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# Changes in Chemical Composition of Ripe Mango Wine

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**A B S T R A C T**

An investigation on "Standardization of wine making technology from mature green and ripe Alphonso mango (*Mangifera indica* L.) fruits" was conducted during the year 2020-2021 and 2021-2022 at College of Horticulture, Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli. In case of effect of TSS and dilution levels on chemical composition of raw Alphonso mango wine it was observed that TSS, reducing sugars, total sugars, ascorbic acid, tannins, protein and vitamin A content decreased during storage of wine and titratable acidity and alcohol content was increased at three months and then decreased at six months. pH of wine increased with increase in TSS and dilution levels except in dilution level of raw Alphonso mango. Vitamin A content decreased with increase in dilution level but showed no specific trend with TSS levels. Alcohol increased with increase in TSS levels. Lowest TSS, tannin was recorded by $T_1D_5$ and $T_4D_5$ respectively.

## Introduction

Mango (*Mangifera indica* L.) is one of the most highly priced desert fruits of the tropics. It has rich, luscious, aromatic flavour and a delicious taste in which sweetness and acidity is delightfully blended (Reddy and Reddy, 2009). Mango is known as 'King of fruits' owing to its nutritional richness, unique taste, pleasant aroma and religious and medicinal importance. Mango is believed to be originated in South East Asia, Indo-Burma region and in foot hills of the Himalayas (Mukherjee, 1951). India is largest producer of mango in the world and ranks first in area and production.

The total area under mango in India is 2,350,000 hectare and production is about 21,011,000 MT with productivity of 8.7 $MTha^{-1}$, which is 35.80 per cent of total area and 21.19 per cent of the total production under fruit crops in the country (Anon, 2022). One of the largest mango growing belt in the country is Konkan region on the west coast of Maharashtra occupying 0.110 million ha productive area under mango cultivation having annual production of 3, 08,480 MT.

Mango is highly perishable seasonal fruit and is processed into various products like slices, nectar, jams and pickles. Mangoes are a good source of dietary fibre (Bronce and Ona, 2015). The ripe mango is reported to have 83.46-86.70 per cent moisture, 0.82 g protein, 0.38 g fat, 14.98 g carbohydrate, 11 mg calcium, 14 mg phosphorus, 0.16 mg iron, 0.135 -1.872 Vitamin A (mg/100g beta carotene), 0.038g / 10g Riboflavin and 36 mg / 100 g ascorbic acid, 12.0-23.0 (˚Brix) TSS and 0.12-0.38 per cent acidity per 100 g edible portion of fruit. Mangoes processing is done for the following reasons: to decrease post-harvest losses and extend shelf

life; create variety and hence widen the market; add value, thereby generating extra income; create new investment and employment opportunities and support local small-scale industry through the demand for equipment required for processing, preservation and packaging.

An alternative way of preserving surplus mangoes could be to ferment the juice to fruit wine. The country's wine sector is more than a decade old with a total production of nearly 2 crore litres annually and consumption stands at 1.5 crore litres per year. Exports barely account for 10 % of the total production. There are around 110 wineries in India including 72 in Maharashtra. While the domestic wine industry has an annual turnover of just 600 crores.

## Materials and Methods

The experiment entitled "Standardization of wine making technology from mature green and ripe Alphonso mango (*Mangifera indica* L.) fruits." was conducted during the year 2020-21 and 2021-22 at Pomology Laboratory, Fruit Processing Unit of College of Horticulture, Dapoli and Fruit Beverage Research Centre of Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli, Dist. Ratnagiri.

In this experiment, must was prepared by diluting the raw Alphonso mango fruit pulp as per the treatments i.e., 1:0, 1:0.5, 1:1, 1:1.5 and 1:2 and adjusting the T.S.S. to control, 20°Brix, 24°Brix and 28°Brix. The pH was adjusted to 3.5 as per the treatments.

For extraction of pulp from ripe fruits, fruits were boiled in sufficient quantity of water till they become soft, fruits skin was removed by hand. Then peeled fruits were subjected to pulper and pulp was extracted. The inoculum prepared by taking white wine yeast powder (*Saccharomyces cerevisiae*) at the rate of 0.3g/kg of must in 10 times quantity of luke warm water for activation of yeast cells. After adjustment of T.S.S. and pH, must of each combination was transferred to conical flasks separately. The must was supplemented with 0.1 per cent, diammonium hydrogen phosphate (DAHP) and 30 mg/kg potassium metabisulphide (KMS). The prepared must was then used for inoculation, 2 hours after addition of KMS. Must was inoculated with yeast culture @ 0.30 g $kg^{-1}$ and kept for fermentation at room temperature. After fermentation, the assembly was dismantled. Bentonite at the rate of 1g $kg^{-1}$ was added, mixed well and kept for 7 days as such at cold storage (12±1°C) to separate colloidal material from wine.

## Results and Discussion

### Chemical composition of ripe Alphonso mango wine during storage

### T.S.S. ($^0$Brix)

TSS of wine decreased from 0 (7.47 $^0$B) to 6 months (6.61 $^0$B) during storage. Decrease in TSS during storage may be due to micro fermentation during storage which converts sugars into alcohol. TSS of wine was increased with T.S.S. levels from $T_1$ (3.46 $^0$B) to $T_4$ (12.39 $^0$B) at 0, $T_1$ (3.20 $^0$B) to $T_4$ (11.05 $^0$B) at 3 and $T_1$ (3.01 $^0$B) to $T_4$ (10.72 $^0$B) at 6 months storage. Increase in T.S.S. may be impact of original adjustment of T.S.S. levels of must before fermentation. Lowest TSS recorded by $T_1$ at 0 (3.46 $^0$B), 3 (3.20 $^0$B) and 6 month (3.01 $^0$B) storage was significantly superior over others. Analogous findings were also reported by Anand (2003) in cashew apple wine and More (2010) in karonda wine. TSS increased from 7.14 $^0$B ($D_1$) to 7.93 $^0$B ($D_5$) at 0, 6.54 $^0$B ($D_1$) to 7.46 $^0$B ($D_5$) at 3 and 6.26 $^0$B ($D_1$) to 7.30 $^0$B ($D_5$). Lowest T.S.S recorded by $D_1$ was at par with $D_2$ (7.19 $^0$B) and $D_3$ (7.50 $^0$B) at 0 month, $D_2$ (6.64 $^0$B), $D_3$ (6.73 $^0$B) and $D_4$ (6.78 $^0$B) at 3 months storage. At 6 months storage $D_1$ was at par with $D_2$ (6.40 $^0$B), $D_3$ (6.46 $^0$B) and significantly superior over others. Increase in T.S.S with increase in dilution levels may be the impact of dilution on fermentation of must and hence conversion of sugar into alcohol might have hindered with increase in dilution level. Interaction $T_1$ $D_5$ recorded minimum TSS (2.10 $^0$B) at 0 month was at par with $T_1$ $D_4$ (2.25 $^0$B) and significantly superior over others. At 3 months$T_1D_5$ (1.60 $^0$B) recorded minimum T.S.S. was at par with $T_1D_4$ (2.20 $^0$B) and significantly superior over others. At 6 months same interaction i.e. $T_1D_5$ recorded minimum (1.35 $^0$B) T.S.S and was significantly superior over others. The highest T.S.S during storage was recorded by $T_4D_5$ at '0' (14.10 $^0$B), 3 (13.25 $^0$B) and 6 (13.05 $^0$B) months. Results of the present findings are supported by Sapkal (2011) in mango wine and Pawaskar *et al.,* (2016) in kokum wine.

### Reducing sugars (%)

Reducing sugar of wine decreased from 0 (1.50 %) to 6 months (1.37 %) during storage. This might be due to utilization of reducing sugars in maillard reaction and other degradative reaction such as formation of organic acid and it may due to more conversion of sugar into alcohol by yeast during storage. Reducing sugars was

increased with increase in T.S.S. levels from $T_1$ (0.29 %) to $T_4$ (3.05 %) at 0, $T_1$ (0.24 %) to $T_4$ (2.88 %) at 3 and $T_1$ (0.23 %) to $T_4$ (2.81 %) 6 months of storage, irrespective of dilution levels. Increase in reducing sugars may be impact of adjustment of T.S.S level in must by addition of sugar. Yeast converts specific amount of reducing sugars from different T.S.S. levels into alcohol and hence the leftover reducing sugars showed increasing trend in wine. Lowest reducing sugar recorded by $T_1$ at 0 (0.29 %), 3 (0.24 %) and at 6 month (0.23 %) storage was significantly superior over others. Reducing sugars increased from 1.11 % ($D_1$) to 1.88 % ($D_5$) at 0, 1.03 % ($D_1$) to 1.76 % ($D_5$) at 3 and 1.00 % ($D_1$) to 1.73 % ($D_5$) at 6 months of storage. Increase in reducing sugars with increase in dilution levels may be due to improper fermentation in diluted juice. Results analogous to these findings were reported by Pawar (2009) in sapota wine.

In interactions of T.S.S. and dilution levels, $T_1$ $D_1$ recorded minimum reducing sugars (0.26 %) at 0 month was at par with $T_1$ $D_2$ (0.27 %), $T_1$ $D_3$ (0.27 %), $T_1$ $D_4$ (0.31 %), $T_1$ $D_5$ (0.32 %), $T_2$ $D_1$ (0.28 %), $T_2$ $D_2$ (0.31 %), $T_2$ $D_3$ (0.32 %) and significantly superior over others. At 3 months storage $T_1D_1$ (0.22 %) recorded minimum reducing sugars was at par with $T_1D_2$ (0.23 %), $T_1D_3$ (0.24 %), $T_1D_4$ (0.25 %), $T_1D_5$ (0.27 %), $T_2D_1$ (0.25 %), $T_2D_2$ (0.28 %), $T_2D_3$ (0.31 %) and significantly superior over others. At 6 months same interaction i.e. $T_1D_1$ recorded minimum (0.21 %) reducing sugars was at par with $T_1D_2$ (0.22 %), $T_1D_3$ (0.23 %), $T_1D_4$ (0.24 %), $T_1D_5$ (0.27 %), $T_2D_1$ (0.23 %), $T_2D_2$ (0.25 %), $T_2D_3$ (0.29 %) and significantly superior over others. Highest reducing sugars during storage was recorded by $T_4D_5$ at '0' (3.70 %), 3 (3.47 %) and 6 (3.41 %) months.

## Total sugars (%)

Total sugars of wine decreased from 0 (2.82 %) to 6 months (2.75 %) during storage. This decrease in total sugars during storage might be due to conversion of sugars into alcohol during storage. Even it may due to the maillard reaction resulting in non-enzymatic browning due to reaction of sugar with amino acid during storage. Total sugars increased with increase in T.S.S. levels from $T_1$ (1.05 %) to $T_4$ (5.84 %) at 0, $T_1$ (0.93 %) to $T_4$ (5.70 %) at 3 and $T_1$ (1.22 %) to $T_4$ (5.66 %) 6 months of storage. Total sugar of wine showed same increasing trend as that of T.S.S. and reducing sugars. Reasons behind increase in total sugars are same as mentioned in 4.10.1 (TSS) and 4.10.2 (Reducing sugars). Lowest total sugars recorded by $T_1$ at 0 (1.05 %), 3 (0.93 %) and at 6 month (1.22 %) storage was significantly superior over others. Similar findings were reported by Sapkal (2011) in mango wine and Anand (2003) in cashew apple wine. In dilution levels total sugars showed same increasing trend with increase in dilution levels from $D_1$ to $D_5$ irrespective of TSS levels. Total sugars increased from 2.04 ($D_1$) to 3.64 per cent ($D_5$) at 0, 1.93 ($D_1$) to 3.54 per cent ($D_5$) at 3 and 2.03 ($D_1$) to 3.49 per cent ($D_5$) at 6 months storage. Increase in total sugars might be due to reason as mentioned in TSS levels and reducing sugars. Lowest total sugar recorded by $D_1$ at 0 (2.04 %), 3 (1.93 %) and 6 months (2.03 %) was significantly superior over all others. Interaction$T_1$ $D_1$ recorded minimum total sugars (0.58 %) at 0 and was at par with $T_1$ $D_2$ (0.71 %), $T_1$ $D_3$ (0.74 %). At 3 months storage $T_1D_1$ (0.44 %) recorded minimum total sugars and was at par with $T_1D_2$ (0.57 %) and at 6 months same interaction i.e. $T_1D_1$ recorded minimum (0.45 %) total sugars. Highest total sugars during storage was recorded by $T_4D_5$ at '0' (7.17 %), 3 (6.95 %) and 6 (6.99 %) months.

## Tannins (%)

Tannin content of wine decreased from 0 (0.0210 %) to 6 months (0.0190 %) during storage. Decrease in tannins during storage may be due to the result of oxidation and precipitation with proteins. Tannin was decreased with increase in T.S.S. levels from $T_1$ (0.0240 %) to $T_4$ (0.0180 %) at 0, $T_1$ (0.0220 %) to $T_4$ (0.0160 %) at 3 and $T_1$ (0.0210 %) to $T_4$ (0.0140 %) at 6 months storage. Tannin content of wine showed decreasing trend as that of TSS levels. This might be due to dilution of native tannins with addition of sugar. Lowest tannin recorded by $T_4$ at 0 (0.0180 %), 3 $T_1$ (0.0160 %) and at 6 month (0.0140 %) of storage was significantly superior over others. Tannin decreased from 0.0250 ($D_1$) to 0.0180 per cent ($D_5$) at 0, 0.0230 ($D_1$) to 0.0160 per cent ($D_5$).

## Vitamin A (IU)

Vitamin A of wine decreased from 0 (5.28 IU) to 6 months (4.95 IU). Decrease in vitamin A during storage might be due to degradation of vitamin A. Highest vitamin A content recorded by $T_4$ at 0 (5.51 IU), 3 (5.41 IU) and was significantly superior over others. At 6 month storage $T_4$ (5.12 IU) recorded highest vitamin A content was at par with $T_1$ (5.06 IU). These results are in agreement with the results obtained by Patil (1994) in grape, Pawar (2009) in sapota, and Joshi *et al.,* (2012) in jamun wine. In dilution levels vitamin A showed decreasing trend with increase in dilution levels from $D_1$ to $D_5$.

**Table.1** Changes in TSS (0Brix) of ripe Alphonso mango wine during storage.

| Treatment comb$^{n}$. | 2020-21 | | | 2021-22 | | | Pooled | | |
|---|---|---|---|---|---|---|---|---|---|
| | Storage (months) | | | Storage (months) | | | Storage (months) | | |
| | 0 | 3 | 6 | 0 | 3 | 6 | 0 | 3 | 6 |
| $T_1$ | 3.34 | 3.04 | 2.90 | 3.58 | 3.36 | 3.12 | 3.46 | 3.20 | 3.01 |
| $T_2$ | 6.18 | 5.78 | 5.64 | 6.36 | 6.00 | 5.78 | 6.27 | 5.89 | 5.71 |
| $T_3$ | 7.66 | 7.12 | 7.04 | 7.70 | 7.22 | 6.88 | 7.68 | 7.17 | 6.96 |
| $T_4$ | 12.08 | 11.06 | 10.76 | 12.78 | 11.04 | 10.68 | 12.39 | 11.05 | 10.72 |
| **Average** | 7.32 | 6.75 | 6.59 | 7.61 | 6.91 | 6.62 | 7.45 | 6.83 | 6.61 |
| **S.E.m±** | **0.08** | **0.07** | **0.08** | **0.11** | **0.05** | **0.05** | **0.09** | **0.06** | **0.06** |
| **C.D.at 1%** | **0.30** | **0.28** | **0.32** | **0.45** | **0.19** | **0.19** | **0.36** | **0.22** | **0.25** |
| $D_1$ | 7.0 | 6.50 | 6.30 | 7.28 | 6.58 | 6.23 | 7.14 | 6.54 | 6.26 |
| $D_2$ | 7.05 | 6.60 | 6.35 | 7.33 | 6.68 | 6.45 | 7.19 | 6.64 | 6.40 |
| $D_3$ | 7.1 | 6.63 | 6.43 | 7.90 | 6.83 | 6.50 | 7.50 | 6.73 | 6.46 |
| $D_4$ | 7.5 | 6.65 | 6.58 | 7.60 | 6.90 | 6.58 | 7.56 | 6.78 | 6.58 |
| $D_5$ | 7.93 | 7.38 | 7.28 | 7.93 | 7.55 | 7.33 | 7.93 | 7.46 | 7.30 |
| **Average** | 7.32 | 6.75 | 6.59 | 7.61 | 6.91 | 6.62 | 7.47 | 6.83 | 6.61 |
| **S.E.m±** | **0.08** | **0.08** | **0.09** | **0.12** | **0.05** | **0.05** | **0.10** | **0.06** | **0.07** |
| **C.D. at 1%** | **0.34** | **0.32** | **0.36** | **0.50** | **0.21** | **0.21** | **0.40** | **0.25** | **0.27** |
| $T_1 D_1$ | 5.2 | 5.0 | 4.8 | 5.4 | 5.2 | 5.00 | 5.30 | 5.11 | 4.9 |
| $T_1D_2$ | 4.0 | 3.8 | 3.8 | 4.3 | 4.1 | 4.00 | 4.15 | 3.95 | 3.9 |
| $T_1D_3$ | 3.4 | 3.0 | 2.9 | 3.6 | 3.3 | 3.10 | 3.50 | 3.15 | 3.0 |
| $T_1D_4$ | 2.1 | 2.0 | 1.8 | 2.4 | 2.4 | 2.00 | 2.25 | 2.20 | 1.9 |
| $T_1D_5$ | 2.0 | 1.4 | 1.2 | 2.2 | 1.8 | 1.50 | 2.10 | 1.60 | 1.35 |
| $T_2D_1$ | 6.0 | 5.0 | 4.7 | 6.3 | 5.1 | 4.90 | 6.15 | 5.05 | 4.8 |
| $T_2D_2$ | 6.2 | 5.6 | 5.3 | 6.5 | 5.8 | 5.6 | 6.35 | 5.70 | 5.45 |
| $T_2D_3$ | 6.2 | 6.1 | 6.0 | 6.3 | 6.4 | 6.20 | 6.25 | 6.25 | 6.1 |
| $T_2D_4$ | 6.1 | 6.0 | 6.0 | 6.2 | 6.2 | 6.00 | 6.17 | 6.10 | 6.0 |
| $T_2D_5$ | 6.4 | 6.2 | 6.2 | 6.5 | 6.5 | 6.20 | 6.45 | 6.35 | 6.2 |
| $T_3D_1$ | 6.8 | 6.5 | 6.4 | 7.0 | 6.7 | 6.00 | 6.90 | 6.60 | 6.2 |
| $T_3D_2$ | 7.0 | 6.4 | 6.3 | 7.3 | 6.6 | 6.40 | 7.15 | 6.50 | 6.35 |
| $T_3D_3$ | 7.6 | 6.6 | 6.5 | 7.5 | 6.8 | 6.50 | 7.55 | 6.70 | 6.5 |
| $T_3D_4$ | 7.8 | 7.3 | 7.3 | 7.7 | 7.5 | 7.00 | 7.75 | 7.40 | 7.15 |
| $T_3D_5$ | 9.1 | 8.8 | 8.7 | 9.0 | 8.5 | 8.5 | 9.05 | 8.65 | 8.6 |
| $T_4D_1$ | 10.0 | 9.5 | 9.3 | 10.4 | 9.3 | 9.00 | 10.20 | 9.40 | 9.15 |
| $T_4D_2$ | 11.0 | 10.6 | 10.0 | 11.2 | 10.2 | 9.80 | 11.10 | 10.4 | 9.9 |
| $T_4 D_3$ | 11.2 | 10.8 | 10.3 | 14.2 | 10.8 | 10.2 | 12.70 | 10.8 | 10.25 |
| $T_4 D_4$ | 14.0 | 11.3 | 11.2 | 14.1 | 11.5 | 11.3 | 14.05 | 11.4 | 11.25 |
| $T_4 D_5$ | 14.2 | 13.1 | 13.0 | 14.0 | 13.4 | 13.1 | 14.10 | 13.25 | 13.05 |
| **Average** | 7.32 | 6.75 | 6.59 | 7.61 | 6.91 | 6.62 | 7.46 | 6.83 | 6.60 |
| **S.E.m±** | **0.17** | **0.16** | **0.18** | **0.25** | **0.11** | **0.11** | **0.20** | **0.12** | **0.14** |
| **C.D. at 1%** | **0.68** | **0.64** | **0.72** | **1.00** | **0.42** | **0.42** | **0.81** | **0.50** | **0.55** |

**Table.2** Changes in reducing sugars (%) of ripe Alphonso mango wine during storage.

| Treatment comb$^{n}$. | 2020-21 | | | 2021-22 | | | Pooled | | |
|---|---|---|---|---|---|---|---|---|---|
| | Storage (months) | | | Storage (months) | | | Storage (months) | | |
| | 0 | 3 | 6 | 0 | 3 | 6 | 0 | 3 | 6 |
| $T_1$ | 0.27 | 0.24 | 0.22 | 0.30 | 0.25 | 0.23 | 0.29 | 0.24 | 0.23 |
| $T_2$ | 0.48 | 0.44 | 0.43 | 0.50 | 0.45 | 0.40 | 0.49 | 0.45 | 0.42 |
| $T_3$ | 2.16 | 2.01 | 1.99 | 2.19 | 2.06 | 2.01 | 2.17 | 2.04 | 2.00 |
| $T_4$ | 3.03 | 2.86 | 2.83 | 3.06 | 2.89 | 2.78 | 3.05 | 2.88 | 2.81 |
| **Average** | 1.49 | 1.39 | 1.37 | 1.51 | 1.41 | 1.36 | 1.50 | 1.40 | 1.37 |
| **S.E.m±** | **0.02** | **0.02** | **0.02** | **0.02** | **0.01** | **0.01** | **0.02** | **0.02** | **0.02** |
| **C.D.at 1%** | **0.10** | **0.08** | **0.10** | **0.06** | **0.04** | **0.04** | **0.08** | **0.06** | **0.07** |
| $D_1$ | 1.11 | 1.04 | 1.03 | 1.11 | 1.02 | 0.98 | 1.11 | 1.03 | 1.00 |
| $D_2$ | 1.29 | 1.18 | 1.16 | 1.31 | 1.19 | 1.14 | 1.30 | 1.20 | 1.15 |
| $D_3$ | 1.41 | 1.31 | 1.28 | 1.44 | 1.35 | 1.30 | 1.42 | 1.32 | 1.30 |
| $D_4$ | 1.77 | 1.67 | 1.66 | 1.80 | 1.71 | 1.64 | 1.79 | 1.69 | 1.65 |
| $D_5$ | 1.86 | 1.74 | 1.73 | 1.89 | 1.78 | 1.73 | 1.88 | 1.76 | 1.73 |
| **Average** | 1.49 | 1.39 | 1.37 | 1.51 | 1.41 | 1.36 | 1.50 | 1.40 | 1.37 |
| **S.E.m±** | **0.03** | **0.02** | **0.03** | **0.02** | **0.01** | **0.01** | **0.02** | **0.02** | **0.02** |
| **C.D. at 1%** | **0.11** | **0.09** | **0.11** | **0.07** | **0.05** | **0.05** | **0.09** | **0.07** | **0.08** |
| $T_1 D_1$ | 0.25 | 0.20 | 0.20 | 0.27 | 0.23 | 0.21 | 0.26 | 0.22 | 0.21 |
| $T_1D_2$ | 0.26 | 0.22 | 0.21 | 0.28 | 0.24 | 0.22 | 0.27 | 0.23 | 0.22 |
| $T_1D_3$ | 0.26 | 0.24 | 0.22 | 0.28 | 0.24 | 0.23 | 0.27 | 0.24 | 0.23 |
| $T_1D_4$ | 0.30 | 0.25 | 0.24 | 0.32 | 0.25 | 0.24 | 0.31 | 0.25 | 0.24 |
| $T_1D_5$ | 0.30 | 0.27 | 0.27 | 0.34 | 0.28 | 0.26 | 0.32 | 0.27 | 0.27 |
| $T_2D_1$ | 0.27 | 0.25 | 0.24 | 0.28 | 0.24 | 0.22 | 0.28 | 0.25 | 0.23 |
| $T_2D_2$ | 0.30 | 0.28 | 0.26 | 0.32 | 0.28 | 0.23 | 0.31 | 0.28 | 0.25 |
| $T_2D_3$ | 0.32 | 0.31 | 0.31 | 0.33 | 0.30 | 0.26 | 0.32 | 0.31 | 0.29 |
| $T_2D_4$ | 0.69 | 0.62 | 0.62 | 0.71 | 0.68 | 0.61 | 0.70 | 0.65 | 0.62 |
| $T_2D_5$ | 0.81 | 0.75 | 0.74 | 0.84 | 0.75 | 0.70 | 0.83 | 0.75 | 0.72 |
| $T_3D_1$ | 1.56 | 1.46 | 1.45 | 1.58 | 1.45 | 1.42 | 1.57 | 1.46 | 1.44 |
| $T_3D_2$ | 1.81 | 1.60 | 1.58 | 1.82 | 1.65 | 1.59 | 1.81 | 1.63 | 1.59 |
| $T_3D_3$ | 2.21 | 2.05 | 2.00 | 2.26 | 2.15 | 2.11 | 2.23 | 2.10 | 2.06 |
| $T_3D_4$ | 2.57 | 2.42 | 2.40 | 2.61 | 2.45 | 2.36 | 2.59 | 2.44 | 2.38 |
| $T_3D_5$ | 2.65 | 2.51 | 2.50 | 2.66 | 2.58 | 2.55 | 2.66 | 2.55 | 2.53 |
| $T_4D_1$ | 2.34 | 2.25 | 2.22 | 2.32 | 2.15 | 2.05 | 2.33 | 2.20 | 2.14 |
| $T_4D_2$ | 2.77 | 2.60 | 2.57 | 2.80 | 2.6 | 2.50 | 2.79 | 2.66 | 2.54 |
| $T_4 D_3$ | 2.85 | 2.62 | 2.60 | 2.88 | 2.72 | 2.59 | 2.87 | 2.63 | 2.60 |
| $T_4 D_4$ | 3.52 | 3.40 | 3.37 | 3.56 | 3.45 | 3.35 | 3.54 | 3.43 | 3.36 |
| $T_4 D_5$ | 3.67 | 3.42 | 3.41 | 3.72 | 3.51 | 3.40 | 3.70 | 3.47 | 3.41 |
| **Average** | 1.49 | 1.39 | 1.37 | 1.51 | 1.41 | 1.36 | 1.50 | 1.4 | 1.37 |
| **S.E.m±** | **0.05** | **0.05** | **0.05** | **0.04** | **0.02** | **0.02** | **0.04** | **0.03** | **0.04** |
| **C.D. at 1%** | **0.22** | **0.14** | **0.21** | **0.14** | **0.10** | **0.09** | **0.17** | **0.14** | **0.15** |

**Table.3** Changes in Total sugars (%) of ripe Alphonso mango wine during storage.

| Treatment comb$^{n}$. | 2020-21 | | | 2021-22 | | | Pooled | | |
|---|---|---|---|---|---|---|---|---|---|
| | Storage (months) | | | Storage (months) | | | Storage (months) | | |
| | 0 | 3 | 6 | 0 | 3 | 6 | 0 | 3 | 6 |
| $T_1$ | 1.03 | 0.92 | 0.91 | 1.07 | 0.94 | 0.93 | 1.05 | 0.93 | 1.22 |
| $T_2$ | 1.63 | 1.52 | 1.49 | 1.65 | 1.58 | 1.52 | 1.64 | 1.55 | 1.51 |
| $T_3$ | 2.74 | 2.62 | 2.61 | 2.78 | 2.71 | 2.63 | 2.76 | 2.67 | 2.62 |
| $T_4$ | 5.82 | 5.68 | 5.64 | 5.85 | 5.71 | 5.67 | 5.84 | 5.70 | 5.66 |
| **Average** | 2.81 | 2.69 | 2.66 | 2.84 | 2.74 | 2.69 | 2.82 | 2.72 | 2.75 |
| **S.E.m±** | **0.04** | **0.04** | **0.03** | **0.02** | **0.02** | **0.04** | **0.03** | **0.02** | **0.03** |
| **C.D.at 1%** | **0.17** | **0.17** | **0.13** | **0.07** | **0.10** | **0.14** | **0.12** | **0.08** | **0.14** |
| $D_1$ | 2.02 | 1.91 | 1.89 | 2.06 | 1.95 | 1.91 | 2.04 | 1.93 | 2.03 |
| $D_2$ | 2.33 | 2.20 | 2.19 | 2.36 | 2.23 | 2.21 | 2.35 | 2.22 | 2.32 |
| $D_3$ | 2.85 | 2.73 | 2.71 | 2.87 | 2.78 | 2.73 | 2.86 | 2.75 | 2.85 |
| $D_4$ | 3.21 | 3.09 | 3.06 | 3.24 | 3.14 | 3.08 | 3.23 | 3.11 | 3.07 |
| $D_5$ | 3.62 | 3.50 | 3.48 | 3.66 | 3.58 | 3.50 | 3.64 | 3.54 | 3.49 |
| **Average** | 2.81 | 2.69 | 2.66 | 2.84 | 2.74 | 2.69 | 2.82 | 2.72 | 2.75 |
| **S.E.m±** | **0.05** | **0.05** | **0.04** | **0.02** | **0.03** | **0.04** | **0.03** | **0.02** | **0.04** |
| **C.D. at 1%** | **0.19** | **0.19** | **0.15** | **0.08** | **0.11** | **0.16** | **0.13** | **0.09** | **0.15** |
| $T_1 D_1$ | 0.55 | 0.44 | 0.44 | 0.60 | 0.46 | 0.46 | 0.58 | 0.44 | 0.45 |
| $T_1D_2$ | 0.69 | 0.57 | 0.56 | 0.72 | 0.59 | 0.58 | 0.71 | 0.57 | 1.07 |
| $T_1D_3$ | 0.73 | 0.63 | 0.61 | 0.74 | 0.65 | 0.63 | 0.74 | 0.63 | 1.12 |
| $T_1D_4$ | 1.50 | 1.38 | 1.37 | 1.55 | 1.41 | 1.39 | 1.53 | 1.38 | 1.38 |
| $T_1D_5$ | 1.68 | 1.57 | 1.55 | 1.72 | 1.59 | 1.57 | 1.70 | 1.56 | 1.56 |
| $T_2D_1$ | 1.20 | 1.08 | 1.06 | 1.22 | 1.15 | 1.08 | 1.21 | 1.10 | 1.07 |
| $T_2D_2$ | 1.31 | 1.20 | 1.18 | 1.33 | 1.23 | 1.20 | 1.32 | 1.20 | 1.19 |
| $T_2D_3$ | 1.64 | 1.52 | 1.49 | 1.66 | 1.58 | 1.54 | 1.65 | 1.54 | 1.52 |
| $T_2D_4$ | 1.92 | 1.80 | 1.77 | 1.93 | 1.88 | 1.79 | 1.93 | 1.83 | 1.78 |
| $T_2D_5$ | 2.09 | 2.00 | 1.97 | 2.11 | 2.05 | 1.99 | 2.10 | 2.00 | 1.98 |
| $T_3D_1$ | 2.06 | 1.95 | 1.94 | 2.10 | 2.01 | 1.96 | 2.08 | 1.97 | 1.95 |
| $T_3D_2$ | 2.23 | 2.10 | 2.10 | 2.26 | 2.15 | 2.12 | 2.25 | 2.11 | 2.11 |
| $T_3D_3$ | 2.80 | 2.72 | 2.71 | 2.84 | 2.78 | 2.73 | 2.82 | 2.74 | 2.72 |
| $T_3D_4$ | 3.04 | 2.91 | 2.90 | 3.09 | 2.97 | 2.92 | 3.07 | 2.93 | 2.91 |
| $T_3D_5$ | 3.57 | 3.42 | 3.40 | 3.61 | 3.63 | 3.42 | 3.59 | 3.51 | 3.41 |
| $T_4D_1$ | 4.28 | 4.15 | 4.12 | 4.31 | 4.19 | 4.15 | 4.3 | 4.15 | 4.14 |
| $T_4D_2$ | 5.10 | 4.92 | 4.90 | 5.14 | 4.94 | 4.92 | 5.12 | 4.86 | 4.91 |
| $T_4 D_3$ | 6.21 | 6.05 | 6.01 | 6.24 | 6.11 | 6.03 | 6.23 | 6.07 | 6.02 |
| $T_4 D_4$ | 6.37 | 6.25 | 6.21 | 6.39 | 6.30 | 6.23 | 6.38 | 6.26 | 6.22 |
| $T_4 D_5$ | 7.14 | 7.01 | 6.98 | 7.19 | 7.03 | 7.00 | 7.17 | 6.95 | 6.99 |
| **Average** | 2.81 | 2.68 | 2.66 | 2.84 | 2.74 | 2.69 | 2.82 | 2.69 | 2.73 |
| **S.E.m±** | **0.10** | **0.09** | **0.07** | **0.04** | **0.06** | **0.08** | **0.06** | **0.05** | **0.08** |
| **C.D. at 1%** | **0.38** | **0.37** | **0.30** | **0.16** | **0.22** | **0.32** | **0.26** | **0.19** | **0.31** |

**Table.4** Changes in Tannin content (%) of ripe Alphonso mango wine during storage.

| Treatment comb$^{n}$. | 2020-21 | | | 2021-22 | | | Pooled | | |
|---|---|---|---|---|---|---|---|---|---|
| | Storage (months) | | | Storage (months) | | | Storage (months) | | |
| | 0 | 3 | 6 | 0 | 3 | 6 | 0 | 3 | 6 |
| $T_1$ | 0.0230 | 0.0210 | 0.0200 | 0.0250 | 0.0230 | 0.0220 | 0.0240 | 0.0220 | 0.0210 |
| $T_2$ | 0.0210 | 0.0200 | 0.0180 | 0.0240 | 0.0220 | 0.0200 | 0.0230 | 0.0210 | 0.0190 |
| $T_3$ | 0.0190 | 0.0170 | 0.0160 | 0.0210 | 0.0200 | 0.0200 | 0.0200 | 0.0190 | 0.0180 |
| $T_4$ | 0.0170 | 0.0150 | 0.0130 | 0.0180 | 0.0170 | 0.0150 | 0.0180 | 0.0160 | 0.0140 |
| **Average** | 0.0200 | 0.0180 | 0.0170 | 0.0220 | 0.0220 | 0.0200 | 0.0210 | 0.0200 | 0.0190 |
| **S.E.m±** | **0.0003** | **0.0004** | **0.0005** | **0.0004** | **0.0002** | **0.0002** | **0.0003** | **0.0003** | **0.0002** |
| **C.D.at 1%** | **0.0013** | **0.0016** | **0.0021** | **0.0016** | **0.0012** | **0.0009** | **0.0013** | **0.0010** | **0.0008** |
| $D_1$ | 0.0240 | 0.0220 | 0.0200 | 0.0260 | 0.0240 | 0.0220 | 0.0250 | 0.0230 | 0.0210 |
| $D_2$ | 0.0210 | 0.0200 | 0.0180 | 0.0230 | 0.0220 | 0.0200 | 0.0220 | 0.0210 | 0.0190 |
| $D_3$ | 0.0200 | 0.0180 | 0.0170 | 0.0220 | 0.0200 | 0.0200 | 0.0210 | 0.0190 | 0.0190 |
| $D_4$ | 0.0180 | 0.0170 | 0.0160 | 0.0210 | 0.0190 | 0.0200 | 0.0200 | 0.0180 | 0.0180 |
| $D_5$ | 0.0170 | 0.0150 | 0.0130 | 0.0190 | 0.0170 | 0.0150 | 0.0160 | 0.0160 | 0.0140 |
| **Average** | 0.0200 | 0.0180 | 0.0170 | 0.0220 | 0.0220 | 0.0200 | 0.0210 | 0.0200 | 0.0190 |
| **S.E.m±** | **0.0004** | **0.0004** | **0.0006** | **0.0004** | **0.0003** | **0.0002** | **0.0004** | **0.0003** | **0.0002** |
| **C.D. at 1%** | **0.0014** | **0.0016** | **0.0023** | **0.0018** | **0.0014** | **0.0011** | **0.0015** | **0.0012** | **0.0009** |
| $T_1 D_1$ | 0.0280 | 0.0260 | 0.0240 | 0.0300 | 0.0280 | 0.0260 | 0.0290 | 0.0270 | 0.0250 |
| $T_1D_2$ | 0.0250 | 0.0230 | 0.0210 | 0.0270 | 0.0250 | 0.0230 | 0.0260 | 0.0240 | 0.0220 |
| $T_1D_3$ | 0.0240 | 0.0210 | 0.0200 | 0.0260 | 0.0230 | 0.0220 | 0.0250 | 0.0220 | 0.0210 |
| $T_1D_4$ | 0.0210 | 0.0180 | 0.0190 | 0.0230 | 0.0200 | 0.0210 | 0.0220 | 0.0190 | 0.0200 |
| $T_1D_5$ | 0.0190 | 0.0170 | 0.0160 | 0.0210 | 0.0190 | 0.0180 | 0.0200 | 0.0180 | 0.0170 |
| $T_2D_1$ | 0.0250 | 0.0230 | 0.0210 | 0.0270 | 0.0250 | 0.0230 | 0.0260 | 0.0240 | 0.0220 |
| $T_2D_2$ | 0.0240 | 0.0210 | 0.0200 | 0.0260 | 0.0230 | 0.0220 | 0.0300 | 0.0220 | 0.0210 |
| $T_2D_3$ | 0.0210 | 0.0200 | 0.0180 | 0.0230 | 0.0220 | 0.0200 | 0.0220 | 0.0210 | 0.0190 |
| $T_2D_4$ | 0.0200 | 0.0190 | 0.0170 | 0.0220 | 0.0210 | 0.0190 | 0.0210 | 0.0200 | 0.0180 |
| $T_2D_5$ | 0.0180 | 0.0160 | 0.0140 | 0.0200 | 0.0180 | 0.0160 | 0.0190 | 0.0170 | 0.0150 |
| $T_3D_1$ | 0.0240 | 0.0200 | 0.0200 | 0.0260 | 0.0220 | 0.0220 | 0.0250 | 0.0210 | 0.0210 |
| $T_3D_2$ | 0.0200 | 0.0180 | 0.0170 | 0.0220 | 0.0200 | 0.0190 | 0.0210 | 0.0190 | 0.0180 |
| $T_3D_3$ | 0.0190 | 0.0180 | 0.0150 | 0.0210 | 0.0200 | 0.0170 | 0.0200 | 0.0190 | 0.0160 |
| $T_3D_4$ | 0.0180 | 0.0160 | 0.0150 | 0.0200 | 0.0180 | 0.0170 | 0.0190 | 0.0170 | 0.0160 |
| $T_3D_5$ | 0.0160 | 0.0150 | 0.0140 | 0.0180 | 0.0170 | 0.0160 | 0.0170 | 0.0160 | 0.0150 |
| $T_4D_1$ | 0.0210 | 0.0190 | 0.0150 | 0.0210 | 0.0200 | 0.0170 | 0.0210 | 0.0200 | 0.0160 |
| $T_4D_2$ | 0.0180 | 0.0160 | 0.0140 | 0.0180 | 0.0180 | 0.0160 | 0.0180 | 0.0170 | 0.0150 |
| $T_4 D_3$ | 0.0160 | 0.0140 | 0.0130 | 0.0180 | 0.0160 | 0.0150 | 0.0170 | 0.0150 | 0.0140 |
| $T_4 D_4$ | 0.0150 | 0.0140 | 0.0120 | 0.0170 | 0.0160 | 0.0140 | 0.0160 | 0.0150 | 0.0130 |
| $T_4 D_5$ | 0.0150 | 0.0120 | 0.0090 | 0.0160 | 0.0140 | 0.0110 | 0.0155 | 0.0130 | 0.0100 |
| **Average** | 0.0203 | 0.0183 | 0.0167 | 0.0221 | 0.0202 | 0.0187 | 0.0214 | 0.0193 | 0.0177 |
| **S.E.m±** | **0.0007** | **0.0009** | **0.0012** | **0.0009** | **0.0005** | **0.0004** | **0.0007** | **0.0006** | **0.0005** |
| **C.D. at 1%** | **0.0028** | **0.0036** | **0.0049** | **0.0036** | **0.0027** | **0.0021** | **0.0030** | **0.0023** | **0.0019** |

**Table.5** Changes in Vitamin A (IU) of ripe Alphonso mango wine during storage

| Treatment comb$^{n}$. | 2020-21 | | | 2021-22 | | | Pooled | | |
|---|---|---|---|---|---|---|---|---|---|
| | Storage (months) | | | Storage (months) | | | Storage (months) | | |
| | 0 | 3 | 6 | 0 | 3 | 6 | 0 | 3 | 6 |
| $T_1$ | 5.14 | 5.06 | 4.94 | 5.16 | 5.08 | 5.17 | 5.15 | 5.07 | 5.06 |
| $T_2$ | 5.18 | 5.09 | 4.89 | 5.20 | 5.11 | 4.92 | 5.19 | 5.10 | 4.91 |
| $T_3$ | 5.50 | 4.90 | 4.70 | 5.02 | 5.03 | 4.72 | 5.01 | 4.97 | 4.71 |
| $T_4$ | 5.50 | 5.39 | 5.11 | 5.52 | 5.41 | 5.12 | 5.51 | 5.41 | 5.12 |
| **Average** | 5.33 | 5.11 | 4.91 | 5.23 | 5.16 | 4.98 | 5.28 | 5.14 | 4.95 |
| **S.E.m±** | **0.04** | **0.03** | **0.04** | **0.04** | **0.03** | **0.06** | **0.04** | **0.02** | **0.05** |
| **C.D.at 1%** | **0.15** | **0.13** | **0.15** | **0.17** | **0.10** | **0.25** | **0.15** | **0.09** | **0.19** |
| $D_1$ | 5.47 | 5.38 | 5.22 | 5.49 | 5.40 | 5.25 | 5.48 | 5.39 | 5.24 |
| $D_2$ | 5.32 | 5.25 | 5.05 | 5.35 | 5.27 | 5.06 | 5.34 | 5.26 | 5.05 |
| $D_3$ | 5.3 | 5.22 | 4.99 | 5.32 | 5.24 | 5.02 | 5.31 | 5.24 | 5.00 |
| $D_4$ | 5.01 | 4.91 | 4.70 | 5.04 | 4.93 | 4.72 | 5.03 | 4.93 | 4.71 |
| $D_5$ | 4.92 | 4.79 | 4.60 | 4.94 | 4.94 | 4.88 | 4.93 | 4.87 | 4.87 |
| **Average** | 5.33 | 5.11 | 4.91 | 5.23 | 5.16 | 4.98 | 5.28 | 5.14 | 4.95 |
| **S.E.m±** | **0.04** | **0.04** | **0.04** | **0.05** | **0.03** | **0.07** | **0.04** | **0.02** | **0.05** |
| **C.D. at 1%** | **0.16** | **0.15** | **0.17** | **0.19** | **0.12** | **0.28** | **0.17** | **0.10** | **0.21** |
| $T_1 D_1$ | 5.40 | 5.36 | 5.33 | 5.42 | 5.38 | 5.35 | 5.41 | 5.37 | 5.34 |
| $T_1D_2$ | 5.13 | 5.10 | 5.01 | 5.15 | 5.12 | 5.03 | 5.14 | 5.11 | 5.02 |
| $T_1D_3$ | 5.05 | 5.01 | 4.83 | 5.07 | 5.03 | 4.86 | 5.06 | 5.02 | 4.85 |
| $T_1D_4$ | 4.93 | 4.86 | 4.71 | 4.95 | 4.88 | 4.73 | 4.94 | 4.87 | 4.72 |
| $T_1D_5$ | 5.20 | 4.98 | 5.86 | 5.22 | 5.01 | 5.88 | 5.21 | 5.00 | 5.87 |
| $T_2D_1$ | 5.36 | 5.26 | 5.10 | 5.38 | 5.28 | 5.13 | 5.37 | 5.27 | 5.12 |
| $T_2D_2$ | 5.21 | 5.13 | 5.00 | 5.24 | 5.15 | 5.02 | 5.23 | 5.14 | 5.01 |
| $T_2D_3$ | 5.48 | 5.36 | 5.03 | 5.50 | 5.37 | 5.05 | 5.49 | 5.37 | 5.04 |
| $T_2D_4$ | 4.98 | 4.9 | 4.71 | 5.00 | 4.92 | 4.73 | 4.99 | 4.91 | 4.72 |
| $T_2D_5$ | 4.85 | 4.8 | 4.63 | 4.88 | 4.81 | 4.65 | 4.87 | 4.81 | 4.64 |
| $T_3D_1$ | 5.36 | 5.23 | 4.96 | 5.38 | 5.25 | 4.98 | 5.37 | 5.24 | 4.97 |
| $T_3D_2$ | 5.28 | 5.18 | 4.86 | 5.30 | 5.20 | 4.88 | 5.29 | 5.19 | 4.87 |
| $T_3D_3$ | 5.13 | 5.08 | 4.90 | 5.16 | 5.10 | 4.93 | 5.15 | 5.09 | 4.92 |
| $T_3D_4$ | 4.78 | 4.68 | 4.53 | 4.80 | 4.70 | 4.55 | 4.79 | 4.69 | 4.54 |
| $T_3D_5$ | 4.46 | 4.35 | 4.25 | 4.48 | 4.88 | 4.27 | 4.47 | 4.64 | 4.26 |
| $T_4D_1$ | 5.75 | 5.68 | 5.50 | 5.78 | 5.70 | 5.52 | 5.77 | 5.69 | 5.51 |
| $T_4D_2$ | 5.68 | 5.58 | 5.31 | 5.70 | 5.61 | 5.31 | 5.69 | 5.60 | 5.31 |
| $T_4 D_3$ | 5.53 | 5.45 | 5.20 | 5.55 | 5.47 | 5.22 | 5.54 | 5.46 | 5.21 |
| $T_4 D_4$ | 5.36 | 5.21 | 4.85 | 5.39 | 5.23 | 4.87 | 5.38 | 5.24 | 4.86 |
| $T_4 D_5$ | 5.16 | 5.03 | 4.68 | 5.18 | 5.05 | 4.70 | 5.17 | 5.04 | 4.69 |
| **Average** | 5.20 | 5.11 | 4.96 | 5.23 | 5.16 | 4.98 | 5.22 | 5.14 | 4.97 |
| **S.E.m±** | **0.08** | **0.07** | **0.08** | **0.09** | **0.06** | **0.14** | **0.08** | **0.05** | **0.11** |
| **C.D. at 1%** | **0.33** | **0.29** | **0.33** | **0.38** | **0.23** | **0.57** | **0.34** | **0.20** | **0.42** |

**Table.6** Changes in Alcohol content (%) of ripe Alphonso mango wine during storage

| Treatment comb$^{n}$. | 2020-21 | | | 2021-22 | | | Pooled | | |
|---|---|---|---|---|---|---|---|---|---|
| | Storage (months) | | | Storage (months) | | | Storage (months) | | |
| | 0 | 3 | 6 | 0 | 3 | 6 | 0 | 3 | 6 |
| $T_1$ | 3.14 | 3.39 | 3.34 | 3.20 | 3.44 | 3.40 | 3.17 | 3.42 | 3.37 |
| $T_2$ | 7.26 | 7.34 | 7.27 | 7.32 | 7.34 | 7.32 | 7.29 | 7.37 | 7.30 |
| $T_3$ | 9.35 | 9.43 | 9.37 | 9.40 | 9.48 | 9.44 | 9.30 | 9.45 | 9.41 |
| $T_4$ | 10.16 | 10.33 | 10.25 | 10.21 | 10.38 | 10.31 | 10.20 | 10.36 | 10.28 |
| **Average** | 7.48 | 7.62 | 7.56 | 7.53 | 7.67 | 7.62 | 7.51 | 7.65 | 7.59 |
| **S.E.m±** | **0.07** | **0.06** | **0.07** | **0.02** | **0.02** | **0.02** | **0.05** | **0.04** | **0.04** |
| **C.D.at 1%** | **0.29** | **0.25** | **0.29** | **0.09** | **0.08** | **0.06** | **0.18** | **0.16** | **0.18** |
| $D_1$ | 8.59 | 8.93 | 8.87 | 8.66 | 8.97 | 8.92 | 8.64 | 8.95 | 8.9 |
| $D_2$ | 8.04 | 8.14 | 8.09 | 8.09 | 8.12 | 8.15 | 8.07 | 8.16 | 8.12 |
| $D_3$ | 7.43 | 7.54 | 7.48 | 7.49 | 7.60 | 7.53 | 7.46 | 7.57 | 7.50 |
| $D_4$ | 6.95 | 7.05 | 6.99 | 7.00 | 7.11 | 7.04 | 6.89 | 7.08 | 7.01 |
| $D_5$ | 6.37 | 6.46 | 6.39 | 6.42 | 6.52 | 6.46 | 6.40 | 6.49 | 6.43 |
| **Average** | 7.48 | 7.62 | 7.56 | 7.53 | 7.67 | 7.62 | 7.51 | 7.65 | 7.59 |
| **S.E.m±** | **0.08** | **0.07** | **0.08** | **0.03** | **0.02** | **0.02** | **0.05** | **0.04** | **0.05** |
| **C.D. at 1%** | **0.32** | **0.28** | **0.33** | **0.11** | **0.09** | **0.07** | **0.20** | **0.18** | **0.20** |
| $T_1 D_1$ | 5.62 | 6.69 | 6.64 | 5.70 | 6.74 | 6.69 | 5.66 | 6.72 | 6.67 |
| $T_1D_2$ | 3.91 | 4.02 | 4.00 | 3.95 | 4.05 | 4.06 | 3.93 | 4.04 | 4.03 |
| $T_1D_3$ | 2.85 | 2.89 | 2.85 | 2.96 | 2.94 | 2.90 | 2.91 | 2.92 | 2.88 |
| $T_1D_4$ | 2.08 | 2.09 | 2.02 | 2.13 | 2.15 | 2.08 | 2.11 | 2.12 | 2.05 |
| $T_1D_5$ | 1.22 | 1.25 | 1.20 | 1.25 | 1.32 | 1.27 | 1.24 | 1.29 | 1.24 |
| $T_2D_1$ | 7.92 | 7.96 | 7.91 | 7.97 | 7.99 | 7.96 | 7.95 | 7.98 | 7.94 |
| $T_2D_2$ | 7.65 | 7.70 | 7.62 | 7.71 | 7.74 | 7.69 | 7.68 | 7.72 | 7.66 |
| $T_2D_3$ | 7.18 | 7.21 | 7.11 | 7.21 | 7.27 | 7.14 | 7.20 | 7.24 | 7.13 |
| $T_2D_4$ | 6.90 | 7.13 | 7.06 | 6.99 | 7.18 | 7.08 | 6.95 | 7.16 | 7.07 |
| $T_2D_5$ | 6.64 | 6.72 | 6.67 | 6.70 | 6.80 | 6.73 | 6.67 | 6.76 | 6.70 |
| $T_3D_1$ | 9.90 | 9.98 | 9.90 | 9.95 | 10.02 | 9.95 | 9.93 | 10 | 9.93 |
| $T_3D_2$ | 9.75 | 9.82 | 9.80 | 9.81 | 9.88 | 9.87 | 9.78 | 9.85 | 9.84 |
| $T_3D_3$ | 9.42 | 9.53 | 9.49 | 9.46 | 9.57 | 9.53 | 9.44 | 9.55 | 9.51 |
| $T_3D_4$ | 9.21 | 9.26 | 9.20 | 9.23 | 9.33 | 9.26 | 8.87 | 9.3 | 9.23 |
| $T_3D_5$ | 8.47 | 8.54 | 8.48 | 8.53 | 8.60 | 8.57 | 8.48 | 8.57 | 8.53 |
| $T_4D_1$ | 10.92 | 11.08 | 11.01 | 11.01 | 11.13 | 11.09 | 11.0 | 11.11 | 11.05 |
| $T_4D_2$ | 10.83 | 11.00 | 10.92 | 10.87 | 11.04 | 10.98 | 10.9 | 11.02 | 10.95 |
| $T_4 D_3$ | 10.27 | 10.53 | 10.45 | 10.33 | 10.61 | 10.53 | 10.3 | 10.57 | 10.49 |
| $T_4 D_4$ | 9.61 | 9.72 | 9.67 | 9.64 | 9.77 | 9.72 | 9.63 | 9.75 | 9.70 |
| $T_4 D_5$ | 9.16 | 9.31 | 9.21 | 9.21 | 9.34 | 9.25 | 9.19 | 9.33 | 9.23 |
| **Average** | 7.48 | 7.62 | 7.56 | 7.53 | 7.67 | 7.62 | 7.49 | 7.65 | 7.59 |
| **S.E.m±** | **0.16** | **0.14** | **0.16** | **0.05** | **0.04** | **0.04** | **0.10** | **0.09** | **0.10** |
| **C.D. at 1%** | **0.65** | **0.56** | **0.66** | **0.21** | **0.17** | **0.14** | **0.41** | **0.36** | **0.40** |

Vitamin A decreased from 5.48 IU ($D_1$) to 4.93 IU ($D_5$) at 0, 5.39 IU ($D_1$) to 4.87 IU ($D_5$) 3 months and 5.24 IU ($D_1$) to 4.87 IU ($D_5$) at 6 months of storage. Decrease in vitamin A may be due to dilution of native vitamin A of pulp with the addition of water. Similar reports were found by Taskar (2007) in jamun and Pawar (2009) in

sapota wine. Highest vitamin A recorded by $D_1$ at 0 (5.48 IU), 3 (5.39 IU) and 6 months (5.24 IU) was at par with $D_2$ at 0 (5.34 IU) and 6 months (5.05 IU) and significantly superior over others. Lowest vitamin A was recorded by $D_5$ at 0 (4.93 IU), 3 (4.87 IU) and 6 months (4.87 IU). In interactions $T_4D_1$ recorded highest vitamin A content at 0 month (5.77 IU) and it was at par with $T_2D_3$ (5.49 IU), $T_4D_2$ (5.69 IU) and $T_4D_3$ (5.54 IU). At 3 month again $T_4D_1$ (5.69 IU) recorded highest vitamin A which was at par with $T_4D_2$ (5.60 IU) and at 6 months $T_1D_5$ (5.87 IU) recorded highest vitamin A and was at par with $T_4D_1$ (5.51 IU). Lowest vitamin A during storage was recorded by $T_3D_5$ at '0' (4.47 IU), '3' (4.64 IU) and 6 (4.26 IU) months.

## Alcohol content (%)

Alcohol content of wine increased from 0 (7.51 %) to 3 (7.65 %) and slightly decreased at 6 months (7.59 %). Increase in alcohol during storage might be due to micro fermentation during storage which converts sugars into alcohol and further slight decrease at 6 months may be due to its involvement in esterification as mentioned at 4.4.10. Alcohol content was increased with increase in T.S.S. levels from $T_1$ (3.17 %) to $T_4$ (10.20 %) at 0, $T_1$ (3.42 %) to $T_4$ (10.36 %) at 3 and $T_1$ (3.37 %) to $T_4$ (10.28 %) at 6 months storage. Increase in alcohol may be due to increase in T.S.S. levels of must by addition of sugars. Sugars are the main constituent of T.S.S which are converted to alcohol by the action of yeast. Yeast produces pyruvic decarboxylase and alcohol dehydrogenase enzymes and these enzymes converts reducing sugars to ethanol. The highest alcohol content recorded by $T_4$ at 0 (10.20 %), 3 (10.36 %) and at 6 month (10.28 %) was significantly superior over others.

Alcohol decreased from 8.64 ($D_1$) to 6.40 per cent ($D_5$) at 0, 8.95 ($D_1$) to 6.49 per cent ($D_5$) at 3 and 8.90 ($D_1$) to 6.43 per cent ($D_5$) at 6 months storage. Decrease in alcohol may be due to improper fermentation and conversion of sugars to alcohol in diluted juice. Similar reports were found by Taskar (2007) in jamun and Pawar (2009) in sapota wine. Highest alcohol recorded by $D_1$ at 0 (8.64 %), 3 (8.95 %) and 6 months (8.90 %) and lowest alcohol recorded by $D_5$ at 0 (6.40 %), 3 (6.49 %) and 6 months (6.43 %). Interactions $T_4D_1$ recorded highest alcohol content at 0 (11.0 %), 3 (11.11 %) and 6 months (11.05 %). $T_4D_1$ was at par with $T_4D_2$ at 0 (10.90 %), 3 (11.02 %) and 6 month (10.95 %) Lowest alcohol content during storage was recorded by $T_1D_5$ at '0' (1.24 %), '3' (1.29 %) and 6 (1.24 %) months.

## Author Contributions

Solanke: Investigation, formal analysis, writing—original draft. A. Ankita: Validation, methodology, writing—reviewing. C. D. Pawar:—Formal analysis, writing—review and editing. B. R. Salvi: Investigation, writing—reviewing. V. G. Salvi: Resources, investigation writing—reviewing. P. G. Borkar: Validation, formal analysis, writing—reviewing.

## Data Availability

The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

## Declarations

**Ethical Approval** Not applicable.

**Consent to Participate** Not applicable.

**Consent to Publish** Not applicable.

**Conflict of Interest** The authors declare no competing interests.

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