Effect of storage conditions, preservative levels and packing materials on ascorbic acid juice of mandarin cv. Nagpur Santra

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ABSTRACT

The research was done with the aim of considering vitamin C affectability under different storage conditions and packages at the post-harvest center of Mpkv, Rahuri Agricultural University in India. Juice of Nagpur Santra in three packaging materials glass bottles of 200 mL (B1), pet bottles of 200 mL (B2) and standy pouches (B3) which were added sodium benzoate as preservative substance in three levels 150 ppm (P1), 250 ppm (P2) and 350 ppm (P3), were kept in roaming temperature range 19 to 28°C (S1) and cold storage 5±2°C (S2) were used for vitamin C consideration at days 30, 60, 90, 120, 150 and 180 of storage period. Results showed that ascorbic acid of Nagpur Santra juice was significantly influenced by storage conditions, preservative levels, packaging materials and their interactions. The ascorbic acid (AA) of fresh juice was 43.46 mg 100 mL−1. During storage AA was found to be decreased in all the treatment combinations. However, the rate was faster under ambient condition (S1) as compared to cold storage (S2) condition. The minimum decrease in AA of juice was found in high preservative level when packed in glass bottle and stored in cold storage. The maximum AA was recorded in S2P3B1 (35.21 mg 100 mL−1) followed by S2P3B2 (34.23 mg 100 mL−1) at 180 days of storage. The minimum AA was recorded in S1P1B3 (23.69 mg 100 mL−1) followed by S1P1B2 (24.60 mg 100 mL−1) at 90 days of storage period and afterward it spoiled. It can be said due to high quantity of AA in Nagpur Santra even after long period of storage time the level of AA of mentioned fruit juice was at acceptable level from view point of nutritional value.

1. Introduction

Nagpur Mandarin (Nagpur Santra) is one of the richest vitamin C source among the horticultural crops as it is reported 42.43 mg 100 mL−1 in LB8-9 Mandarin Dou and Gmitter (2007). Beltrán-González et al. (2008) studied that vitamin C important part of fruit juices and its degradation is related with non-enzymatic browning. Beltran (2009) revealed that numerous complex factors can effect amount of vitamin C level of juices it related to the processing methods and packing materials which are used. The average value of AA in juice Nagpur Santra were recorded between 38 to 53.21 mg 100 mL−1 by (Patil et al., 2011; Shankar et al., 2012; Bharad et al., 2015). Decrease in AA during storage of pasteurized juices is related to storage time, storage conditions, pathways which are following for processing, packaging bottles and exposure to the light (Chobe, 1999; Sonawane, 2000; Polydera et al., 2003; Perez et al., 2005; Ros-Chumillas et al., 2007; Ahmed et al., 2008; Bhardwaj, 2013; Balaji, 2014; Malav et al., 2014; Nirmaljit and Anil, 2014). Beltrán-González et al. (2008) revealed that vitamin C level of juices is greatly influenced by temperature during storage and heat during processing, oxygen, metal ion contents, high oxygen content in the headspace of the containers and association of some enzymes like, cytochrome oxidase, ascorbic acid oxidase, and peroxidase can cause losses in AA contains. Same results were reported by (Bhardwaj, 2011; Pareek et al., 2011; Xu et al., 2012). The shelf life of orange juice is usually estimated from a value higher than 20 mg 100 mL−1 at ending storage time. (Bacigalupi et al., 2013).

2. Materials and methods

Juice of Nagpur Santra in three packaging materials glass bottles of 200 mL (B1), pet bottles of 200 mL (B2) and standy pouches (B3) which were added sodium benzoate as preservative substance in three levels 150 ppm (P1), 250 ppm (P2) and 350 ppm (P3), were kept in roaming temperature range 19 to 28°C (S1) and cold storage 5±2°C (S2) were used for vitamin C consideration at day 30, 60, 90, 120, 150 and 180 of storage period. Juice sample of 10 mL was diluted to 100 mL with 3.00 per cent metaphoric acid and filtered. Ten microliter extract of each sample was titrated with dye and L-ascorbic acid content of the sample was calculated taking into consideration the dye factor. The results were expressed as mg ascorbic acid per 100 mL fruit juice. For determination of vitamin C an aliquot (10 mL) was pipette out in a conical...
flask and titrated with 2, 6 dichlorophenol indophenol dye and a burette reading at pink color development for 15 secs was recorded. Ascorbic acid content in the sample was calculated in mg 100 mL\(^{-1}\) as per the formula suggested by (Association of Official Analytical Chemists, 1990; Ranganna, 2005).

(Titer-blank) x dye factor x Volume of extract

Ascorbic acid = \(\frac{\text{Extract taken for titration (mL)}}{\text{Volume of sample taken (mL)}}\) x 100

### 3. Results

The data on individual effect of storage conditions, preservative levels, packaging materials and their treatment combinations on ascorbic acid content of Nagpur Santra juice are presented in the following Table 1. The ascorbic acid of Nagpur Santra juice was significantly influenced by storage conditions, preservative levels, packaging materials and their interactions. The ascorbic acid of fresh juice was 43.46 mg 100 mL\(^{-1}\). The ascorbic acid was found to be decreased in all the treatment combinations during the advancement of 180 days of storage. However, the rate was faster S1 condition as compared to S2 condition.

### Table 1. Effect of storage conditions, preservative levels and packing materials on ascorbic acid (mg 100 mL\(^{-1}\)) of Nagpur Santra Juice along with their treatment combinations

| Particulars | Storage Period (Days) |
|-------------|------------------------|
|              | 30  | 60  | 90  | 120 | 150 | 180 |
| **Factor S** |     |     |     |     |     |     |
| S1          | 30.09 | 28.90 | 27.33 | 26.98 | 27.38 | 26.75 |
| S2          | 38.42 | 37.01 | 35.72 | 34.37 | 32.92 | 31.39 |
| SE. m(±)    | 0.0056 | 0.0073 | 0.0063 | 0.0089 | 0.0088 | 0.0090 |
| CD @ 5%     | 0.0160 | 0.0210 | 0.0237 | 0.0255 | 0.0252 | 0.0259 |
| CD @ 1%     | 0.0215 | 0.0281 | 0.0318 | 0.0342 | 0.0338 | 0.0346 |
| **Factor P** |     |     |     |     |     |     |
| P1          | 31.46 | 30.33 | 28.64 | 27.93 | 30.12 | 28.59 |
| P2          | 32.70 | 31.40 | 30.05 | 31.60 | 30.15 | 29.84 |
| P3          | 33.95 | 32.65 | 31.30 | 31.42 | 31.07 | 31.06 |
| SE. m(±)    | 0.0068 | 0.0090 | 0.0101 | 0.0109 | 0.0108 | 0.0111 |
| CD @ 5%     | 0.0196 | 0.0257 | 0.0291 | 0.0312 | 0.0309 | 0.0317 |
| CD @ 1%     | 0.0263 | 0.0344 | 0.0390 | 0.0419 | 0.0414 | 0.0426 |
| **Factor B** |     |     |     |     |     |     |
| B1          | 35.51 | 34.38 | 32.70 | 31.46 | 31.47 | 31.18 |
| B2          | 34.57 | 33.27 | 31.92 | 31.98 | 31.77 | 31.70 |
| B3          | 32.69 | 31.22 | 29.96 | 31.42 | 31.35 | 29.82 |
| SE. m(±)    | 0.0068 | 0.0090 | 0.0101 | 0.0109 | 0.0108 | 0.0111 |
| CD @ 5%     | 0.0196 | 0.0257 | 0.0291 | 0.0312 | 0.0309 | 0.0317 |
| CD @ 1%     | 0.0263 | 0.0344 | 0.0390 | 0.0419 | 0.0414 | 0.0426 |
| **S x P**   |     |     |     |     |     |     |
| S1P1        | 27.30 | 26.33 | 24.31 | 24.20 | * | * |
| S1P2        | 30.74 | 29.44 | 28.09 | 26.69 | 26.48 | * |
| S1P3        | 32.24 | 30.94 | 29.59 | 28.19 | 27.83 | 26.75 |
| S2P1        | 35.62 | 34.32 | 32.97 | 31.57 | 30.12 | 28.59 |
| S2P2        | 39.02 | 37.72 | 36.37 | 34.97 | 33.52 | 31.99 |
| S2P3        | 40.63 | 39.00 | 37.83 | 36.58 | 35.13 | 33.60 |
| SE. m(±)    | 0.0097 | 0.0127 | 0.0143 | 0.0154 | 0.0152 | 0.0157 |
| CD @ 5%     | 0.0277 | 0.0363 | 0.0411 | 0.0442 | 0.0437 | 0.0449 |
| CD @ 1%     | 0.0372 | 0.0487 | 0.0551 | 0.0592 | 0.0586 | 0.0602 |
| **S X B**   |     |     |     |     |     |     |
| S1B1        | 31.33 | 30.37 | 28.35 | 27.28 | 27.38 | 26.75 |
| S1B2        | 30.42 | 29.12 | 27.77 | 27.93 | 27.38 | * |
| S1B3        | 28.52 | 27.22 | 25.87 | 25.56 | * | * |
| S2B1        | 39.69 | 38.39 | 37.04 | 35.64 | 34.19 | 32.66 |
| S2B2        | 38.73 | 37.43 | 36.08 | 34.68 | 33.23 | 31.70 |
| S2B3        | 36.85 | 35.22 | 34.05 | 32.80 | 31.35 | 29.82 |
| SE. m(±)    | 0.0097 | 0.0127 | 0.0143 | 0.0154 | 0.0152 | 0.0157 |
| CD @ 5%     | 0.0277 | 0.0363 | 0.0411 | 0.0442 | 0.0437 | 0.0449 |
| CD @ 1%     | 0.0372 | 0.0487 | 0.0551 | 0.0592 | 0.0586 | 0.0602 |
| **P X B**   |     |     |     |     |     |     |
| P1B1        | 32.40 | 31.60 | 29.25 | 28.35 | 31.05 | 29.52 |
| P1B2        | 31.46 | 30.16 | 28.81 | 31.58 | 30.13 | 28.60 |
| P1B3        | 30.52 | 29.22 | 27.87 | 30.65 | 29.20 | 27.67 |
| P2B1        | 36.13 | 34.83 | 33.48 | 32.08 | 30.63 | 33.25 |
| P2B2        | 35.19 | 33.89 | 32.54 | 31.14 | 33.80 | 32.27 |
| P2B3        | 33.31 | 32.01 | 30.66 | 29.26 | 31.97 | 30.44 |
| P3B1        | 38.01 | 36.71 | 35.36 | 33.96 | 32.51 | 30.98 |
| P3B2        | 37.07 | 35.77 | 34.42 | 33.02 | 31.57 | 34.23 |
| P3B3        | 34.23 | 32.43 | 31.36 | 30.18 | 30.20 | 31.37 |
| SE. m(±)    | 0.0118 | 0.0155 | 0.0176 | 0.0189 | 0.0187 | 0.0192 |
| CD @ 5%     | 0.0340 | 0.0445 | 0.0503 | 0.0541 | 0.0535 | 0.0550 |
| CD @ 1%     | 0.0455 | 0.0597 | 0.0675 | 0.0725 | 0.0718 | 0.0737 |
3.1. Effect of storage

The ascorbic acid was decreased from 30.09 to 26.75 mg 100 mL\(^{-1}\) in S1 and 38.42 to 31.39 mg 100 mL\(^{-1}\) in S2 during 30 to 180 days of storage. The decreasing trend was maximum in S1 followed S2 during 180 days of storage period.

3.2. Effect of preservative levels

Among the preservative levels, the ascorbic acid was decreased from 31.46 to 28.59 mg 100 mL\(^{-1}\) at 150 ppm (P1), followed by 32.70 to 29.84 mg 100 mL\(^{-1}\) at 250 ppm (P2) and 33.95 to 31.06 mg 100 mL\(^{-1}\) at 350 ppm (P3) during 30 to 180 days of storage. The decreasing trend was maximum in P1 followed by P2 and P3 during storage.

3.3. Effect of packaging materials

Among the packaging materials, the ascorbic acid was decreased from 35.51 to 31.18 mg 100 mL\(^{-1}\) during package in glass bottles (B1) followed by 34.57 to 31.70 mg 100 mL\(^{-1}\) during package in PET bottles (B2) and 32.69 to 29.82 mg 100 mL\(^{-1}\) during package in standy pouches (B3) during 30 to 180 days of storage. The minimum decrease in AA was found in B1 followed by B2 and B3 during 180 days of storage.

3.4. Combined effect of two factors

The minimum decrease in ascorbic acid was observed in S2P3 from 40.63 to 33.60 mg 100 mL\(^{-1}\) followed by S2P2 from 39.02 to 31.99 mg 100 mL\(^{-1}\) during 180 of storage. The minimum decrease in ascorbic acid was observed in S2B1 from 39.69 to 32.66 mg 100 mL\(^{-1}\) followed by S2B2 from 38.73 to 31.70 mg 100 mL\(^{-1}\) during 180 of storage. Whereas, maximum decrease in ascorbic acid was observed in S1B3 followed by S1B2. The minimum decrease in ascorbic acid was observed in P3B1 followed by P3B2 while maximum decrease in ascorbic acid was observed in P1B3 followed by P1B2.

3.5. Interaction

The treatment combination of storage conditions, preservative levels and packaging materials indicated that the ascorbic acid of Nagpur mandarin juice was found to be statistically significant. The minimum decrease in ascorbic acid of juice was found in high preservative level when packed in glass bottle and stored in cold storage. The maximum ascorbic acid was recorded in S2P3B1 (35.21 mg 100 mL\(^{-1}\)) followed by S2P3B2 (34.23 mg 100 mL\(^{-1}\)) at 180 days of storage. The minimum ascorbic acid was recorded in S1P1B3 (23.69 mg 100 mL\(^{-1}\)) followed by S1P1B2 (24.60 mg 100 mL\(^{-1}\)) at 90 days of storage period and afterward it spoiled.

4. Discussion

The data on effect of treatment combination of storage conditions, preservative levels and packaging materials indicated that the ascorbic acid of Nagpur Santra juice were found to be statistically significant. The minimum decrease in ascorbic acid of juice was found in high preservative level packed in glass bottle and stored in cold storage. The maximum ascorbic acid was recorded in S2P3B1 (from 43.46 to 35.21 mg 100 mL\(^{-1}\)) followed by S2P3B2 (from 43.46 to 34.23 mg 100 mL\(^{-1}\)) during 180 days of storage. The minimum ascorbic acid was recorded in S1P1B3 (from 43.46 to 23.69 mg 100 mL\(^{-1}\)) during 90 days followed by S1P1B1 (from 43.46 to 24.20 mg 100 mL\(^{-1}\)) during 120 days of storage period and afterward it spoiled.

5. Conclusion

The juice of Nagpur Santra that preserved by using different
preservative levels packed in different packaging materials and stored at ambient and cold storage was studied. The data regarding vitamin C composition revealed that, there was decreasing in ascorbic acid, decreased in all treatment combination of juice during 180 days of storage, but minimum decreasing of juice were packed in glass bottles with using higher preservative level and were stored at cold condition were recorded and even after long period of storage time the level of AA of mentioned fruit juice was at acceptable level from view point of nutritional value

**Authors’ Contributions**

Zaki Ahmad Faizi: Methodology, Investigation, Conceptualization, Validation, Review and editing.

Mohammad Younis Mahen: Methodology, Investigation, Conceptualization, Validation, Writing - original draft, Review and editing, Visualization.

**Conflict of interest**

The authors declare that they have no conflict of interest.

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