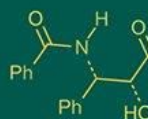


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Analysis of morphological and biochemical parameters and their effect on shelf life of eight genotypes of grapes

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Abstract

The experiment was conducted to know the effect of fruit morphology and biochemical parameters on shelf life of Eight grapes genotypes. These grape genotypes were collected across the regions of Then Palani and Odaipatti in the Theni district of Tamil Nadu. Fresh and mature grape bunches of each variety were collected randomly from the plants. The required data were collected and analysed as per Randomized Block Design (RBD) with three replications. The study materials were kept in room temperature. The results revealed that the total Bunch weight loss was minimal in red globe (40.56%) followed by Tas-e-Ganesh (41.14%) and Muscat (45.54%). It might be due to the pulpy nature and more fibre content. These leads to reduced water loss. Jyothi has the lowest proportion of Cumulative berry weight loss (34.83%), followed by Red Globe (37.06%) and Madhu Angoor (47.67%). Red Globe had a lower reduction in berry firmness (40%), followed by Tas-e-Ganesh (66.67%) and Muscat (66.67%). This Cumulative weight loss is caused by the water loss, which also reduces firmness and causes berry cracking. When compared to other genotypes, Tas-e-Ganesh (2.26%) and Muscat (3.30%) have the fewest berries that have fallen. Tas-e-Ganesh (2.26%) has less rotten berries, followed by Muscat (3.30%) and Madhu Angoor (4.89%). From the above results, it can be concluded that Red Globe more shelf life with less physiological loss in weight suits well for Table purpose followed by Tas-e-Ganesh stands next to it based on Morphological and Biochemical parameters studied on their shelf life.

Keywords: Weight reduction, berry firmness, rotten berries, desiccation, berry shrivelling

Introduction

Grapes are members of the Vitaceae family and were first grown in Asia. (Elagamey *et al.*, 2013) [5]. It is one of the most significant cash fruit crops in the world. They are consumed as both fresh (table grape) and processed Products (wine, grape juice, molasses, and raisins). The grape is a good source of water (82%), carbohydrates (12-18%), proteins (0.5-0.6%), and fat (0.3-0.4%). It also has small amounts of calcium (0.01-0.02%) and phosphorus (0.08-0.01%), as well as significant amounts of potassium (0.1-0.2%), vitamin C (0.01-0.02%), and vitamin A (0.0015%) (Aamri *et al.*, 2020) [1]. 100 grams of raw grapes provides a fair quantity of vitamin K and consist of 69 calories (Khan *et al.*, 2020) [10]. In ancient Egypt, grapevine sap was utilized to manufacture an eye and skin salve. The fruit was either ripened or crushed into wine elixirs to cure health issues like nausea, constipation, cholera, smallpox, liver disease, and cancer (Dohadwala *et al.*, 2009) [4]. Grape's abundance of bioactive substances, particularly polyphenols, which are mostly composed of proanthocyanidins, anthocyanins, flavanols, phenolic acids, and stilbenes, is largely responsible for its health advantages. Several investigations have proven that grapes contain a range of biological properties, including antioxidant, cardioprotective, gut microbiota-regulating, antidiabetic, and anticancer properties (Zhou *et al.*, 2022) [16].

Approximately 75 million tons of grapes are produced annually, with Europe is leading in production (about 41%), followed by Asia (29%) and the Americas (21%) (Zhou *et al.*, 2022) [16]. In FY2024, over 179.62 thousand hectares will be used for grape production (MoA & FW). The number of grapes exported in FY2025 is approximately 271, 259.89 metric tons, or 353.54 USD million (DGCIS).

Worldwide, 71% of grapes are used to make wine, 27% are used to make fresh fruit, and 2% are used to make dried fruit. Large, seedless fruits with relatively thin skin are typical of table grape varieties. Wine grapes have comparatively thick skins, are typically seeded, and are smaller (Khan *et al.*, 2020) ^[10]. Fruit and vegetable postharvest losses can reach 30 to 40% globally, with certain underdeveloped nations experiencing even greater losses. In addition to lowering production, trading, and distribution costs, reducing post-harvest losses also decreases consumer prices and boosts farmers' earnings (Ajula *et al.*, 2011) ^[12]. Being a non-Climacteric fruit, grapes experiences huge physiological loss of weight, colour changes, taste changes, and faster softening during storage that leads to quality reductions (Rolle *et al.*, 2011) ^[12]. Various experts have reported that the postharvest loss of grapes in the nation ranges from 8.23 to 16%. India is losing over 223 thousand tons of grapes a year, according to the current estimate of 8.23% (Sharma *et al.*, 2018) ^[13].

Grape genotypes will be affected by various factors including genetic effect, pest, diseases, disorders, improper harvesting and handling, pre-cooling delay, packaging, transportation, storage, and market are the factors responsible for post-harvest losses in grapes (Sharma *et al.*, 2018) ^[13]. Considering the above discussed problem in post-harvest storage of grapes, an attempt was made to study the morphological and biochemical changes that take place in several grape genotypes after harvest.

Materials and Methods

The study was conducted at Karunya Institute of Technology and Sciences. The experimental data were collected as per the standard procedure, ambient temperature (25 °C±2 °C) and analysed using a Randomized Block Design (RBD) with three replications. The varieties included Red Globe, Madhu Angoor, Tas-e-Ganesh, Sharad Seedless, Super Sonaka, Muscat, Krishna Seedless and Jyothi. Freshly harvested grape bunches of each genotype were being collected randomly from the Selected vines. Total soluble solids (TSS) are being analysed using Digital Refractometer (° Brix) and morphological characters of berry are collected using digital Vernier Calliper (mm).

Statistical Analysis

Morphological and biochemical parameters were analysed using Randomly Complete Block Design with eight Treatments were replicated thrice. The OPSTAT software suite and Microsoft Excel were used to analyse the tabulated data. The significance level was at ($p \leq 0.01$).

Results and Discussions

The study conducted on the different grape genotypes on their Shelf life from 0-16 Days showed a significant difference on the Morphological and Biochemical parameters (Table 1, 2 and 3). The percentage of loss of weight is lesser in red globe (40.56%) followed by Tas-e-Ganesh (41.14%) and Muscat (45.54%). Higher percentage of loss occurred in Krishna Seedless (61.82%) Followed by Jyothi (52.29%) and Madhu Angoor (50.94%). The bunch weight of grapes depends on the berry weight and number of berries in a bunch (Gupta *et al.*, 2015) ^[8]. As the days pass after the grapes are harvested, moisture and transpiration loss cause a considerable loss in weight. Krishna Seedless shows the less reduction in bunch diameter compared to

other genotypes and followed by Muscat (12.85%) and Red Globe (12.98%). Higher reduction in bunch diameter occurs in Super Sonaka (49.56%) followed by Sharad Seedless (28.02%) and Tas-e-Ganesh (20.25%). Berry diameter and berry weight determine the bunch diameter of the grapes (Gupta *et al.*, 2015) ^[8]. when berry shrivelling results from bunch and berry weight loss, which also affects bunch diameter and decreases grape bunch diameter (Deloire *et al.*, 2021) ^[3]. Super Sonaka has more berries in a bunch (152), followed by Madhu Angoor (123) and Krishna Seedless (121). Red Globe has less berries (70), followed by Tas-e-Ganesh (89) and Muscat (91). Higher average bunch weight (Gupta *et al.*, 2015) ^[8] and grape thinning techniques. Jyothi has the lowest proportion of berry weight loss (34.83%), followed by Red Globe (37.06%) and Madhu Angoor (47.67%). Super Sonaka lost the most weight in berries (67.11%), followed by Krishna Seedless (60.82%) and Sharad Seedless (56.02%). After harvest, grapes experience a significant linear weight reduction under ambient normal conditions. This weight loss is caused by the fruit losing water, which also reduces fruit firmness and causes berry cracking (Khalil *et al.*, 2023) ^[9]. Jyothi had the least reduction in berry length (27.19%), then Tas-e-Ganesh (27.40%) and Muscat (27.88%). Super Sonaka has larger reduction in berry length (34.73%), then comes Sharad Seedless (33.88%) and Krishna Seedless (31.04%). Jyothi has the lowest berry diameter reduction (18.33%), followed by Madhu Angoor (30.33%) and Muscat (29.72%). Super Sonaka has had a greater decline (48.58%), followed by Red Globe (44.43%) and Tas-e-Ganesh (43.29%). Red Globe had a lower reduction in berry firmness (40%), followed by Tas-e-Ganesh (66.67) and Muscat (66.67). Krishna Seedless has a larger drop in berry firmness (87.50%), subsequent to Super Sonaka (87.50%) and Madhu Angoor (83.33%). After picking, grapes quickly lose water through their skins and the stem attachment (pedicels and rachis), which causes berries to shrivel, lose weight, and become less firm. when the berries shrink, allowing the berries' length to get smaller (Zhang *et al.*, 2025). Jyothi (14.13%) has more fallen berries than Red Globe (11.43%) and Krishna Seedless (9.94%). When compared to other genotypes, Tas-e-Ganesh (2.26%) and Muscat (3.30%) have the fewest berries that have fallen. The berries became more desiccated as a result of the losses observed in falling berries. This might be because of the berries' thick skin, which could be decreasing the losses (Goswami *et al.*, 2013) ^[7]. Red Globe (15.71%) and Jyothi (15.22) have more rotting berries than Krishna seedless (14.09%). Tas-e-Ganesh (2.26%) has less rotten berries, followed by Muscat (3.30%) and Madhu Angoor (4.89%). The grapes were kept at room temperature, and as time went on, the amount of berry rotting increased (Goswami *et al.*, 2013) ^[7]. Total soluble solids (TSS) fall during the first four to eight days following fruit harvest, then rise again. Thus, after 16 days, Tas-e Ganesh has a rise in TSS (26.9°Brix), followed by Sharad Seedless (26.4°Brix) and Muscat (25.8°Brix). Jyothi has the least TSS content (16.9 °Brix), subsequently being followed by Super Sonaka (17.1 °Brix) and Red Globe (18.1 °Brix). Samples at room temperature that drop more weight can contain greater sugar concentrations and more total soluble solids (Fabri *et al.*, 2025) ^[6].

The Pearson correlation values between the different morphological and biochemical characteristics of grapes on 0th, 8th and 16th day are shown in Table 4, 5 and 6. The

Bunch weight is positively correlated with Bunch Diameter ($r = 0.699, 0.876, 0.731$), Berry Diameter ($r = 0.904, 0.949, 0.655$), Berry Weight ($r = 0.948, 0.949, 0.946$) and berry length ($r = 0.744, 0.788, 0.736$). The reason for having higher bunch weight due to the presence of Higher berry weight, no. of berries in a bunch and pulp weight compared to other genotypes (Gupta *et al.*, 2015) [8]. Bunch weight is negatively correlated with Berry Firmness ($r = -0.786, -0.457$) and Total soluble Solids ($r = -0.321, -0.483, -0.271$). But on 16th day bunch weight is positively correlated Berry firmness ($r = 0.461$) because from 8th day Berry firmness also shows a sudden decrease due to the increase in weight loss and Desiccation of berries. The results are agreed with (Goswami *et al.*, 2013) [7]. Berry Firmness and TSS are negatively correlated with Berry weight, Berry Diameter, Bunch Weight and Berry Length because when the berry weight is higher it leads to the distribution of sugars and during fruit set the firmness will be higher when the days

goes on the expansion of berries takes place so, firmness is reduced. The results are agreed with (Gupta *et al.*, 2015) [8]. On the 0th day the TSS is positively correlated with berry firmness ($r = 0.288$) when the TSS decreases it becomes positively correlated ($r = 0.515$) followed increase in TSS leads to positive correlation with berry firmness on 16th day ($r = 0.483$). The Rotten Berries and Fallen berries are positively correlated with each other on 8th and 16th day. When the TSS decreases on 8th day, fallen berries and rotten berries are positively correlated and when the TSS starts increasing from the 10th day onwards it shows a negative correlation because surviving berries are getting extremely concentrated in sugar as a result of dehydration, which raises TSS even if more berries are decaying or dropping (high rot). Consequently, there is a negative correlation between high rot/drop (a negative factor) and high sugar content (a positive factor). The results are agreed with (Goswami *et al.*, 2013) [7].

Table 1: Estimation of Morphological and Biochemical Parameters of eight grape genotypes from day 0 to day 16.

Treatments	Bunch Weight (g)					Bunch Diameter (Cm)					Number of Berries in a Bunch (No.)	Berry Weight (g)				
	0 DAY	4 DAY	8 DAY	12 DAY	16 DAY	0 DAY	4 DAY	8 DAY	12 DAY	16 DAY		0 DAY	4 DAY	8 DAY	12 DAY	16 DAY
Red globe	692	616	556	470	426.8	130	123.07	119.12	116.23	113.12	70	17.35	14.77	13.23	11.75	10.92
Madhu Angoor	320	292	199	188	162	52.9	51.14	49.75	46.84	43.72	123	3	2.74	2.54	2.24	1.57
Tas-e-Ganesh	350	302	274	252	216	72.88	66.84	62.61	60.03	58.12	89	3.32	2.86	2.44	2.13	1.7
Sharad seedless	264	232	204	184	148	78.09	65.24	62.13	59.88	56.21	98	3.21	2.97	2.01	1.84	1.41
Super Sona	332	278	246	220	184	97.78	65.21	54.7	50.74	49.32	152	2.98	1.96	1.56	1.24	0.98
Muscat	224	198	175	152	135	87.49	86.94	84.51	80.62	76.25	91	3.82	3.25	2.9	2.17	1.82
Krishna seedless	330	292	234	186	142	71.22	68.81	66.72	66.24	65.09	121	4.9	3.73	2.93	2.26	1.92
Jyothi	306	264	208	184	152	95.84	89.64	84.05	83.58	79.63	92	3.33	3.15	2.83	2.49	2.17
C.D.	3.361	3.486	3.132	1.608	1.231	0.71	0.793	0.687	0.796	0.684	3.897	0.273	0.217	0.196	0.179	0.167
SE(d)	1.552	1.61	1.446	0.743	0.568	0.328	0.366	0.317	0.367	0.316	1.309	0.126	0.1	0.091	0.083	0.077

Significant at 1%.

Table 2: Estimation of Morphological and Biochemical Parameters of eight grape genotypes from day 0 to day 16.

Treatments	Berry Length (mm)					Berry Diameter (mm)					Berry Firmness (N)				
	0 DAY	4 DAY	8 DAY	12 DAY	16 DAY	0 DAY	4 DAY	8 DAY	12 DAY	16 DAY	0 DAY	4 DAY	8 DAY	12 DAY	16 DAY
Red globe	31.96	29.35	26.68	23.7	22.26	30.27	26.38	23.41	19.6	16.82	2.5	2	1.75	1.5	1.5
Madhu Angoor	16.4	16.04	15.17	14.05	13.33	17.51	16.58	14.8	12.98	12.2	3	2.25	1.5	1	0.5
Tas-e-Ganesh	22.26	19.54	18.77	17.12	16.16	15.64	14.92	12.13	10.33	8.87	4.5	3.75	3	2.25	1.5
Sharad seedless	20.66	18.42	15.65	14.09	13.66	15.56	14.93	13.46	12.38	10.64	4.5	4	3.5	2.5	1
Super Sona	26.69	24.56	20.63	18.73	17.42	13.36	11.64	11.01	8.71	6.87	4	3.5	2.5	2	0.5
Muscat	18.69	17.46	14.97	14.67	13.48	16.86	15.29	13.55	13.11	11.85	4.5	3.5	3	2	1.5
Krishna seedless	27.16	26.65	23.54	19.62	18.73	15.21	14.42	13.55	10.91	9.64	4	3.5	3	2.5	0.5
Jyothi	24.53	22.7	19.77	18.64	17.86	14.62	14.21	13.16	12.78	11.94	4	3	2.5	2	1
C.D.	0.665	0.768	0.19	0.194	0.143	0.084	0.534	0.587	0.423	0.076	0.029	0.025	0.024	0.022	0.023
SE(d)	0.307	0.355	0.088	0.089	0.066	0.039	0.247	0.271	0.195	0.035	0.013	0.011	0.011	0.01	0.01

Significant at 1%.

Table 3: Estimation of Morphological and Biochemical Parameters of eight grape genotypes from day 0 to day 16.

Treatments	Fallen Berries (No.)					Rotten Berries (No.)					Total Soluble Solids (°Brix)				
	0 DAY	4 DAY	8 DAY	12 DAY	16 DAY	0 DAY	4 DAY	8 DAY	12 DAY	16 DAY	0 DAY	4 DAY	8 DAY	12 DAY	16 DAY
Red globe	0	0	2	4	6	0	1	6	9	10	15.8	13.5	15.2	17.1	18.1
Madhu Angoor	0	0	1	1	5	0	0	0	0	5	17.1	15.7	17.6	18.6	20.8
Tas-e-Ganesh	0	0	0	0	1	0	0	0	1	1	18.7	16.8	20.8	23.6	26.9
Sharad seedless	0	0	0	0	3	0	0	3	5	8	14	15.6	18	23.2	26.4
Super Sonaka	0	0	3	8	11	0	0	3	7	8	14.9	12.4	15.1	18.7	17.1
Muscat	0	0	0	0	1	0	0	0	0	2	22.1	21.7	26.8	28.9	25.8
Krishna seedless	0	0	8	10	12	0	3	12	15	17	16.8	15.7	24	20.8	19.5
Jyothi	0	0	7	9	11	0	6	8	13	14	18.4	20.7	19.1	17.7	16.9
C.D.	0	0	0.915	0.915	1.637	0	0.682	1.316	0.819	0.915	0.158	0.106	0.194	0.162	0.184
SE(d)	0	0	0.423	0.423	0.756	0	0.315	0.607	0.378	0.423	0.073	0.049	0.09	0.075	0.085

Significant at 1%.

Table 4: Correlation of Morphological and Biochemical parameters of grapes on 0th day.

	BW (0)	BD (0)	BYW (0)	BYD (0)	BYL (0)	BYF (0)	RB (0)	FB (0)	TSS (0)
BW (0)	1								
BD (0)	0.699	1							
BYW (0)	0.948		1						
BYD (0)	0.904	0.643	0.964	1					
BYL (0)	0.744	0.774	0.703	0.496	1				
BYF (0)	-0.786	-0.357	-0.724	-0.770	-0.379	1			
RB (0)	-	-	-	-	-	-	1		
FB (0)	-	-	-	-	-	-	-	1	
TSS (0)	-0.321	-0.133	-0.193	-0.110	-0.388	0.288	-	-	1

BW-Bunch weight, BD-Bunch Diameter, BYW-Berry Weight, BYD-Berry Diameter, BYL-Berry Length, BYF-Berry Firmness, RB-Rotten Berries, FB-Fallen Berries, TSS-Total Soluble Solids.

Table 5: Correlation of Morphological and Biochemical parameters of grapes on 8th day.

	BW (8)	BD (8)	BYW (8)	BYD (8)	BYL (8)	BYF (8)	RB (8)	FB (8)	TSS (8)
BW (8)	1								
BD (8)	0.876	1							
BYW (8)	0.949	0.971	1						
BYD (8)	0.949	0.971	1.000	1					
BYL (8)	0.788	0.574	0.698	0.698	1				
BYF (8)	-0.457	-0.554	-0.502	-0.502	-0.271	1			
RB (8)	0.206	0.184	0.222	0.222	0.690	0.072	1		
FB (8)	-0.045	-0.081	-0.035	-0.035	0.528	-0.031	0.907	1	
TSS (8)	-0.483	-0.324	-0.338	-0.338	-0.311	0.515	0.039	0.086	1

BW-Bunch weight, BD-Bunch Diameter, BYW-Berry Weight, BYD-Berry Diameter, BYL-Berry Length, BYF-Berry Firmness, RB-Rotten Berries, FB-Fallen Berries, TSS-Total Soluble Solids.

Table 6: Correlation of Morphological and Biochemical parameters of grapes on 16th day.

	BW (16)	BD (16)	BW (16)	BYD (16)	BYL (16)	BYF (16)	RB (16)	FB (16)	TSS (16)
BW (16)	1								
BD (16)	0.731	1							
BW (16)	0.946	0.871	1						
BYD (16)	0.655	0.787	0.824	1					
BYL (16)	0.736	0.706	0.742	0.362	1				
BYF (16)	0.461	0.623	0.466	0.463	0.119	1			
RB (16)	0.010	0.264	0.170	0.097	0.575	-0.473	1		
FB (16)	-0.071	0.022	-0.016	-0.192	0.532	-0.676	0.858	1	
TSS (16)	-0.271	-0.268	-0.314	-0.154	-0.650	0.483	-0.685	-0.874	1

BW-Bunch weight, BD-Bunch Diameter, BYW-Berry Weight, BYD-Berry Diameter, BYL-Berry Length, BYF-Berry Firmness, RB-Rotten Berries, FB-Fallen Berries, TSS-Total Soluble Solids.

**Fig 1:** Loss percentage of Bunch Weight, Bunch Diameter, Berry Weight, Berry Length, Berry Diameter, Berry Firmness, Fallen Berries and Rotten Berries of eight different grape genotypes from Day 0 to Day 16.

Conclusion

The Red Globe variety of grapes exhibited a lower percentage of weight loss, lesser fallen and rotten berries were recorded in Tas-e-Ganesh compared to other genotypes across all eight morphological characters, according to the aforementioned study on the shelf life of eight grape genotypes. However, compared to other genotypes, the biochemical characteristics are not extremely beneficial but they are better in Tas-e-Ganesh and Sharad Seedless based decrease after increase in TSS after 4-8 Days of Harvest. Therefore, Red Globe may be utilized as a table variety and can be stored for a longer period of time after harvest. In the future, other grape genotypes may be tested in ambient condition to determine shelf-life and value-added product preparation. This aids us in selecting higher-quality grapes for various grape uses, such as raisin, table, and wine.

References

1. Aamri AAA, Rubkhi ZAA, Abri ASA. Evaluation of nutritional fact and study of various physico-chemical parameters of black, green and red grapes samples in the local fruit market. *Asian Journal of Chemical Sciences*. 2020;8(3):1-8.
2. Aujla KM, Shah NA, Ishaq M, Farooq A. Post-harvest losses and marketing of grapes in Pakistan. *Sarhad J Agric*. 2011;27(3):485-490.
3. Deloire A, Rogiers S, Šuklje K, Antalick G, Zeyu X, Pellegrino A. Grapevine berry shrivelling, water loss and cell death: an increasing challenge for growers in the context of climate change. *IVES Technical Reviews*. 2021.
4. Dohadwala MM, Vita JA. Grapes and cardiovascular disease. *Journal of Nutrition*. 2009;139(9):1788S-1793S.
5. Elagamey AA, Abdel-Wahab MA, Shima MME, Abdel-Mogib M. Comparative study of morphological characteristics and chemical constituents for seeds of some grape table varieties. *Journal of American Science*. 2013;9(1):447-454.
6. Fabri ALS, Jordão AM, Correia AC, Pinto AF, Amboni RDDMC, Feltes MMC. Effect of storage temperature on physicochemical, physical, microbiological, and sensory characteristics of table grapes ('Red Globe' variety). *Scientia Plena*. 2025;21(4).
7. Goswami AK, Somkuwar RG, Samarth R, Sharma AK, Nawale SN, Itroutwar P. Evaluation of coloured seedless table grape varieties for increase in shelf life. 2013.
8. Gupta N, Brar KS, Gill MIS, Arora NK. Studies on variability, correlation and path analysis of traits contributing to fruit yield in grapes. *Indian Journal of Plant Genetic Resources*. 2015;28(3):317-320.
9. Khalil U, Rajwana IA, Razzaq K, Farooq U, Saleem BA, Brecht JK. Quality attributes and biochemical changes in white and colored table grapes as influenced by harvest maturity and ambient postharvest storage. *South African Journal of Botany*. 2023;154:273-281.
10. Khan N, Fahad S, Naushad M, Faisal S. Grape production: critical review in the world. Available from: SSRN 3595842; 2020.
11. Patil PN, Al-Aamri AA, Al-Rubkhi ZA, Al Abri AS. Evaluation of nutritional fact and study of various physico-chemical parameters of black, green and red grapes samples in the local fruit market. 2018.
12. Rolle L, Giacosa S, Gerbi V, Novello V. Comparative study of texture properties, color characteristics, and chemical composition of ten white table-grape varieties. *American Journal of Enology and Viticulture*. 2011;62(1):49-56.
13. Sharma AK, Sawant S, Somkuwar RG, Naik S. Postharvest losses in grapes: Indian status. 2018.
14. Xia EQ, Deng GF, Guo YJ, Li HB. Biological activities of polyphenols from grapes. *International Journal of Molecular Sciences*. 2010;11:622-646.
15. Zhang C, Wang Q, He H, Wu Y, Shan W, Liu H. Postharvest preservation strategies for table grapes: A comprehensive review from practical methods to future developments. *Plants*. 2025;14(16):2462.
16. Zhou DD, Li J, Xiong RG, Saimaiti A, Huang SY, Wu SX, *et al*. Bioactive compounds, health benefits and food applications of grape. *Foods*. 2022;11(18):2755.