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Effect of Temperature on Shelf life of Muscat Hamburg Grapes under Storage

U. Tamizheezham*[1], I. Muthuvel[2] and A. Subbiah[3]
[1]Department of Fruit Crops, Tamil Nadu Agricultural University, Coimbatore
[2]Department of Fruit Crops, HC & RI, Periyakulam.
[3]Grapes Research Station, Theni.

Grape is one of the commercially important fruit crop cultivated in the country under wide range of soil and climatic conditions. In India, it is cultivated in an area of 1.18 lakh ha with annual production of 25.85 lakh MT. Tamil Nadu (1.8 %) ranks third with a production of 0.47 lakh MT over an area of 2,800 ha after Maharashtra and Karnataka. The major grape growing regions in Tamil Nadu are Theni, Dindigul and Coimbatore districts. Grape berries are highly perishable in nature and losses due to inadequate post-harvest management amounts to about 20 to 30 per cent. Muscat Hamburg (Gulabi/ Panneer) grape variety is extensively grown in Tamil Nadu with an average yield is 10 to 12 tonnes per hectare. The storage experiment was laid out in Completely Randomized Design (CRD) with two treatments and ten replications. A total weight of ten kilogram was stored in each replication under each treatment. The grape bunches were harvested (120 days after pruning), trimmed and packed in corrugated fiber board boxes from farmer's vineyard. Then the grapes were stored at Horticultural College and Research Institute, Periyakulam under ambient condition (30±2°C; 50-70 %) as well as under cold storage condition (4±2°C; 90-92 %). In this experiment, all the observations on post-harvest quality characters were made on daily basis under ambient storage condition, whereas two days interval under cold storage condition till the berries were over-ripe and become unfit for consumption. The results showed that grape bunches stored under cold storage condition had better shelf-life of 31.33 days with 4.51 % physiological loss in weight, 4.50 N mm^{-1} berry firmness, 14.77°Brix TSS, 0.32 % titrable acidity and organoleptic score of 6.4 than grape bunches stored at ambient condition.

Key words: Grapes, Shelf-life, Storage

Grapevines (*Vitis vinifera* L.) occupy more land in the world than any other single fruit and account for almost half of the total production of fruits in the world (Al-Obeed, 2011). Grape is one of the commercially important fruit crops cultivated in the country under wide range of soil and climatic conditions. In India, it is cultivated in an area of 1.18 lakh ha with annual production of 25.85 lakh MT (NHB, 2014). Among the fruit crops grown in the country, grapes productivity shares 15.8 per cent with a production of 17.37 lakh MT. The major grape growing states are Maharashtra, Karnataka, Telangana, Andhra Pradesh, Tamil Nadu, Punjab, Uttar Pradesh and Haryana. Among them, Maharashtra ranks first with an area of about 0.90 lakh ha (83.5 %) with a production of 21.60 lakh MT. Tamil Nadu (1.8 %) ranks third with a production of 0.47 lakh MT over an area of 2,800 ha after Karnataka (11.7 %). The major grape growing regions in Tamil Nadu rest with Theni, Dindigul and Coimbatore districts (NHB, 2014). Grape is a source of carbohydrates, sugars, minerals and tannins. It is also rich in vitamins *viz.,* vitamin A, vitamin C, vitamin K, carotenes and B-complex vitamins such as pyridoxine, riboflavin and thiamin and micronutrients like copper, zinc, iron and manganese. Grape also contains a variety of antioxidants and polyphenols. These beneficial antioxidants scavenge harmful free radicals to prevent the process of oxidation that damages cells.

*Corresponding author's email: tamilsow12@gmail.com

In India, while 78 per cent of grape produced is used for table purpose, nearly 17 to 20 per cent is dried for raisin production, while the remaining two per cent is used for manufacturing of juice and wine (Chadha, 2008). Grape berries are highly perishable in nature and losses due to inadequate post-harvest management amounts to about 20 to 30 per cent. Under normal conditions, berries have shelf-life of about four to six days. The storage life of grape berries can be extended up to a period of two to three months under controlled conditions (Radha and Mathew, 2007). Table grapes are very well cold stored at 0°C soon after harvest for retaining freshness, quality and reduction of berry decay results in delayed senescence. After cold storage, the grapes have shelf-life up to three to four days at room temperature (around 20°C) in the retail stores for marketing. Differential response of varieties to low temperature storage is evident in grapes.

During the storage period, reduction of berry decay and disease buildup is very much important under refrigerated storage conditions. In grapes, rachis browning/ discolouration and *Botrytis* grey

mould disease are the two important factors predispose the shelf-life and quality of table grapes (Nelson, 1985 and Lichter *et al*., 2006).The difference in freshness, shipping quality of grape depends on varieties, vineyard management, viticultural practices, field handling and postharvest storage facility. The maintenance of postharvest grape quality is becoming increasingly significant as the supply of high quality commodities constantly exceed demand, not only for marketing at harvest time but also after storage. Therefore, main focus is to evolve novel methods and strategies for enhancing grape berry quality characteristics, suitable for extended shelf-life and long distance transportation of grapes. This would be highly helpful for improving consumer appeal in grape berries, suitable for export and distant markets free from quality deterioration. Most commercial requirements are one to two months of storage to reach distant markets. In this regard, the present investigation was carried out to study the shelf-life of grapes under different storage conditions.

Material and Methods

The experimental trial was conducted at Theni district lies at the foot hills of the Western Ghats of India between 9˚ 39' and 10˚ 30' of North latitude and between 77˚ 00' and 78˚ 30' of East longitude during 2016-2017. Muscat Hamburg (Gulabi / Panneer) grape variety is extensively grown in Tamil Nadu. Berries are small in size, deep purple, spherical and seeded. The TSS is 18 to 20° Brix. Variety has a good keeping quality and is used for table purpose. Variety is not susceptible to cracking but it is susceptible to rust and downy mildew. Average yield is 10 to 12 tonnes per hectare. The storage experiment was laid out in Completely Randomized Design (CRD) with two treatments and ten replications. A total weight of ten kilogram was stored in each replication under each treatment. Grapes were harvested (120 days after pruning) from the farmer's vineyard, trimmed, packed in corrugated fiber board boxes and stored at Horticultural College and Research Institute, Periyakulam under ambient condition (30±2°C & 50-70 % relative humidity) and cold condition (4±2°C & 90-92 % relative humidity). In this experiment, all the observations on post-harvest quality characters were made on daily basis under ambient storage condition, whereas two days interval under cold storage condition till the berries were over-ripe and become unfit for consumption.

The physiological loss in weight was calculated by adopting the following formula described by A.O.A.C. (2001) and expressed in per cent. Total soluble solids was estimated at room temperature with the help of a hand held refractometer. TSS was expressed in °Brix (Saini *et al*., 2012). Five berries in all replication were taken under each treatment for recording values. Titrable acidity was determined by titrating the sample extracted in water against 0.1N NaOH using phenolphthalein as indicator. The acidity was calculated by using the following formula and expressed in per cent (Ranganna, 1977). In grapes, the predominant acid is tartaric acid. Equivalent weight of tartaric acid is 77.50 (Saini *et al*., 2012).

Total sugars were determined by using Anthrone method. Sugar solution was extracted with ethanol and boiled for 10 minutes after adding anthrone reagent. The solution was cooled under running tap water and the reading was measured at 625 nm absorbance on spectrophotometer (Bala *et al*., 2013). Total sugars were estimated by Somoigyi (1952) and the results were expressed in percentage. Total reducing sugars content was determined by using Nelson reagent method. The reading of the sugar solution was measured at 510 nm absorbance on spectrophotometer for reducing sugar estimation (Bala *et al.,* 2013) and expressed in per cent. The difference in the concentration of total sugars and reducing sugars was taken as the concentration of non-reducing sugars. Non-reducing sugars was calculated by using the following formula and expressed in per cent. Ascorbic acid was calculated by using the following formula and expressed in mg $100g^{-1}$ (Bala *et al.,* 2013). Organoleptic evaluation was carried out on the last day of each treatment's shelf-life *i.e.,* before the fruit losses its marketability and consumer's appeal. Organoleptic evaluation was conducted with a well trained panel of 15 members by using 9 point Hedonic scale from dislike extremely to like extremely for appearance, colour, texture, flavour, taste and overall acceptability.

Results and Discussion

The shelf-life of berries was determined by recording the number of days the berries remained in good condition during storage.

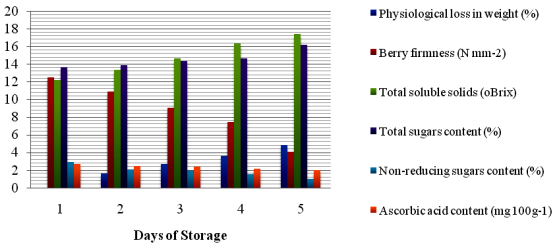

Fig. 1. Effect of ambient storage condition on quality of Muscat Hamburg grapes

When the total spoilage of berries under different treatment conditions exceeded 15 per cent, it was considered as the end of storage life (Ramprasad *et al*., 2004). The effect of temperature on shelf-life of Muscat Hamburg grapes showed that the grapes stored for 31 days under cold condition (4±2°C & 90-92 % relative humidity) whereas under room temperature the grapes had shelf-life of 5 days. Thus, the shelf-life extended under cold storage condition might be due to the low temperature combined with high relative humidity in comparison with the ambient condition which helps in the reduction of water loss.

The weight loss of five per cent during storage is considered to be the maximum acceptable limit that fresh produce can have during storage, above which

the fruit shows shriveling and become unmarketable (Mahajan *et al*., 2009). Earlier reports of Deng *et al.* (2006) indicated that approximately five per cent weight loss was found to be the normal acceptable limit for table grapes. In the present study, the grapes stored under cold condition recorded 4.51 per cent physiological loss in weight on 31st day of storage whereas loss was 4.83 per cent under ambient storage even on 5th day of storage. Water loss in grapes could have negative effects on both berries and stems. If the berries transpire too much of water, they lose their turgidity (firmness) and get slightly shrivelled. Water loss also results in the visible dehydration of stem tissues, particularly the smaller pedicels attached directly to the berries (Lydakis and Aked, 2003).

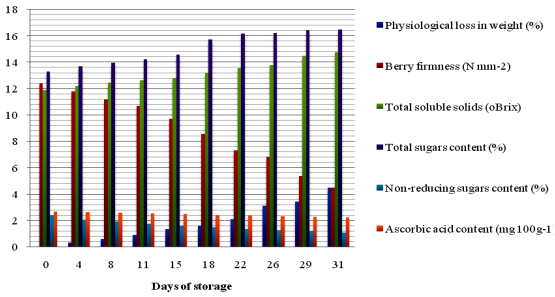

Fig. 2. Effect of cold storage condition on quality of Muscat Hamburg grapes

The berry firmness data showed decreasing trend from 12.52 N mm^{-2} to 4.07 N mm^{-2} under ambient storage and 12.42 N mm^{-2} to 4.5 N mm^{-2} under cold storage. Brummell and Harpster (2001) reported that decrease in firmness in all storage conditions was accompanied by a dramatic decrease in hemicelluloses (38-63 %) and moderate decreases in cellulose (9-16 %) and total pectin (7-15 %). This indicates that the softening of grapes resulted from an increase in depolymerization and degradation of cell wall polysaccharides. The increase in water-soluble pectin accompanied by a loss of proto-pectin (Na_2CO_3-soluble pectin) during storage might be the reason for the firmness reduction in grapes as narrated by Deng *et al*. (2005). The pectate lyase degrades pectin by the mechanism of β-elimination. But, earlier researches indicated that textural changes of fruit flesh during storage attributed to degradation of primary cell wall and middle lamella structures (Huber, 1983; Yang *et al*., 2007).

The soluble solids content and titrable acidity are the most important quality parameters used for judging the post-harvest storage effect of table grapes. The total soluble solids increased from 12.17 °Brix to 17.43 °Brix within 5 days under ambient condition, however TSS reached 14.77 °Brix from 11.87 °Brix over a storage period of 31 days under cold condition. The increase in TSS content during storage might be result from hydrolysis of starch into sugars. This could be due to the concentration of sugar molecules and reduction of moisture content inside the vacuoles. Thus higher the temperature, faster rate of sugar conversion will takes place. According to Imlak *et al*. (2017), TSS of the fruits also increased during storage mainly due to glycogenesis and metabolism of fruiting tissues that becomes partially inactive due to changes in glucose and fructose.

The consumer preference of grapes relies mostly on the peculiar taste that arises mainly from the organic acids present in the berries responsible for its titrable acidity (Imlak *et al*., 2017). The titrable acidity data showed decreasing trend under both the ambient (from 1.34 % to 0.27 %) and cold storage condition (from 1.72 % to 0.32 %). But the decreasing rate was higher under ambient condition rather than cold storage condition. The acidity reduction could be attributed to consumption of acids during the process of respiration. The acidity of grapes was calculated with respect to the tartaric acid, since tartaric acid is the major organic acid followed by malic acid and citric acid in grapes (Ustun *et al*., 2006). Accumulation of tartaric acid could be due to its chemical characteristics, since it is difficult to metabolize because of its tendency to form salts which are not easily degraded by any known enzymes (Esteban *et al*., 1999). The earlier works of Salunkhe and Kadam (1995) are in accordance with the present results which could be ascribed to utilization of more acids in the process of respiration, accumulation of potassium to the dried vacuoles and maturity.

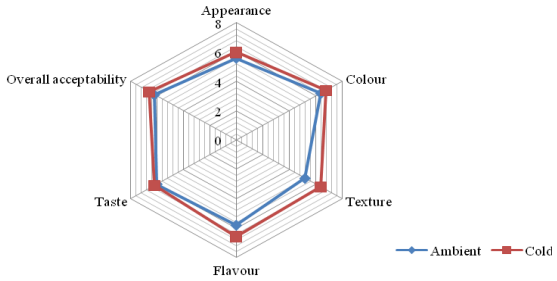

Fig.3. Oraganoleptic evaluation

Prolonged storage period resulted in greater deviation of sugar composition with reference to harvested value. The effect of temperature on total sugars reported the increasing trend irrespective of the storage condition but was faster under ambient storage condition. Thus the higher temperature enhanced the starch conversion. This increment in total sugars was attributed towards rapid conversion of complex starch molecules into simpler sugars. Excess loss of moisture from the fruiting tissues and vacuoles may also be ascribed as valid reason behind this increment (Imlak *et al*., 2017). The data on total reducing sugars of grapes revealed that there was an increasing trend during the storage period which may be due to the conversion of starch into monosaccharides *viz.,* glucose and fructose. Apart from glucose and fructose, the important third sugar is sucrose that is non-reducing by nature and present relatively in smaller amounts with level not exceeding more than one per cent (Imlak *et al*., 2017). The decrease in the non-reducing sugar may be due to the conversion of sucrose into glucose and fructose, resulting in an enhancement of the reducing sugar content as discussed earlier.

Ascorbic acid is one of the most important nutritional components in table grapes and also acts as potential antioxidant involved in the restriction of senescence (Zhou *et al*., 2008). The data on ascorbic acid showed decreasing trend under both the storage conditions but comparatively less reduction was observed under cold condition. This reduction might be due to the oxidation of the ascorbic acid as the storage period prolonged. Owing to the conversion of ascorbic acid to dehydroascorbic acid by the action of ascorbic acid oxidase might be the fact on reduction of ascorbic acid content during storage. Table grape quality refers to a range of attributes related to the appearance, colour, texture, flavour and aroma. The organoleptic evaluation of Muscat Hamburg grapes stored under cold condition scored 6.4 mean value even after 31 days of storage whereas 5.9 under ambient condition after 5 days of storage.

It is concluded that grape bunches stored under cold storage condition (4±2°C & 90-92 % relative humidity) had lesser physiological loss in weight of 4.51 % with 4.50 N mm^{-1} berry firmness, 14.77 °Brix TSS, 0.32 % titrable acidity and organoleptic score of 6.4 than grape bunches stored at ambient condition. Thus, storage of Muscat Hamburg grapes under cold condition fetches better price in market by prolonging the shelf-life up to 31 days and also avoids the glut in the markets at the peak season. Future line of work are to be focused on the rachis browning, berry drop, bunch retention on the vines and disease incidence in grapes for better understanding.

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