almost the only way of assessing this quantitative parameter would be visual observation. The shrinkage levels were ranked into High (H), Medium (M) and Low shrinkage (L). Data were subjected to analysis of variance (ANOVA) using MSTATC software while a comparison of the means being made through Duncan's Multiple Range Test (DMRT).

RESULTS

Harvest Date

Data analysis showed that the effect of harvest date on yield, drying ratio, the amount of wastes, sugar content as well as the economic value of product was significant ($P< 0.01$) (Tables 1 and 2). Fresh grape Soluble Solids (SS) consistently increased from 15.5 °Brix in the first harvest date to 21 °Brix in the fourth date. Means comparisons of raisin yield showed a gradual increase from the first to fourth harvest date. The difference between the first and second harvest was significant, but there were no significant differences observed between the second and third stages of fruit harvest, although, the differences observed between fourth and the other fruit harvests were significant ($P< 0.01$). The drying ratio showed a significant decrease ($P< 0.01$) from the first to fourth harvest, so that in the first harvest 1 kg of raisin was obtained from 4.42 kg of grapes while in the fourth fruit harvest the same amount of raisin was obtained from 3.35 kg of grapes (Table 2). The amount of waste became higher with each succeeding harvest date, but there were no significant differences observed for this trait among the first three harvest dates. The fourth harvest date was accompanied by the greatest raisin wastes (Table 2). In addition, the sugar content of raisin increased throughout the whole harvest period, significant differences being

Table 1. Analysis of variance (ANOVA) for yield and other quantity, quality and price attributes of green raisin in different harvest dates and post harvest alkaline solution treatments.

Source of variation S.O.V	Yield (kg of raisin from 7 kg grapes)		Drying ratio (fresh grape to obtained raisin)		Wastes (g decayed raisin per 7 kg grape)		Sugar content (%)		Price (U.S. $ per kg)	
	MS [a]	F [b]	MS	F	MS	F	MS	F	MS	F
Harvest date (H)	0.48	30.58**	1.86	48.09**	0.0	21.09**	214.48	155.89**	41.43	62.15**
Alkaline solution (B)	0.004	0.24[ns]	0.05	1.36[ns]	0.01	7.90**	1.25	0.91[ns]	32.25	48.37**
H ×B	0.01	0.51[ns]	0.05	1.19[ns]	0.001	1.26[ns]	1.48	1.08[ns]	20.46	30.99**

[a] Mean square.
[b] *F* value: * ($P\leq0.05$), **($P\leq0.01$) and ns, Not significant

Table 2. Effects of harvest date on yield and other quantity and quality attributes of green raisin.

Treatment	Yield (kg of raisin from 7 kg of grapes)	Drying ratio (fresh grape to obtained raisin)	Wastes (g decayed raisin per 7 kg of grape)	Sugar content (%)
First harvest date	1.58c	4.42a	139.44b	52.51c
Second harvest date	1.78b	3.88b	145.55b	55.44b
Third harvest date	1.90b	3.63c	161.11b	61.44a
Fourth harvest date	2.14a	3.35d	308.88a	62.8a

Mean separation within column by Duncan multiple range tests at $P\leq0.01$.

observed among different harvest dates (Table 2).

Alkaline Solutions

Alkaline solutions significantly affected the amount of wastes and raisin price but did not influence raisin yield, drying ratio and sugar content (Table 1). As shown in Figure 1, the highest level of wastes was resulted from the first solution treatment and the lowest from the third solution (Figure 1). The highest and the lowest raisin prices were obtained from B_3 and B_1 solution treatments respectively.

The Interaction Effects

There were significant interaction effects observed between harvest date and alkaline solution treatments for the price of raisin but not for the other traits. Mean comparisons showed that the highest and the lowest prices belonged to the mutual effect of forth harvest date with third solution treatment and the second harvest date with the first solution treatment respectively (Figure 2).

Effect of harvest date and postharvest alkaline solution treatments on raisin qualitative traits showed that raisin color from the first harvest date was pale or yellowish green and there were no obvious differences in terms of raisin color among the three alkaline solution treatments. In the second harvest the color gradually turned into yellow but there were no differences observed among post harvest solution treatments. As for the third harvest date, the color of raisins obtained from B_1 and B_2 treatments was close to yellow (mixed yellow), but for B_3 treatment the color was amber yellow. The number of raisins per 100 g decreased from the first to the fourth harvest date so that the number decreased from 258.6 raisin berries$\times$100 g raisin^{-1} in the first harvest to 223 raisin berries $\times$100 g raisin^{-1} in the fourth harvest date.

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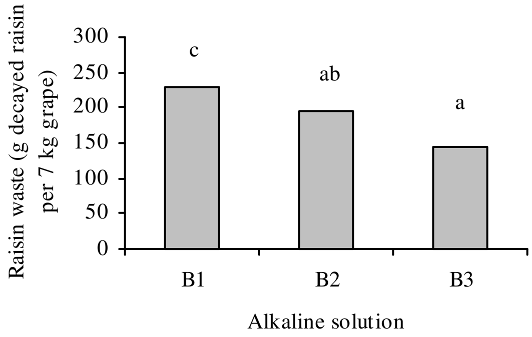

Figure 1. Effect of post harvest alkaline solutions on raisin waste. B_1, B_2 and B_3 solutions were 2% alkaline solutions with adjusted temperature of 27°C, 50°C and 27°C respectively. Bars labeled with the same letters were not significantly different at $P≤0.01$.

The alkaline solution residue on the final product was observed only with B_1 and B_2 solution treatments. The rate of shrinkage decreased from the first to the fourth harvest dates (Table 3). Raisins produced from the first, second and third harvest dates showed high, medium and low shrinkages respectively. Raisins produced from the fourth harvest date exhibited no shrinkage signs, keeping their original natural shape.

DISCUSSION

Results obtained from this research demonstrated that harvest date and postharvest alkaline solution treatments affect quality and quantity of produced raisins. ºBrix increased rather steadily from 15.8 in the first harvest to 21 in the last one, at a rate averaging 0.17 ºBrix per day. This rate is somewhat higher than the rate of °Brix increment observed for '*Thompson Seedless*' cultivar (Christensen *et al*., 1995a).

Raisin yield, without the amount of wastes being taken into account, increased from the first to the last harvest date, although there was no significant difference observed between the second and third harvest dates

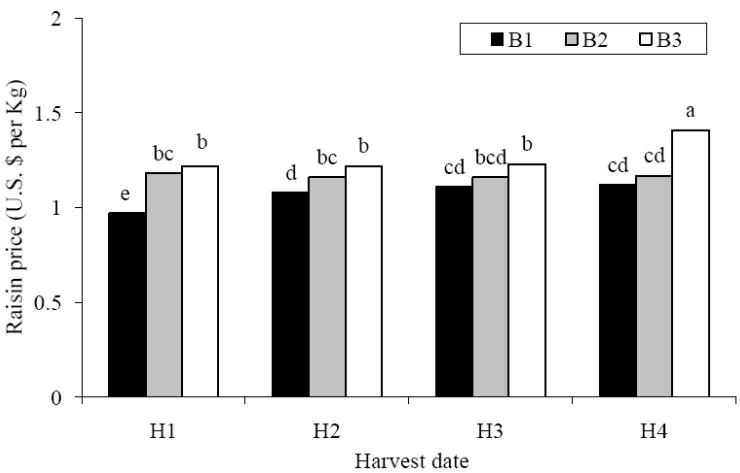

Figure 2. Interaction effects of harvest date and post harvest alkaline solution treatments on raisin price. H_1: Harvest 1; H_2: Harvest 2, H_3: Harvest 3 and H_4: Harvest 4, B_1, B_2 and B_3 solutions were 2% alkaline solutions with adjusted temperature of 27°C, 50°C and 27°C respectively. Bars labeled with the same letters were not significantly different at $P≤0.01$.

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Table 3. Effect of harvest date (H) and post harvest alkaline solution (B) on raisin surface, covering solution residues, raisin size, and color.

Treatments	The raisin covering surface texture	Solution residues	Raisin size [e]	Color [f]
H_1B_1	H [a]	+	Medium	A
H_1B_2	H	+	Large	A
H_1B_3	H	-	small	A
H_2B_1	M [b]	+	Medium	B
H_2B_2	M	+	Large	B
H_2B_3	M	-	small	B
H_3B_1	L [c]	+	Large	E
H_3B_2	L	+	Medium	E
H_3B_3	L	-	Large	C
H_4B_1	No [d]	+	Large	D
H_4B_2	No	+	Medium	D
H_4B_3	No	-	Large	C

[a] H= High shrinkage, [b] M= Medium shrinkage, [c] L= Low shrinkage and [d] No= No shrinkage, += With residue and –= No residue, [e] Large= 210-240 raisins per 100 g, Medium= 240-270 raisins per 100 g and Small=270-300 raisins per 100 g, [f] A= Pale green; B= Yellow; C= Amber yellow, D= Dark amble yellow and E=Mixed yellow.

(Table 2). Maximum yield (2.14 kg) was obtained for the fourth harvest date. Christensen *et al*. (1995 a) showed increasing raisin yield with delayed harvest date in `*Thompson Seedless*' and mentioned that this effect can be largely attributed to increased SS.

The effect of harvest date and post harvest alkaline solution treatments on raisin wastes was significant. Although early harvest greatly reduced the quality and quantity of the product, in late harvests too, the percentage of fruit decay and raisin wastes increased considerably due to sun burn and other adverse environmental factors. The difference among harvest dates was significant as the quality and quantity of the product is concerned. The increase in waste may be explained by the increase in the amount of decayed berries. Other studies have demonstrated losses of yield from late harvests, some of which are attributable to increased fruit decay (Christensen *et al*., 1995 a). Several authors reported that alkali concentration and long dipping time can cause adverse changes in the quality of dried grapes (Doymaz and Pala, 2002; Saravacos *et al*., 1988). The results obtained here demonstrated that raisin wastes were also affected by the post harvest treatments. B_3 and B_1 solutions resulted in the minimum and maximum wastes respectively.

Sugar content of raisins was not affected by the post harvest treatments (Table 1), but showed a 10% change from the first to the fourth harvest, which affects both grape berry weight and final product quality. In addition, both harvest date and post harvest treatments affected raisin price, so that the best result was obtained by the last harvest date along with B_3 post harvest treatment. However, there was a trend towards increase in raisin waste from the first to last harvest date, but the economic value of raisin was improved, somehow compensating for the loss due to waste.

Fruit ripening stage and dipping treatments affected such qualitative traits as color and raisin size. As a general trend, raisin had its highest size from the last harvest date. The same results were reported by Christensen *et al*. (1995 a, b). In this study, fresh berry SS and raisin sugar contents became higher and higher with each succeeding harvest date. Increase in SS and in sugar content and a decrease in water content by progression of ripening stage, may be the cause for raisin size improvement. When the fruit was more fully ripened the resulting raisin color improved and a more homogenous amber yellow color was obtained.

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Shrinkage level became lower in the last harvest date with the different dipping treatments almost having no effect on shrinkage.

It has been reported that the aim of using pretreatment solutions is to increase drying rates and to produce raisins of a more desired quality level (Doymaz and Pala, 2002; Pangavhane and Sawhney, 2002). In alkaline solution treatments concentration and temperature are two important factors. Kazemi (1990) reported that 5% potassium carbonate along with 0.5% olive oil as an emulsifying component is the best combination for alkaline solution treatment, but this formulation will be different for other cultivars and for the other procedures of raisin production. The proper concentration of alkaline rock was reported as much as preventing the irritation of the finger skin and the best temperature was recommended to be at the boiling point of solution (Sheibani, 1987). It seems this recommended temperature is not suitable for all cultivars, because of changing the color and spoiling the raisin texture. Results of this study showed that a use of potassium carbonate alkaline solution does not leave any visually evident defect on the raisin, while alkaline rock produces white spots on the surface of raisin, which adversely affects quality and market-ability of the final product. It is concluded that the best time of grape harvest for raisin production is sometime between the third and fourth harvest dates, when the ripening stage is close to 21 °Brix. In addition potassium carbonate (2%) together with olive oil is more appropriate than alkaline rock. In the case of using alkaline rock solution, care must be taken to apply a fine filtration of the solution. Methods recommended for other regions would be adjusted for, depending on raisin production process, and climatic conditions of the region.

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اثرات زمان برداشت و محلول های قلیایی پس از برداشت روی کمیت و کیفیت کشمش سبز کاشمر

ک. ارزانی، ا. ح. شرافتی و م. کوشش صبا

چکیده

عوامل متعددی میزان عملکرد و کیفیت کشمش را تحت تاثیر قرار می دهند که از مهم‌ترین آنها زمان برداشت انگور و تیمار پس از برداشت می باشد. به این منظور ترکیبی از زمان های برداشت مختلف (چهار زمان برداشت) و تیمار محلول های قلیایی پس از برداشت (سه محلول قلیایی) بر روی تولید کشمش سبز پیکامی در شهرستان کاشمر (استان خراسان) مورد بررسی قرار گرفت. برخی صفات کمی و کیفی کشمش از قبیل عملکرد، نسبت انگور به کشمش، ضایعات کشمش، میزان قند، قیمت، رنگ، یکنواختی رنگ، اندازه کشمش، آثار باقی مانده محلول و وضعیت سطح پوست کشمش (چروکیدگی) اندازه گیری شد. نتایج زمان برداشت نشان داد که میزان قند انگور و کشمش به ترتیب از ۱۵/۵ تا ۲۱ و ۵۳ ٪ تا ۶۲٪ افزایش یافت. علاوه بر آن میزان عملکرد کشمش در برداشت چهارم در مقایسه با برداشت اول ۳۰ درصد افزایش یافت. میزان ضایعات کشمش در برداشت چهارم بیش تر از سایر زمان های برداشت بود اما، صفات کمی از قبیل رنگ و اندازه با پیشرفت رسیدگی انگور افزایش یافت. اثر متقابل محلول قلیایی و زمان برداشت روی قیمت و اندازه کشمش (تعداد کشمش در ۱۰۰ گرم) معنی دار (P< ۰/۰۱) بود. میزان ضایعات کشمش تحت تاثیر محلول های قلیایی قرار گرفت و اختلاف بین تیمارهای پس از برداشت معنی دار بود. رنگ کشمش تحت تاثیر محلول های قلیایی قرار نگرفت اما، با پیشرفت رسیدگی کیفیت آن بهبود پیدا کرد.

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