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Physicochemical and nutritional composition of raisin made from different grape varieties

R.G. Somkuwar[1], R.D. Nale[2]*, Ajay Kumar Upadhyay[1] and A. K. Sharma[1]

[1]ICAR-National Research Centre for Grapes, Pune, Maharashtra 412307, India

ABSTRACT

Raisins are dried grapes consumed globally that contain essential nutrient components for human health and their ability to reduce the risk of several chronic diseases. The quality of raisin is important as it has direct impact on consumer's health. We aimed to study physiochemical and nutritional traits of seeded raisin varieties. Physicochemical parameters such as raisin weight, raisin recovery, *p*H, moisture, ash content and mineral content such as potassium, phosphorus, calcium, magnesium, sodium, copper, iron and zinc were assessed. Results revealed that Red Globe had maximum raisin weight and diameters while Black Champa has maximum raisin recovery. Highest calcium, iron and copper content was noted in E5/20 (Anab-E-Shahi × Black Champa). Maximum potassium and phosphorus content was noted in Muscat Hamburg. The consumer acceptability score of both raisins was found at par.

Key words: *Vitis vinifera*, dried grapes, minerals, physicochemical parameters, health benefits.

INTRODUCTION

Traditional diets and lifestyles are changing globally due to the rising challenges of food insecurity and diseases. Human health depends on an organism's ability to maintain a stable internal state which is known as homeostasis. This involves adapting to environmental changes by regulating the exchange of matter and energy with the environment through metabolic processes (Goldstein *et al.*, 7). Micronutrients play essential roles in various homeostatic processes, such as managing energy metabolism, redox systems, inflammatory responses, and immune function (Haryanto *et al.,* 8) and differ from macronutrients in key characteristics. Water, proteins, carbohydrates, and fats are also consumed in large quantities, vitamins and minerals are ingested in much smaller amounts. Despite minimal presence of micro and macro nutrients in both diet and body, vitamins and minerals are crucial for regulating health and function, including performance during physical activities. The crucial role of vitamins and minerals for human health was established over a century ago (Tardy *et al.,* 23).

Raisins (dried grapes) are consumed globally and offer health benefits due to their high content of fiber and phytochemicals, including phenolic compounds. They are used in the mediterranean diet because of their unique flavor and texture (Jeszka-Skowron and Czarczynska-Goslinska, 10). Like other dry fruits, they are low in fat, saturated fat, and cholesterol. Raisins have a sweet taste due to approximately 60% sugar content, mainly fructose and glucose, leading to the widespread belief that they are unhealthy (Olmo-Cunillera *et al.,* 16). Raisins are especially noteworthy because of their distinctive phytochemical profile and inherent qualities, making them an attractive source of essential minerals such as potassium, iron, calcium, magnesium, sodium, and copper (Somkuwar *et al.,* 18). However, they are rich in nitrogenous compounds, ash, and both soluble and insoluble dietary fiber (3.3-4.5 g per 100 g) which contributes to their prebiotic effect as they are selectively used by host microorganisms and confer a health benefit (Li and Komarek, 11). Raisins are also among the top sources of boron, an essential trace element that may play a significant role in maintaining bone health. The nutritional composition of raisins is important as it directly impacts consumers' health and well-being. Raisins are regarded as a highly nutritious dried fruit, often consumed by the sick, elderly, and children to restore health and are incorporated into the daily diet due to their high content of beneficial elements. In India, chemical composition, and health benefits of grape and wine have been studied and published extensively (Somkuwar *et al.,* 18; Somkuwar *et al.,*19; Somkuwar *et al.,* 20) while raisin have received comparatively little attention. The present study was therefore carried out to determine the physicochemical composition in black seeded varieties to bring out the data on the nutrient content of raisin.

MATERIALS AND METHODS

The study was conducted at the farm of ICAR-National Research Centre for Grapes, Pune (18.32 °N, 73.51 °E) during 2022-23. After attaining maturity,

*Corresponding Author: rutujanale2502@gmail.com

[2]Department of Horticulture, Mahatma Phule Krishi Vidyapeeth, Rahuri, Maharashtra 413722

fresh grapes from 14 different grape varieties grafted on Dogridge rootstock were collected. The grapes were then dipped in a solution of ethyl oleate (1.5%) and potassium carbonate (2.5%) for about 10 minutes, and the drying was completed within 10-15 days. The analysis of raisins parameters was carried out in triplicates with 10 randomly chosen fruits. The raisin weight was recorded using the electronic weighing balance. The length and diameter of the raisin were measured using a caliper. When moisture content of dried grapes (raisin) reached to 16%, final weight and raisin recovery were calculated. Raisin recovery = Weight of raisins / Weight of fresh grapes × 100 (Ahamad *et al.,* 4; Somkuwar *et al.,* 21). Moisture content was calculated using moisture analyzer. The pH values were calculated as per Ghrairi *et al.* (6). To eliminate carbon, approximately 5 g of powdered flesh was placed in a porcelain container and burned in a muffle furnace at around 105°C. The ash content was then calculated as a percentage of the dry weight. Phosphorus was estimated by using ammonium molybdate meta-vananadate reagent. An atomic absorption spectrophotometer (Perkin –Elmer AA100) was used to estimate K, Na, Ca, Mg, Zn, Fe, Cu and Mn in the acid digest (Sharma *et al.,* 17). To evaluate the sensory attributes of raisins, an organoleptic test was carried out. The raisins prepared 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 (Ahamad *et al.,* 1; Somkuwar *et al.,* 22). All parameters were determined in triplicate for each sample. The results were expressed as mean ± standard deviation. The analysis of variance and significant differences among the mean values were performed with one-way ANOVA. Principal component analysis (PCA) was carried out using GRAPE software.

RESULTS AND DISCUSSION

The study indicated significant varietal differences in key parameters of raisin including raisin weight, diameter, length, and raisin recovery (Table 1). The highest raisin weight was recorded in Red Globe (2.18±0.26g) while lowest in Kishmish Maldeev (0.87±0.08g). The raisin length and diameter varied significantly from 13.52±1.47mm (Muscat Hamburg) to 22.66±1.63mm (H25/11) and 7.68±1.42mm (E5/20 (Anab-E-Shahi × Black Champa) to 11.12±1.01mm (Red Globe) respectively. The maximum raisin recovery was recorded in Black Champa (24.91±2.12%) followed by Rizamet (24.38±1.93%) and Red Muscat (24.04±1.55%), while minimum in E5/20 (20.72±1.63%). The results of the present study are in accordance with the findings of Ghrairi *et al.* (6) and Olivati *et al.* (15). The differences in physical properties among various raisin varieties can be attributed to both the morphological characteristics of the grapes before drying and the drying conditions, including temperature and drying time. These morphological differences have practical implications for quality and market preference with larger and uniform sized raisins often favored by consumer. The maximum raisin recovery in Black Champa might be due to higher total soluble solid (TSS) content in fresh grape. Higher TSS generally leads to less moisture loss proportionally during drying, enhancing yield recovery (Somkuwar *et al.,* 21). Choosing grapes with higher sugar content with 20°Brix or above leads to better raisin yields and enhances the quality, appearance, and flavor of the raisins.

Table 1: Morphological characteristic of different seeded raisins varieties.

Varieties/accession	Raisin weight (g)	Raisin diameter (mm)	Raisin length (mm)	Raisin recovery (%)
Kishmish Maldeev	0.87±0.08^{j}	9.41±1.53^{cd}	18.78±1.12^{ef}	21.05±0.81^{j}
E7/22 (Anab-E-Shahi × Convent Large Black)	1.46±0.18^{cd}	11.03±1.15^{b}	22.41±2.45^{ab}	22.14±2.89^{g}
E5/20 (Anab-E-Shahi × Black Champa)	1.47±0.05^{c}	7.68±1.42^{i}	19.21±1.21^{de}	20.72±1.63^{k}
H25/11	1.30±0.18^{e}	9.45±1.56^{cd}	22.66±1.63^{a}	22.56±1.56^{e}
Red Globe	2.18±0.26^{a}	11.12±1.01^{a}	21.00 ±0.93^{b}	23.32±2.71^{d}
E-8-5	1.38±0.11^{d}	8.79±0.42^{e}	19.33±1.57^{d}	21.67±1.67^{i}
Muscat Hamburg	1.13±0.16^{g}	7.89±1.21^{h}	13.52±1.47^{h}	22.23±1.18^{f}
Black Champa	0.95±0.09^{h}	9.89±0.67^{c}	17.81±1.82^{f}	24.91±2.12^{a}
E5/12 (Anab-E-Shahi × Black Champa)	1.91±0.11^{b}	8.55±0.61^{f}	20.56±0.63^{c}	21.81±1.49^{h}
Rizamet	0.89±0.08^{i}	8.01±0.42^{g}	18.87±1.37^{e}	24.38±1.93^{b}
Red Muscat	1.25±0.14^{f}	8.96±0.72^{d}	16.56±1.34^{g}	24.04±1.55^{c}

Values in the same column with different subscript letters represent significant differences between varieties at each ripening stage at $p < 0.05$ by Tukey's test (n = 3).

Raisin provides essential nutrients and health protective bioactive components. There was a significant difference ($p < 0.05$) in the moisture content between the different varieties of raisin ranging from 12.76±0.06% in Red Globe to 14.82±0.12% in E7/22 (Table 2). The results of the present study also confirm the results reported by Zemni *et al.* (25); Ghrairi *et al.* (6) and Niketh and Keshamma (14) who demonstrated that the drying of grape berries reduces their water content to 14-15%. As per codex standard, the maximum water content in raisin for storage should not exceed 17%. Rheological properties of raisins typically exhibit significant variability, which can be attributed to the inconsistent characteristics of the raw material, uneven drying conditions, the drying method used, and also the storage conditions. The evaporation of water during the drying process can lead to an increase in acidity (Somkuwar *et al.,* 22). The results of the present study proved that all raisin varieties have an acidic pH ranging from 4.22±0.07 % for Kishmish Maldeev to 4.62±0.04 % for E-8-5. The ash content of raisins reflects their total mineral content. Maximum ash content was recorded in Rizamet (7.50±0.18%) followed by Red Muscat (5.53±0.09%), while minimum in E7/22 (3.53±0.02%). The results of the present study also confirms with the results of Ghrairi *et al.* (6).

The mineral composition of raisins made from different grape varieties varied significantly with potassium content from 0.95±0.028% (E5/20 (Anab-E-Shahi × Black Champa) to 1.249±0.045% (Muscat Hamburg). Raisin could be an excellent source of mineral salt as the mean content of K, Mg, Ca, and Fe were highest (Table 3). From a nutritional point of view, potassium, calcium, magnesium, and iron are especially important. Different groups often experience deficiencies in these minerals, such as iron in vegans, calcium in those with osteoporosis, and potassium and magnesium in individuals who are physically active or on a gluten-free diet. Mineral content and their proportions play a significant role in enhancing the nutritional value of raisin. Ghrairi *et al.* (6) reported maximum potassium content (628–854 mg/100 g dry weight) in Turkish raisin varieties while Gary and Arianna (5) found 7.47 mg/g potassium in seedless raisin. Potassium plays a crucial role in maintaining human health. A diet high in potassium helps lower blood pressure and reduces the risk of cardiovascular disease and related mortality (Whelton *et al.,* 24). Furthermore, consuming potassium can reduce urinary calcium loss and lower the risk of developing osteoporosis (Ahamad *et al.,* 3; He and MacGregor, 9). Highest calcium content was observed in E5/20 (Anab-E-Shahi × Black Champa) raisin (0.088±0.013%) while lowest in Red Muscat raisin (0.047±0.002%). Phosphorus content varied from 0.0 82±0.017 (Kishmish Maldeev) to 0.121±0.011% (Muscat Hamburg) followed by Red Globe (0.119 ±0.012). Phosphorus along with calcium is essential for the formation of bones. Inadequate dietary calcium during bone development can hinder linear growth and prevent the attainment of peak bone mass. The magnesium concentrations varied between 0.145±0.016 (E5/12 (Anab-E-Shahi × Black Champa) and 0.211±0.018 (H25/11). Magnesium is crucial for all living cells, as it significantly influences the function of key biological polyphosphate compounds such as ATP, DNA, and RNA. However, our findings differ notably from those reported by Ghrairi *et al.,* (6), Niketh and Keshamma (14), and Maki and Yasin (13). They attributed variations in mineral levels in raisin concentrate samples due to factors such as inappropriate drying conditions (including drying time, temperature, and inadequate crushing) as well as

Table 2: Physico-chemical composition of different seeded raisin varieties.

Varieties/accession	Moisture content (%)	Raisin pH	Ash content (%)
Kishmish Maldeev	14.2±0.23^{d}	4.22±0.07^{f}	4.76±0.05^{e}
E7/22 (Anab-E-Shahi × Convent Large Black)	14.82±0.12^{a}	4.44±0.07^{b}	3.53±0.02^{j}
E5/20 (Anab-E-Shahi × Black Champa)	14.06±0.15^{f}	4.27±0.09^{e}	3.63±0.05^{h}
H25/11	14.1±0.17^{e}	4.42±0.02^{bc}	4.68±0.06^{f}
Red Globe	12.76±0.06^{i}	4.36±0.08^{cd}	3.62±0.05^{hi}
E-8-5	13.43±0.21^{h}	4.62±0.04^{a}	3.58±0.08^{i}
Muscat Hamburg	14.73±0.15^{b}	4.42±0.10^{bc}	4.98±0.05^{d}
Black Champa	14.71±0.10^{bc}	4.36±0.09^{cd}	5.22±0.06^{c}
E5/12 (Anab-E-Shahi × Black Champa)	13.7±0.11^{g}	4.43±0.08^{bc}	4.21±0.06^{g}
Rizamet	14.80±0.10^{ab}	4.35±0.10^{d}	7.5±0.18^{a}
Red Muscat	14.60±0.01^{c}	4.37±0.06^{c}	5.53±0.09^{b}

Values in the same column with different subscript letters represent significant differences between varieties at each ripening stage at $p < 0.05$ by Tukey's test (n = 3).

Table 3: Mineral composition of different white seeded raisin varieties.

Varieties/accession	P (%)	K (%)	Na (%)	Ca (%)	Mg (%)	Zn (ppm)	Cu (ppm)	Fe (ppm)
Kishmish Maldeev	0.082 ± 0.017	1.022 ± 0.031	0.098 ± 0.006	0.063 ± 0.005	0.207 ± 0.012	5.311 ± 0.316	2.475 ± 0.377	59.85 ± 4.086
E7/22 (Anab-E-Shahi × Convent Large Black)	0.096 ± 0.010	1.198 ± 0.073	0.101 ± 0.009	0.066 ± 0.007	0.160 ± 0.032	5.05 ± 0.404	2.85 ± 0.580	67.4 ± 3.128
E5/20 (Anab-E-Shahi × Black Champa)	0.092 ± 0.010	0.95 ± 0.028	0.074 ± 0.009	0.088 ± 0.013	0.170 ± 0.009	5.375 ± 1.144	3.75 ± 0.661	86.075 ± 10.329
H25/11	0.097 ± 0.015	1.021 ± 0.043	0.099 ± 0.009	0.059 ± 0.002	0.211 ± 0.018	4.723 ± 0.319	2.675 ± 0.403	58.075 ± 5.009
Red Globe	0.119 ± 0.012	1.11 ± 0.029	0.098 ± 0.007	0.052 ± 0.006	0.186 ± 0.011	4.275 ± 0.896	2.6 ± 0.535	61.475 ± 6.771
E-8-5	0.082 ± 0.014	1.121 ± 0.06	0.13 ± 0.015	0.063 ± 0.005	0.162 ± 0.025	5.175 ± 0.624	3.05 ± 0.497	69.75 ± 5.155
Muscat Hamburg	0.121 ± 0.011	1.249 ± 0.045	0.105 ± 0.011	0.052 ± 0.002	0.169 ± 0.019	4.075 ± 0.350	3.725 ± 0.457	78.25 ± 5.580
Black Champa	0.087 ± 0.011	1.072 ± 0.029	0.117 ± 0.023	0.071 ± 0.004	0.191 ± 0.011	4.712 ± 0.876	2.875 ± 0.311	72.65 ± 5.814
E5/12 (Anab-E-Shahi × Black Champa)	0.088 ± 0.017	1.28 ± 0.041	0.095 ± 0.008	0.06 ± 0.006	0.145 ± 0.016	5.325 ± 0.797	2.45 ± 0.222	70.3 ± 6.594
Rizamet	0.097 ± 0.016	1.036 ± 0.046	0.118 ± 0.022	0.056 ± 0.003	0.189 ± 0.018	4.525 ± 0.250	2.6 ± 0.294	55.95 ± 3.610
Red Muscat	0.103 ± 0.08	1.133 ± 0.048	0.078 ± 0.004	0.047 ± 0.002	0.167 ± 0.021	4.275 ± 0.263	2.225 ± 0.287	73.35 ± 4.192

Values were expressed as Mean ± SD; n=3

the composition of the fruit and its growing conditions (Ahamad *et al.,* 4).

A significant amount of iron, zinc, and copper contents in all the raisin varieties was observed (Table 3). Iron is a crucial dietary mineral that supports essential human functions, including red blood cell production, cellular energy metabolism, and the development and functioning of the immune system. Despite its importance, iron deficiency which leads to anemia is the most prevalent nutritional disorder worldwide. Highest iron content (86.075±10.329) was reported in E5/20 (Anab-E-Shahi × Black Champa), while lowest (55.95±3.61 ppm) in Rizamet. Foods that are considered excellent source of iron often also contain significant amount of zinc (Lim *et al.,* 12). However, zinc content varied from 4.075±0.350ppm in Muscat Hamburg to 5.375±1.144ppm in E5/20 (Anab-E-Shahi × Black Champa) while copper was recorded in low concentration (2.225±0.287ppm) in Red Muscat to 3.75±0.661ppm in E5/20 (Anab-E-Shahi × Black Champa). A certain level of copper is crucial for maintaining immune system function. These results underscore that raisins play the significant role in supporting human health when consumed in recommended amounts.

A multivariate statistical analysis was performed using PCA. Figure 1 was plotted according to the correlation between physio-biochemical parameters (raisin weight, length, diameter, pH, moisture content, ash content, and raisin recovery) and nutrient content (K, P, Ca, Mg, Na, Fe, Cu, Zn). PC1 accounted for 71.5 % of the total variance (89.1%), and PC2 accounted for 17.6%. The position of each variable in the loading plot described its relationship with the other variables. Variables that are close to each other have high correlations. Variables on the same side of the origin (0.0) are positively correlated and those on the opposite side of the origin are negatively correlated. Raisin varieties could be discriminated on the PCA plane. PC1 was positively related to raisin pH, potassium (K) content, iron, and copper content while PC2 was related to moisture content, ash content, raisin diameter, raisin length, and magnesium content. Muscat Hamburg, Black Champa, Red muscat, E-8-5 located on the positive side while on the other hand Rizamet and Kishmish Maldeev were located on the negative side of PC2. By studying the biplot, it is possible to observe the relative positions of the varieties showing their similarities or differences in terms of the studied parameters.

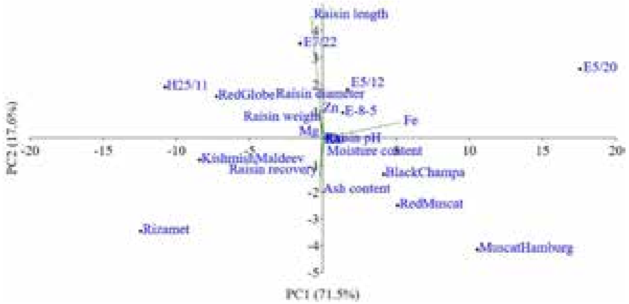

Fig. 1. Biplot for the first two principal components (PC1/PC2) for the studied raisin varieties on physiochemical and nutritional characteristics.

In addition to nutritional value, assessing the sensory qualities of a food product is crucial for determining consumer acceptance. The present result indicated that Black Champa received the highest overall acceptability rating at 7.3, followed by Muscat Hamburg at 7.1, with E7/22 (Anab-E-Shahi × Convent Large Black) receiving the lowest rating of 6.3. Black Champa (7.4 and 7.3) and Muscat Hamburg (7.0 and 7.2) were preferred for raisin colour and flavor as compared to remaining varieties (Fig. 2). Red Globe scored maximum in terms of sweetness (7.3). The highest mean score for texture was observed in Red Muscat (7.40) followed by Muscat Hamburg (7.2) with E5/12 (Anab-E-Shahi × Black Champa) having the lowest mean score (6.3). The highest mean scores for mouth feel (7.2) and taste (7.6) were recorded for Black Champa while Muscat Hamburg followed with a mean score of 7.4. Evaluating raisin quality encompasses various factors such as appearance, texture, taste, cleanliness, and other pertinent attributes. These criteria are essential for determining the market demand for raisins. An organoleptic test is a crucial method for assessing the product's quality and consumer acceptability. Differences in organoleptic scores are noted due to variations in grape quality and drying conditions (Ahamad *et al.,* 2; Somkuwar *et al.,* 19). Similarly, Somkuwar *et al.* (21) also reported variability in the organoleptic quality of raisins made from different grape varieties.

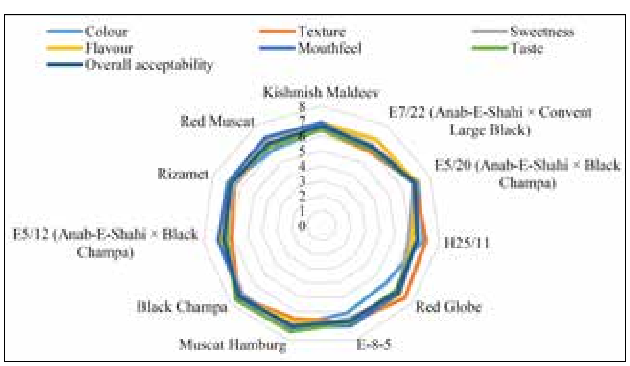

Fig. 2. Sensory analysis of different seeded raisin varieties.

Our findings demonstrated that all raisin varieties are natural sources of energy and essential minerals like potassium, magnesium, calcium, and iron which may help prevent various diseases. Muscat Hamburg, E5/20 (Anab-E-Shahi × Black Champa), Black Champa raisin consumption is associated with better nutrient intake, diet quality due to maximum mineral content as well as favorable organoleptic properties.

AUTHORS' CONTRIBUTION

Conceptualization and design of experiment (RGS, AKU), data collection and analysis (RN) and data interpretation and manuscript writing (RGS, AKU, AKS).

DECLARATION

The authors do not have any conflict of interest.

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REFERENCES

1. Ahamad, S., Asrey, R., Menaka, M., Vinod, B. R., Kumar, D. and Balubhai, T. P. 2025. 24-Epibrassinolide treatment boosts bioactive compound preservation, delays softening and extends shelf life of cherry tomatoes during storage. *Food Chem*. 145051.
2. Ahamad, S., Asrey, R., Singh, A. K., Sethi, S., Joshi, A., Vinod, B. R. and Choupdar, G. K. 2024. Melatonin treatment enhances bioactive compound retention, antioxidant activity and shelf-life of bell pepper (*Capsicum annuum* L.) during cold storage. *Int. J. Food Sci. Technol.*, **59**(10): 7918-7931.
3. Ahamad, S., Asrey, R., Vinod, B. R., Meena, N. K., Menaka, M., Prajapati, U. and Saurabh, V. 2024. Maintaining postharvest quality and enhancing shelf-life of bell pepper (*Capsicum annuum* L.) using brassinosteroids: A novel approach. *S. Afr. J. Bot.* **169**: 402-412.
4. Ahamad, S., Sagar, V. R., Asrey, R., Islam, S., Tomar, B. S., Vinod, B. R. and Kumar, A. 2024. Nutritional retention and browning minimisation in dehydrated onion slices through potassium metabisulphite and sodium chloride pre-treatments. *Int. J. Food Sci. Technol.* **59**(8): 5794-5805.
5. Gary, W. and Arianna, C. 2010. Polyphenol content and health benefits of raisins. *Nutr. Res.* **30**(8): 511–519.

6. Ghrairi, F., Lahouar, L., Brahmi, F., Ferchichi, A., Achour, L. and Said, S. 2013. Physicochemical composition of different varieties of raisins (*Vitis vinifera* L.) from Tunisia. *Ind. Crops Prod*. **43**: 73-77.

7. Goldstein, D.S. 2019. How does homeostasis happen? Integrative physiological, systems biological, and evolutionary perspectives. *Am. J. Physiol. Regul. Integr. Comp. Physiol.* **316**: 301–317.

8. Haryanto, B., Suksmasari, T., Wintergerst, E.S. and Maggini, S. 2015 Multivitamin supplementation supports immune function and ameliorates conditions triggered by reduced air quality. *Vitam. Miner.*, **4**: 2376-1318.

9. He, F. and MacGregor, G. 2008. Beneficial effects of potassium on human health. *J. Plant. Biol.* **133**: 725–735.

10. Jeszka-Skowron, M. and Czarczynska-Goslinska, B. 2020. Raisins and the other dried fruits: Chemical profile and health benefits. In *The Mediterranean Diet* (pp. 229-238). Academic Press.

11. Li, Y.O. and Komarek, A. R. 2017. Dietary fibre basics: Health, nutrition, analysis, and applications. *Food Qual. Saf*. **1**: 47–59.

12. Lim, K., Riddell, J., Nowson, A., Booth, O. and Szymlek-Gay, A. 2013. Iron and zinc nutrition in the economically-developed world: A Review. *Nutrients*. **5(8)**: 3184-3211.

13. Maki, R. R. and Yasin, S. S. 2023. A study of the chemical composition, vitamins and minerals of four varieties of raisins. In *IOP Conference Series: Earth and Environmental Science* (Vol. 1262, No. 6, p. 062026). IOP Publishing.

14. Niketh, S. A. and Keshamma E. 2024. Study of the proximate and mineral composition of commercial raisin (*Vitis vinifera* L.) varieties. *Afr. J. Bio. Sc*. **6**(9): 3544-3552.

15. Olivati, C., de Oliveira Nishiyama, Y. P., de Souza, R. T., Janzantti, N. S., Mauro, M. A., Gomes, E. and Lago-Vanzela, E. S. 2019. Effect of the pre-treatment and the drying process on the phenolic composition of raisins produced with a seedless Brazilian grape cultivar. *Food Res. Int.* **116**: 190-199.

16. Olmo-Cunillera, A., Escobar-Avello, D., Perez, A. J., Marhuenda-Munoz, M., Lamuela-Raventos, R. M. and Vallverdu-Queralt, A. 2019. Is eating raisins healthy? *Nutrients*, **12**(1): 54.

17. Sharma, J., Upadhyay, A. K., Sawant, S. D. and Sawant, I. S. 2009. Studies on shiny spot symptom development on grapevine leaves and its effect on fruitfulness, disease incidence and vine yield. *Ind. J. Horti.* **66**(1): 48-52.

18. Somkuwar, R. G., Bondage, D. D., Surange, M., Navale, S. and Sharma, A. K. 2013. Yield, raisin recovery and biochemical characters of fresh and dried grapes (raisin) of Thompson Seedless grapes (*Vitis vinifera*) as influenced by different rootstocks. *Ind. J. Agril. Sci*, **83**: 924-927.

19. Somkuwar, R. G., Ghule, V. S., Sharma, A. K. and Naik, S. 2023. Evaluation of grape varieties for raisin purposes under tropical conditions of India. *Grape Insight*, 75-80.

20. Somkuwar, R. G., Kad, S., Naik, S., Sharma, A. K., Bhange, M. A. and Bhongale, A. K. 2020. Study on quality parameters of grapes (*Vitis vinifera*) and raisins affected by grape type. *Ind. J. Agril. Sci*. **90**(6): 1072-1075.

21. Somkuwar, R. G., Kakade, P. B., Ghule, V. S. and Sharma, A. K. 2024. Performance of grape varieties for raisin recovery and raisin quality under semi-arid tropics. *Plant Arch.* **24**: 61-66.

22. Somkuwar, R. G., Naik, S., Sharma, A. K. and Bhange, M. A. 2019. Performance of grape varieties grown under tropical regions for raisin yield and quality. *Ind. J. Horti.* **76**(2): 355-357.

23. Tardy, A. L., Pouteau, E., Marquez, D., Yilmaz, C. and Scholey, A. 2020. Vitamins and minerals for energy, fatigue, and cognition: a narrative review of the biochemical and clinical evidence. *Nutrients*, **12**(1): 228.

24. Whelton, P., He, J., Cutler, J., Brancati, F., Appel, L., Follmann, D. and Kleg, M. 1997. Effects of oral potassium on blood pressure. Metaanalysis of randomized controlled clinical trials. *J. Am. Med. Assoc.* **277**: 1624–163.

25. Zemni, H., Sghaier, A. and Khiari, R. 2017. Physicochemical, phytochemical and mycological characteristics of italia muscat raisins obtained using different pre-treatments and drying techniques. *Food Bioprocess Technol.* **10**: 479–490.

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