

## ASSESSMENT OF QUALITY OF TABLE GRAPES (*VITIS VINIFERA*) FOR EXPORT IN PACKHOUSE

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**Abstract**—The present investigation entitled “Assessment of Quality of Table Grapes (*Vitis vinifera*) for Export in Pack house” was carried out during grape season at a pack house, in District Nashik, Maharashtra. The study was carried out to assess the physical and chemical quality parameters of grapes from different farms to the pack house and the quality of grapes at various stages of post-harvest operations in the pack house. The grape (Thompson seedless) variety was selected. Five farms were identified and six treatments based on desired quality were finalized. T1 (TSS Brix), T2 (Titratable Acidity), T3 (Grape berry size mm), T4 (Color), T5 (weight per bunches), T6 (Pre-cooling temperature and cold storage temperature). The TSS of the grapes varied from 17.07°Bx (farm 5) to 19.66°Bx (farm 1, 2, 3, 4). The titratable acidity of grapes varied from 3.20% (farm 5) to 3.3.4% (farm 1, 2). The grapes berry size ranged from 16mm (farm 1, 4, 5) to 18 mm (farm 3) while the weight of grape bunches varied from 168g (farm 5) to 210 g (farm 3). For pre-cooling, the temperature was 5°C to 0°C and for cold storage, it was 0°C to 2°C. The farms having such qualities were preferred in pack houses as these grapes can be exported for higher economic returns.

### INTRODUCTION

India is one of the largest producers of fruits and vegetables in the world. As per the database (1st Advance Estimates) published by NHB National Horticulture Board 2023-24, India produced 11.21 million metric tonnes of fruits and 209.39 million metric tonnes of vegetables (<https://apeda.gov.in/>). However, 30% to 50% of the produce is lost in transit due to poor post-harvest facilities. There is an urgent need to stop these losses by improving the post-harvest management. It includes the facility of pre-cooling to remove the field heat immediately after harvesting. India’s diverse climate ensures the availability of all varieties of Fresh fruits and vegetables.

Grapes have been consumed by humans for over 6000 years and have a rich history. They have been used for ages in a variety of ways, including table grapes, which are eaten raw, wine grapes, which are used to make juice and wines, and raisins, which are dried grapes with a longer shelf life. These by-products are widely acknowledged to be important, and strategies for their sustainable use in the

production of wine have been put forth by Kandyilis (2021).

China, Italy, the USA, Spain, France, Turkey, India, Argentina, Chile, and Iran are the leading grape-producing nations, in that order. With a production area of 15,100 hectares and a grape production of 209,843 tons, Azerbaijan holds a 0.22% and 0.29% global share, respectively, in 2021 Alekberova *et al.* (2023).

In India, there were 151 hectares of grapes cultivated overall in 2018-19. The country produced 4001.5 (million tons) of grapes annually, with a productivity of 26.5 (in MT). The main states that cultivate grapes are Maharashtra, Punjab, Haryana, Western Uttar Pradesh, and Maharashtra in the North, and Karnataka, Andhra Pradesh, and Tamil Nadu in the South. Maharashtra has the top position in terms of production, contributing about 81.22% of the nation’s total production and having the highest productivity. The nation exports a significant amount of grapes to the global market. During 2018-19, the nation exported fresh grapes valued at 233525.08 lakh, or 246133.79 (in MT). Additionally, during the 2019–20 fiscal year, the nation exported

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fresh grapes valued at 217686.82 lakh, totaling 193690.54 (in MT) Chavan *et al.* (2024).

Despite the improved requirements in industrialized nations, Indian agricultural exporters still encounter rejections and bans in important markets, with the majority of these cases stemming from non-compliance with food safety and health regulations. Pest infestations, the presence of chemical residues prohibited by the national food law of the importing country, levels of chemical residue exceeding permissible limits, and food contamination from bacterial germination are some of the causes of this non-compliance. In addition to costing exporters, farmers, and processors money, rejection and/or bans have caused exporters from other developing nations who can meet importing nations' standards for food safety and health to lose out on market share Goyal *et al.* (2017).

Grape exports are reliant on the grape's quality, which must meet the stringent phytosanitary regulations of the nation where it is exported. In addition to normal pack-house procedures and export specifications, grapes must be fumigated with CO<sub>2</sub> and SO<sub>2</sub> at designated concentrations for a specific amount of time Vishwakarma *et al.* (2022).

Various laws governing food safety come into effect for the local market. Even while India has embraced International norms for its domestic market, there are still gaps in their adoption and application, particularly when it comes to fresh food sold in the country's unorganized markets. Processing plants vary greatly in quality and can fall short of international standards. Therefore, it's critical to concentrate on standards and quality in the local market to ensure that goods are manufactured and processed according to International guidelines for food safety Roy and Roy, 2022).

To promote the export of safe and high-quality table grapes to the European Union, Grape Net integrates all parties involved in the grape export supply chain, including farmers, exporters, pack houses, state government's horticulture Departments, national referral laboratories, residue testing laboratories, AGMARK Fruit Quality Certification Department, phytosanitary Department, and APEDA. A comprehensive list of 174 chemicals that are available in India for all crops under the (Central Insecticides Board) CIB regulation of the Government of India is monitored in each sample to ensure food safety from all direct and indirect contamination sources. This 100% risk

assessment system is used to evaluate the food safety of Indian table grapes Kaushik *et al.* (2012).

Table Grapes are to be considered fruits derived from *Vitis vinifera* varieties, or cultivars. Minimum specifications: Subject to the unique requirements for every class and the permitted tolerances, bunches, and berries in all classes must be: Produce that has undergone rotting or degradation to the point of being unfit for human consumption is not included. Clean and nearly devoid of any external objects that are apparent, essentially free of pests, essentially free of pest-related damage, with a typical surface moisture content, devoid of any strange tastes or smells, whole, symmetrical, and regularly developed. At least 12°Brix for Alphonse Lavallee, Cardinal, and Victoria grape juices, 13°Brix for other varieties with seeds, and 14°Brix for all seedless varieties indicate grape juice maturity is always preferred. Shamsiddinovich and Akromovich (2021). Hence this study was undertaken to assess the physical and chemical quality parameters in grapes and to determine different stages of post-harvest operations in a pack house.

## MATERIALS AND METHODS

The Flow chart followed for the present study is presented in Fig 1 and the parameters tabulated in Table 1.

### Method

#### Packhouse operations working

Sampling & Pesticide Residue Analysis at grape farms

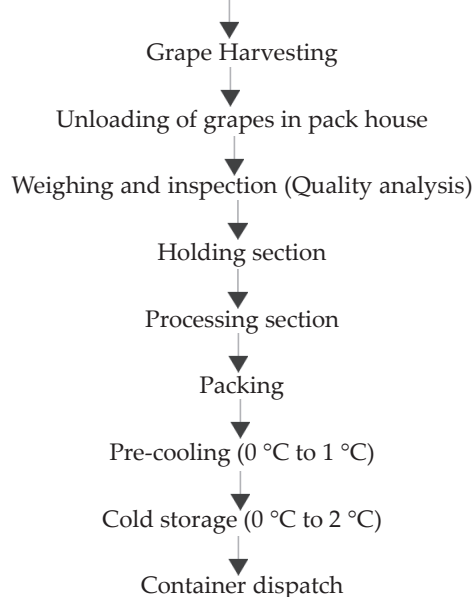


Fig. 1. Packhouse Operations Flow Chart

### Quality parameter of Grapes in the pack house

Five different samples of each grape crate received in the pack house were taken and subjected to physical and chemical evaluation. It includes T.S.S., total acidity, color, weight, Temperature, etc. quality parameters of grapes tested.

#### T.S.S.

To measure the TSS value of the fresh grape a hand Refractometer (Make: Tiaoyeer Model pjzsy54-001) covering a range of 0°Bx to 32°Bx was used.

#### Titrateable acidity

Five-gram samples of grapes were crushed using a pestle and mortar. The grape pulp was filtered via filter paper after being diluted to 15 ml with distilled water. Using phenolphthalein as an indicator, 5 ml of the filtered extract was titrated against a 0.1 normal sodium hydroxide solution until a bright pink color appeared. It was noted how much sodium hydroxide solution was utilized. By using the same solution to titrate 200 milliliters of boiled distilled water, the blank sample reading was acquired. For computations using Eqn (1), the difference between the sample and blank readings was utilized by Thoke *et al.*, (2024).

$$\text{TA titrateable acidity} = \frac{V \times N \times 75 \times 1000}{1000 \times v} \dots\dots$$

Eqn (1)

V = Difference (ml) of sodium hydroxide solution used for titration of sample and blank N = Normality of sodium hydroxide solution (0.1), v = Sample volume (ml).

#### Sizer

The sizer was used to ensure the primary quality grape berries, the size of the berries should be 16+ (mm) and above. If the bunches are found to be big berries they and packed according to customer demand.

### Visual examination of the physical quality of grapes

**Color:** When fully ripe, these grapes give a hint of golden color, but they are usually green. Maintaining color uniformity throughout the bunch is essential for export quality.

**Scent:** The aroma of table grapes, such as Thompson Seedless grapes, is pleasant.

**Taste:** A crucial component of grape quality was sweetness. Grapes with a decent mix of sweetness

and acidity are preferred by consumers.

### Quality of grapes at different post-harvest operations in the pack house

#### Pre-cooling treatment quality of grapes

After removing field heat with a pre-cooling chamber, grapes were processed and packed at a temperature between 0 °C and 1°C, taking 4-5 hours to reach this.

#### Cold storage quality of grapes

Table grapes were stored in cold rooms between 0 °C and 2 °C. It is recommended to keep the relative humidity at approximately 95%. The samples (grapes) were kept in a cold storage chamber maintained between 0 °C and 10 °C, and before being sent, the grapes were kept at a low temperature of 0 °C to 1 °C during the grape season.

## RESULTS AND DISCUSSION

### Physical and chemical parameters in the Grapes Pack House

The first worldwide standard for grape exports was based on chemical parameters. Table 2 summarizes the TSS of grapes received by the pack house and displays the TSS classification as top, middle, and bottom in the table, as calculated by average Brix per grape bunches.

The degree of liking for the grapes of 16.0-17.0, 17.1-18.0, and 19.1-20.0°Brix varied significantly ( $P < 0.05$ ). When grape acidity varied, consumers' preferences for grapes also changed significantly. The data showed that, respectively, the correlation coefficients of determination ( $r^2$ ) between total consumer acceptance and °Brix, acidity, and °Brix/acid ratio were 0.58, 0.79, and 0.85. The best objective metric that accurately represented consumer acceptability was determined to be the °Brix/acid ratio, which can be a trustworthy tool for figuring out when to harvest seedless table grapes Jayasena and Cameron (2008).

The TSS of the grapes was displayed in it was observed that the Brix average recorded at the top of the bunch as 23°Bx from farms 1, 2, 3, 4, and 5. From the middle of the bunch is 19°Bx, from every 5 farms, from the bottom of the bunch is 16°Bx from every 5 farms, and from the top, middle, and bottom average brix was found to be 19.66°Bx (Max) and 17.33°Bx (Min).

**Table 1.** Experimental plan

Variable	Levels	Description
Product	1	Table Grapes
No. Farms	5	F1, F2, F3, F4, F5.
Samples	5×6	F1- T1-T6, F2- T7-T12, F3- T13-T18, F4- T19- T24, F5- T25-T30
Properties	6	Chemical Properties-TSS, TA Physical Properties- Berry size, Color, Weight (per bunches) and Temperature.
Storage condition	1	Cold storage (0-5 °C)
Statistical analysis		Graphical analysis, statistical tools and Microsoft Excel were used to analyze the data obtained.
Pesticide level	3	as per APEDA standard

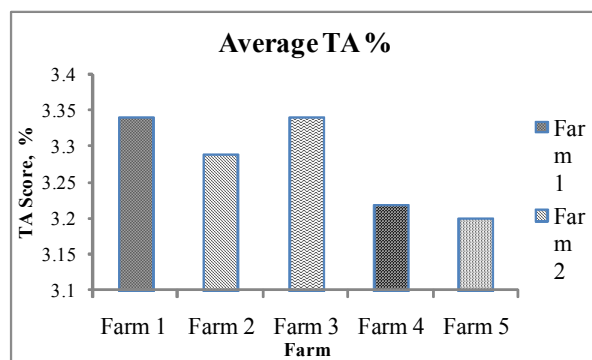
T1- TSS (Brix), T2- Titratable acidity, T3- Grape berry size (mm), T4- Color, T5- Weight (per bunches), T6- Temperature (Pre Cooling and Cold Storage)

**Table 2.** T.S.S. of Grapes bunches

Selection of Farm	Grapes sample	Top <sup>(0Bx)</sup>	Middle <sup>(0Bx)</sup>	Bottom <sup>(0Bx)</sup>	Average <sup>(0Bx)</sup>
Farm 1	Sample 1	22	18	16	18.66
	Sample 2	19	17	16	17.33
	Sample 3	23	19	17	19.66
Farm 2	Sample 4	22	18	16	18.66
	Sample 5	20	17.8	16	17.93
	Sample 6	23	19	17	19.66
Farm 3	Sample 7	21	19	16	18.66
	Sample 8	22	17.9	16.2	18.07
	Sample 9	23	19	17	19.66
Farm 4	Sample 10	22	18.4	16	18.08
	Sample 11	19	17	16	17.33
	Sample 12	22	19	16.6	19.02
Farm 5	Sample 13	21	18.2	16.4	18.53
	Sample 14	19.8	17.3	16	17.07
	Sample 15	23	19	17	19.66

### Titratable acidity in grapes

The TA of the grapes was displayed in the Fig. 2. It was observed that from each of 5 farms with their 15 samples, average Titratable acidity was recorded to be 3.34% (Max) and 3.20% (Min).

**Fig. 2.** Titratable acidity

### Physical quality of grapes

International criteria for the physical characteristics of the grapes were followed. Table 3 indicates that grape samples from five farms were noted according to the weight of bunches grape size, color, and temperature at which the berries were received.

The parameters of each physical stage of grapes are guaranteed by the berry's size, color, weight per bunch, and primary temperature were all measured in the sample by export rules for this study.

The berry sizes were measured and tabulated in Table 3. The average size of berries varied from 16 (Farm 1, 4, 5) - to 18 mm (Farm 3) in all 5 farms. The weight of the Grapes bunches was from 180g (Farm 5) to 210 g (Farm 3)

Grapes receiving berry temperature in each farm were recorded as 21°C (Max), from Farm 4 and 19°C (Min), from Farm 2. Grapes Colour also differed slightly in all 5 farms. It was recorded as Green in

farms 1 and 2, Milky green (farm 3), Amber in farm 4, and Golden Yellow in farm 5.

### Different post-harvest operations in Packhouse

There were different operations carried over in a packed house, pre-cooling by forced-air cooling is a common method where cold air is blown over the grapes to lower their temperature rapidly. Cold storage is essential for preserving the quality of grapes during export by maintaining the optimal temperature and humidity levels.

### Pre-cooling

The process of pre-cooling involves lowering the temperature from 20 °C to 0 °C to eliminate the grape's field heat for grapes to endure prolonged

cold storage at a consistent temperature, the physical and chemical classification of pre-cooled grapes at varying temperatures in cold storage is displayed in the Table 4.

Effective pre-cooling was maintained at farm 4 at a temperature of 5 °C to 0 °C where 3 samples S10, S11, and S12 showed top brix as 22.2°Bx, middle brix 19.1°Bx, bottom brix 16.7°Bx and total Significant average brix recorded to be 19.03°Bx, which is standard and effective than other farms.

### Cold storage

The pre-cooled pallets from the pre-cooling chamber with berry temperature below 2 °C were shifted to the cold store. The cold store was used to extend the shelf life of the grapes. The air temperature of the

**Table 3.** Berry size, bunches weight, receiving berry temperature and colour of Grapes

Selection of Farm	Sample of grapes	Grape berry size (mm)	Weight of bunches(g)	Receiving berry temp °C	Colour
Farm 1	Sample 1	16	194	20	Green
	Sample 2	16	206	20	
	Sample 3	16	194	20	
Farm 2	Sample 4	17	198	19	Green
	Sample 5	17	194	19	
	Sample 6	17	188	19	
Farm 3	Sample 7	18	204	20	Milky green
	Sample 8	18	210	20	
	Sample 9	18	208	20	
Farm 4	Sample 10	16	178	21	Amber
	Sample 11	16	196	21	
	Sample 12	16	191	21	
Farm 5	Sample 13	16	156	20	Golden yellow
	Sample 14	16	178	20	
	Sample 15	16	168	20	

**Table 4.** Cold storage 0 °C to 2°C

Grapes sample	Pre cooling Treatment!	Top <sup>(0)Bx</sup>	Middle <sup>(0)Bx</sup>	Bottom <sup>(0)Bx</sup>	Average <sup>(0)Bx</sup>
Sample 1		24	20.3	18.2	20.83
Sample 2	20 to 15	22	19.5	17.1	19.53
Sample 3		24.2	20.4	18.2	20.93
Sample 4		23	19.4	17.3	19.9
Sample 5	15 to 10	22	19.8	17.5	19.76
Sample 6		24	21.3	18.6	21.3
Sample 7		22.5	20	17.8	20.1
Sample 8	10 to 5	23	19	18.2	20.06
Sample 9		24	19.2	18	20.4
Sample 10		22.2	18.6	16.3	19.03
Sample 11	5 to 0	19.3	17.2	16.2	17.56
Sample 12		22.2	19.1	16.7	19.33
Sample 13		23.1	20.2	18.4	20.56
Sample 14	0 to -5	20.8	19.3	17.5	19.2
Sample 15		24	20.4	18.3	20.9



**Table 5.** Pesticides Residues and Chemical Residues level of the grapes from the farm4

No. Ann.9	Name of pesticide	Result (mg/kg)	Intake (mg/Kg BW)	EU MRL (mg/Kg)	ARFD Values	% EU MRL	% ARFD
240	Spirotetramat and spirotetramatenol	0.033	0.0022	2	1	1.65%	0.22%
131	Fluopyrm	0.033	0.0022	2	0.5	1.65%	0.43%
138	Fosetyl-Al (sum fosetyl + phosphorous acid and their salts, expressed as fosetyl)	0.985	0.645	100	NA	0.99%	—

Ann.9 - Annexures serial numbers, EU - European Union, MRL - Maximum Residue Levels (MRLs), ARFD Values - Acute Reference Dose.

cold store chamber was 0 °C to 2 °C and humidity was around 90-95%.

After being pre-cooled to a range of temperatures, grape samples were kept in cold storage between 0 and 3 °C. Ten days later, another reading was obtained. After being quickly cooled in forced air tunnels for 12 hours at 0 °C to reduce fruit temperature to 1-4 °C, grapes were kept for 60 days at 0 °C (also known as “Thompson seedless” storage). Following cold storage, grapes were kept for three days at 20 °C without the use of a generator pad to replicate a commercialization phase before the determination of the occurrences of shatter, hairline, split, and decay Zoffoli *et al.* (2009).

Farm 1 Grapes samples S1, S2, and S3 were Pre-cooled at 20 °C to 15 °C and shifted to cold storage at 0°C to 2 °C for 10 days, After 10 days it was observed that the top brix increased to 24.2°Bx, middle 20.4°Bx and 18.20.Bx and average brix recoded to be 20.93°Bx (Max). Farm 2 Grapes samples S4, S5, and S6 were Pre-cooled at 15 °C to 10 °C and shifted to cold storage at 0 °C to 2 °C for 10 days, After 10 days it was observed that the top brix increased to 24°Bx, middle 21.3°Bx and 18.6°Bx and average brix recoded to be 21.3°Bx (Max). Farm 3 Grapes samples S7, S8, and S9 were Pre-cooled at 10 °C to 5 °C and shifted to cold storage at 0 °C to 2 °C for 10 days, After 10 days it was observed that the top brix increased to 24°Bx, middle 20°Bx and 18.2°Bx and average brix recoded to be 20.6°Bx (Max). Farm 4 Grapes samples S10, S11, and S12 were cooled at 5 °C to 0 °C and shifted to cold storage at 0 °C to 2°C for 10 days, After 10 days it was observed that the top brix increased to 22.2°Bx, middle 17.2°Bx and 16.7°Bx and average brix recoded to be 19.33°Bx (Max), which is most significant from 5 farms. Farm 5 Grapes samples S13, S14, and S15 were Pre-cooled at 0 °C to -5°C and shifted to cold storage at 0 °C to 2 °C for 10 days, After 10 days it was observed that the top brix

increased to 24°Bx, middle 20.4°Bx and 18.4°Bx and average brix recoded to be 20.56°Bx (Max).

### Pesticide Residues Analysis

The samples analyzed for pesticide residues were as per APEDA standards. Table 5 shows the pesticide residue level of grapes from farm 4 for export purposes

### CONCLUSION

1. Farm 4 demonstrated the best TSS ranging from 17.33°Bx to 19.02°Bx.
2. Farm 4 also showed a preferred acidity of 3.22% (average).
3. Farm 3 had better Grapes in Physical quality with an average of 18 mm.
4. The Grape's bunches weight from each of the 5 farms was recorded to be 210g from farm 3 (sample 8) and 168g from farm 5 (sample 15).
5. Farm 4 was Pre-cooled at 5 °C to 0 °C and shifted to cold storage at 0 °C to 2 °C for 10 days, it was observed that the top brix increased to 22.2°Bx, middle 17.2°Bx and 16.7°Bx and average brix recoded to be 19.33°Bx (Max), had most significant from 5 farms. Effective pre-cooling was maintained at farm 4 at a temperature of 5 °C to 0°C.
6. From the study, it was concluded that farm 4 grapes have better TSS, Titratable acidity, size, bunches weight, temperature, and color of Grapes.

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**Conflict of Interest-** None

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