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PERFORMANCE OF GRAPE VARIETIES FOR RAISIN RECOVERY AND RAISIN QUALITY UNDER SEMI-ARID TROPICS

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ABSTRACT

This study evaluated the quality parameters of different grape varieties for raisin production in tropical climates. The study was conducted at experimental farm of ICAR-National Research Centre for Grapes Pune Maharashtra India. The field experiment was conducted in randomized block design (RBD) with three genotypes as treatments replicated seven times. The growth and quality parameters include shoot length, diameter, inter-nodal length, leaf area, and the number of canes/vines, bunches / vine, average bunch weight, berry diameter, TSS, acidity, yield, raisins recovery and sensory evaluation of raisins. The findings highlight Manjari Kishmish grapes exhibited the highest yield, raisin recovery, and overall acceptability among the varieties tested. Also, Manjari Kishmish and Thompson Seedless showed high total soluble solids (TSS) and optimal acidity levels, contributing to better raisin quality. Significantly, highest shoot length and shoot diameter was observed in Kishmish Rosavis. Manjari Kishmish was preferred for raisin colour, and flavour while Kishmish Rosavis for sweetness. The study concluded that grape variety significantly affects raisin quality with Manjari Kishmish being the best choice for raisin production in tropical regions of Maharashtra.

Key words : Grape, Raisin's recovery, Growth, Quality, Yield.

Introduction

The grape (*Vitis vinifera* L.) is an important fruit crop grown in different parts of the country. Basically, it is a temperate crop that has been successfully adapted to the sub-tropical as well as tropical climate and is well-known for its various health benefits. The cultivated area under grape is approximately 1.62 lakh ha in India, resulting an annual production of 34.45 lakh MT with an average productivity of 21.00 MT/ha (Anonymous, 2022). In India, grapes are enjoyed as table grapes (71%) and remaining used for the production of different products such as juice (0.5%), wine (1.5%) and raisins (27.0%) (Sharma *et al*., 2018). About 90% production of Maharashtra are primarily used for raisin making by using Thompson Seedless or its clonal like Tas-A-Ganesh and Sonaka (Somkuwar *et al*., 2019). This is because seedless raisin varieties have higher phenolic compound, vitamin, and mineral content, as well as higher antioxidant capacity compared to seeded varieties (Kaya *et al*., 2022). The sugar content in grape berries at the time of harvesting also plays a significant role in raisin recovery, in addition to the total yield (Sharma *et al*., 2018). The harvesting dates also impact the yield, colour, and quality of raisins, with well-matured grapes resulting in fewer brown and mixed-coloured raisins and an increase in green-coloured ones in Thompson Seedless or its clonal varieties (Venkatram *et al*., 2020). Physical characteristics, chemical composition, and optimization of drying and pre-treatment operations responsible for quality of raisins (Khiari *et al*., 2018). Both grapes and raisins have a

significant role in the food industry and offer numerous health benefits when included in the diet. Raisins, being dried grapes, inherit all the benefits of grapes and offer additional advantages such as longer shelf life and concentrated nutrients (Ghule *et al*., 2021). They are used in various culinary applications, from snacks to desserts and savoury dishes, due to being a rich source of carbohydrates, glucose, and fructose, making them a healthy snack option (Ghrairi *et al*., 2013). Raisins have been extensively studied as a valuable nutritional resource, rich in vitamins, minerals, antioxidants and fiber. Their consumption is potentially beneficial for the prevention of gastric cancer, treatment of diabetes, obesity, reduction in risk factors for cardiovascular diseases and reduction of dental decay (Jeszka-Skowron *et al*., 2020). Furthermore, individuals who incorporate raisins into their diet tend to have higher energy intake, increased consumption of fibre, potassium, magnesium, as well as vitamins C and E. Moreover, such dietary practices are associated with lower consumptions of extra sugar, sodium and saturated fat and (Fulgoni *et al*., 2017). However, the grapes of Manjari Kishmish variety are better suited for making raisins due to their high sugar content, high acidity, overall acceptability, colour, and flavour, higher protein content and higher carbohydrate content thus making them superior to Thompson Seedless for raisin production (Somkuwar *et al*., 2020). The present study therefore aims to investigate growth, quality parameter, raisins recovery and sensory evaluation of raisins of Manjari Kishmish and its parents under tropical condition of Maharashtra. These findings could significantly benefit the grape and raisin industry, contributing to improved dietary practices and economic growth.

Materials and Methods

The study was conducted at experimental farm of ICAR-National Research Centre for Grapes, (latitude 18°32′N and longitude 73°51′E), Pune during 2015-16 and 2016-17. Y system of training was followed to train the vine. Thirteen-year-old grape varieties grafted on Dogridge rootstock were specifically chosen for this research. The vines were planted with a distance of 3.0 m between the rows and 1.83 m between the vines, thus accommodating 1800 vines per hectare. The climate in this area is characterized as mild to slightly dry. Due to the tropical conditions of the region, single cropping and double pruning approach is being adopted. As a result, the vines were pruned two times in a year - once after the crop harvest (known as back pruning) and a second time for fruit production (known as forward pruning). All the standard cultural practices recommended by ICAR-NRC for Grapes were followed during the period of study. The genotype used for evaluation purpose were Manjari Kishmish, Kishmish Rosavisand Thompson Seedless

Vegetative and yield parameters

Measuring tape was used to measured shoot length. Three vines in each replication were tagged and the shoot length was recorded from 5 shoots. The shoot diameter and internodal length (4th and 5th internode) were measured for the same shoots. The shoot diameter was measured using Vernier calliper. Total bunches/vine and average bunch weight was recorded from the selected vines. From the labelled vines, Diameter was measured by using Vernier calliper, randomly10 berries were collected from bunches and five sets were prepared in each replication. Number of canes per vine was recorded at 120 DAP (foundation pruning) retained after foundation pruning and their means were recorded. BIOVIS, leaf area meter used to measure leaf area, randomly five shoots were selected from each vine and all leaves were removed and leaf area were calculated after 120 DAP (Foundation pruning). Their average was worked out and expressed in cm^2.

Quality parameters

OenoFoss (FTIR based wine analyzer) was used to assay of total soluble solids (TSS) and total acidity (TA). Juice was extracted from crushed berries and centrifuged for 5 min at 5000 rpm. and expressed in °Brix and g/L. For calculating raisin recovery, one- kilogram fresh grapes was soaked for ten minutes in an emulsion of 2.5% potassium carbonate and 1.5% ethyl oleate, and then they were dried under raisin shade. Once the dried grapes' moisture content reached 16%, the final weight was measured.

Raisin recovery = Weight of raisins / Weight of fresh grapes × 100.

Organoleptic test

To evaluate the sensory attributes of raisins, an organoleptic test was carried out. The raisins produced for this research were presented to a panel comprising 20 participants from various age groups. A five-point Hedonic scale was used to collect data on sensory characteristics, with the scale ranging from "dislike extremely" to "like extremely." The sensory parameters assessed included color, texture, flavor, sweetness, and overall taste.

Statistical analysis

The experiment was conducted randomized block design, with three distinct genotypes assigned as

treatments and replicated seven times. The data gathered on various parameters were analyzed using the means of each treatment. The statistical analysis of the collected data followed the standard method of analysis of variance, as outlined by Panse and Sukhatme (1985).

Results and Discussion

Growth parameters

The growth parameters of three grape varieties, namely Manjari Kishmish, Kishmish Rosavis and Thompson Seedless were assessed over two consecutive years (2015-16 and 2016-17) and presented in Table 1. Significant differences were recorded for shoot length among the varieties studied. The shoot length of Kishmish Rosavis was significantly higher (97.14 and 92.28 cm) compared to Manjari Kishmish (79.86 and 84.52 cm) and Thompson Seedless (88.74 and 92.39 cm) respectively during both the year of study. The shoot length increased in all varieties except Kishmish Rosavis, which showed a slight decrease. This variation may be attributed to environmental factors, cultivation practices, or hereditary characteristics of each variety (Somkuwar *et al*., 2023). The shoot diameter was significantly influence by the varieties. Highest shoot diameter was recorded in Kishmish Rosavis (8.31 and 8.12 mm) which was at par with Thompson Seedless (8.00 and 8.06 mm) followed by Manjari Kishmish (7.01 and 7.41 mm) respectively during both the year of study. The shoot diameter remained relatively stable for all varieties, with minimal fluctuations. Consistency in shoot diameter suggests uniform growth patterns across the assessed years. Similar to shoot diameter, the inter-nodal length also demonstrated relatively stable values, indicating consistent length between nodes over the two years. Maximum inter-nodal length was recorded in Thompson Seedless (5.50 and 5.60 cm) which was at par with Kishmish Rosavis (5.34 and 5.50 cm) followed by Manjari Kishmish (4.89 and 5.29 cm) respectively during the 2015-16 and 2016-17. The vegetative parameters, such as shoot length, shoot diameter, and internodal length, have an indirect impact on the yield and quality of grapes. When shoot length increases, it results in a higher utilization of photosynthetic products, leaving less available for the development of cane and sink (Somkuwar *et al*., 2023). Keller *et al*. (1998) proposed that higher nitrogen availability, combined with lowered light conditions, promotes the growth of shoots and the expansion of leaf area in grapevines. However, this combination is also associated with a reduction in grape skin weight and the skin-to-berry ratio. The highest leaf area during 2015-16 was recorded in Thompson seedless (165.41 cm^2) followed by Kishmish Rosavis (162.11 cm^2), while lowest leaf area was observed in Manjari Kishmish (157.46 cm^2). In second year of study (2015-16), highest leaf area was recorded in Kishmish Rosavis (161.61 cm^2) which was at par with Thompson Seedless (159.04 cm^2) and Manjari Kishmish (158.25 cm^2). The leaf area exhibited minimal changes, suggesting that the varieties maintained consistent leaf development over the studied period. Highest number of canes/vines was noted in Thompson Seedless (32.00 and 26.41) followed by Kishmish Rosavis (25.77 and 25.91) and Manjari Kishmish (23.76 and 25.85) respectively during the 2015-16 and 2016-17. The number of canes per vine varied across varieties, with Thompson Seedless showing a substantial decrease. This could be influenced by pruning practices or other cultivation factors. Somkuwar *et al.* (2023) found that the decrease in shoot length in Manjari Kishmish and Thompson Seedless grapes was also associated with an increase in the number of bunches. These studies collectively suggest that shoot length, diameter, internodal length, and leaf area are interrelated, influenced by factors such as defoliation, species differences, and shoot size variation (Somkuwar *et al*., 2023b).

Yield and quality parameters

In this study, the quality parameters of three grape varieties were evaluated over two consecutive seasons (2015-16 and 2016-17). The parameters assessed includes bunches per vine, average bunch weight (g), berry diameter (mm), total soluble solids (TSS, in °Brix), and acidity (g/l) are presented in Table 2. The highest number of bunches/vine during 2015-16were recorded in Manjari Kishmish (62.17) followed by Thompson Seedless (58.75) and Kishmish Rosavis (54.04) while, in 2016-17, highest number of bunches/vine were recorded in Manjari Kishmish (66.01), which was at par with Thompson Seedless (65.26), while the number of bunches were observed in Kishmish Rosavis (54.04). In both the years of study, the higher berry weight and berry diameter was noted in Thompson Seedless (401.54 and262.47 g) and (16.20 and15.93 mm) followed by Kishmish Rosavis (352.14 and 259.79 g) and (15.53 and 15.77 mm) and Manjari Kishmish (325.03 and 242.24 g) and (15.27 and 15.69), respectively. The variety Manjari Kishmish also recorded higher TSS (23.67 and 24.01), which was at par with Thompson Seedless (23.58 and 23.84 ^{0}Brix) and Kishmish Rosavis (23.27 and 23.66 ^{0}Brix) respectively. during 2015-16 and 2016-17. The highest acidity was recorded in Kishmish Rosavis (95.92 and 5.53 g/l), which was at par with Manjari Kishmish (5.84 and 5.47 g/l) while, lowest acidity was recorded in Thompson Seedless (5.40 and 5.38 g/l) respectively during 2015-16 and 2016-

Table 1 : Evaluation of grape varieties for growth parameters.

Varieties	Shoot length (cm)		Shoot diameter (mm)		Inter nodal length (cm)		Leaf area (cm^2)		No. of Canes/vine	
	2015-16	2016-17	2015-16	2016-17	2015-16	2016-17	2015-16	2016-17	2015-16	2016-17
Manjari Kishmish	79.86	84.52	7.01	7.41	4.89	5.29	157.46	158.25	23.76	25.85
Kishmish Rosavis	97.14	92.28	8.31	8.12	5.34	5.50	162.11	161.61	25.77	25.91
Thompson Seedless	88.74	92.39	8.00	8.06	5.50	5.60	165.41	159.04	32.00	26.41
S.Em. ±	2.45	2.49	0.21	0.21	0.14	0.15	0.97	0.81	0.76	0.73
CD at 5%	7.24	7.34	0.63	0.64	0.42	0.45	2.88	2.40	2.25	2.16

Table 2 : Evaluation of grape varieties for quality parameters.

Varieties	Bunches/ vine		Av. Bunch wt (g)		Berry dia. (mm)		TSS (^{0} Brix)		Acidity (g/l)	
	2015-16	2016-17	2015-16	2016-17	2015-16	2016-17	2015-16	2016-17	2015-16	2016-17
Manjari Kishmish	62.17	66.01	325.03	242.24	15.27	15.69	23.67	24.01	5.84	5.47
Kishmish Rosavis	54.04	56.15	352.14	259.79	15.53	15.77	23.27	23.66	5.92	5.53
Thompson Seedless	58.75	65.26	401.54	262.47	16.20	15.93	23.58	23.84	5.40	5.38
S.Em. ±	1.05	0.97	6.36	1.55	0.35	0.27	0.2629	0.19	0.15	0.15
CD at 5%	3.10	2.87	18.78	4.57	1.03	0.81	0.7756	0.57	0.46	0.45

Table 3 : Evaluation of grapes varieties for yield and raisins recovery.

Variety	Yield/vine (kg)		Raisin recovery (%)	
	2015-16	2016-17	2015-16	2016-17
Manjari Kishmish	19.86	17.28	26.20	27.34
Kishmish Rosavis	14.83	13.89	25.00	25.29
Thompson Seedless	17.82	16.79	25.66	25.70
S.Em. ±	0.53	0.29	0.24	0.40
CD at 5%	1.58	0.95	0.73	1.31

17. According to Somkuwar *et al*. (2020), higher temperatures under tropical condition can result in a rise in sugar levels and a decrease in acidity. Increasing TSS and decreasing total acidity in raisins can improve their colour, taste and texture (Arzani *et al*., 2009). The weight of raisins is influenced by the weight of fresh berries and the level of soluble solids in the grapes. The weight of fresh berries is the primary factor that determines the quality of raisins (Atak *et al*., 2022).

Yield and raisin recovery

The data recorded on yield and raisin recovery are presented in Table 3. Significant differences were recorded during both the year (2015-16 and 2016-17) of study with respect to the yield/vine (kg) and raisin recovery (%). Manjari Kishmish recorded highest yield (19.86 and 17.28 kg/vine) followed by Thompson Seedless (17.82 and 16.79 kg/vine) while the lowest yield was recorded in Kishmish Rosavis (14.83 and 13.89) during both the year. The highest raisins recovery was found in Manjari Kishmish (26.20 and 27.34%), which was at par with Thompson Seedless (25.66 and 25.70%), while the lowest raisins recovery was recorded in Kishmish Rosavis (25.00 and 25.29) during both years. The higher raisin recovery in Manjari Kishmish might be attributed to the higher TSS content in fresh grape berries. Somkuwar *et al.* (2020) also found that fresh grapes with the highest sugar levels resulted in high raisin recovery. Selecting grapes with higher sugar levels (Brix of 20% or more) results in higher raisin recovery rates and superior quality, appearance and taste (Cha, 2015). Additionally, there was a correlation between higher TSS and raisin recovery in Manjari Kishmish and Thompson Seedless.

Sensory evaluation of raisins

The results of the organoleptic test are presented in Fig. 1. The study was performed during the year 2015-16 revealed that overall acceptability was ranked maximum in Manjari Kishmish (7.31) followed by Kishmish Rosavis (7.19), while lowest was observed in Thompson Seedless (6.40). Manjari Kishmish was preferred for raisins colour (7.90) and flavor (7.80) as compared to other varieties. Kishmish Rosavis (7.40) scored maximum in terms of sweetness. The maximum mean score for texture was found in Thompson Seedless (7.50) followed by Manjari Kishmish (7.10), while lowest

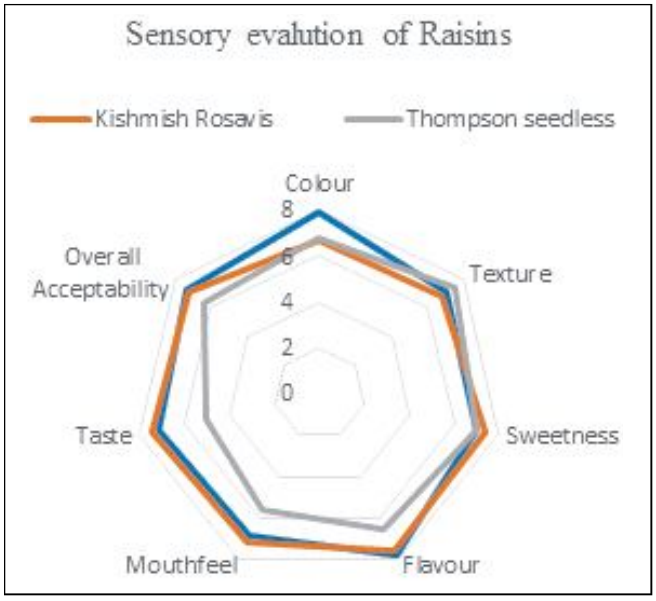

Fig. 1 : Sensory evaluation of raisins.

mean score was recorded in Kishmish Rosavis (6.80). Maximum mean score for mouth feel (7.20) and taste (7.50) was observed in Kishmish Rosavis (6.90) followed by Manjari Kishmish (7.20). The assessment of raisin quality involves several factors, including appearance, texture, taste, cleanliness and other relevant aspects. These criteria are important for establishing the raisins' market demand. Conducting an organoleptic test is a fundamental procedure for evaluating the product's quality and overall acceptability. The outcome of the current study confirm that Manjari Kishmish is the superior choice for producing high-quality raisins in tropical climates. Variability in the organoleptic score is observed due to the quality of grapes and drying conditions. Somkuwar *et al.* (2020) also observed variability in the organoleptic quality of raisins produced from different grape varieties. The present investigation concluded that grape variety affects its vegetative parameters, bunch and berry quality, which is evident in the resulting raisins. However, the quality of produce and processed products, such as raisins, can also be influenced by variations in grape growing conditions, vineyard management practices and raisin-making procedures (Elhami *et al*., 2019).

Conclusion

The study provides a comprehensive evaluation Manjari Kishmish and its parent for raisin production under tropical conditions. The findings suggest that the grape variety Manjari Kishmish exhibits superior characteristics for raisin making with higher yield and raisin recovery rates as well as favourable organoleptic properties. It highlights the importance of selecting the grape variety with suitable vegetative and yield parameters to ensure high-quality raisin production.

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