

Original Research Article

Effect of thermosonication on total soluble solid, pH and titrable acidity of Nagpur mandarin juice

ABSTRACT

Nagpur mandarin is well known globally for its excellent nutritional benefits and flavor. Various physicochemical characteristics get affected during storage due to lack of knowledge & processing techniques. One of the most parameters which decide the quality and taste of fruit juice during storage is total soluble solid, pH & titrable acidity. These parameters get affected during storage and shows a decreasing value for total soluble solid, pH & titrable acidity. Therefore, an experiment was carried out to understand the effect of thermosonication and thermal pasteurization on total soluble solid, pH and titrable acidity of Nagpur mandarin (*Citrus reticulata* Blanco) juice. Samples were analyzed after treatment at 0 day and 7 days of refrigerated storage at 4 °C. Result indicated that thermosonication and thermal pasteurization treatments on total soluble solid, pH and titrable acidity showed non-significant effect. However, heat pasteurization was found to be superior over thermosonication. Heat pasteurization at 95 °C for 20 seconds recorded better performance in total soluble solid, pH & acidity compared to other treatment.

Key words: Thermosonication, Thermal pasteurization, Nagpur mandarin, Juice quality

1. INTRODUCTION

Citrus is group of perennials, evergreen flowering trees and shrubs which belongs to family Rutaceae. Citrus fruits contain fragrance mainly due to flavonoids and limonoids contained in the rind. Citrus fruits are rich in ascorbic acid (vitamin C). Fruit juice generally contains a high quantity of citric acid providing them their characteristic sharp flavor. Citrus fruits are eaten fresh, juice pressed, or preserved as a value-added product. Citrus is grown in more than 100 countries of the world. Among 100 countries, citrus is grown commercially in 53 countries. Nagpur mandarin occupies an area of about 480 '000 Ha of the total area of 1054 '000 Ha under citrus and total production 6368 '000 MT in the country (NHB, 2020) [8]. The area under Nagpur mandarin cultivation in Maharashtra alone is 115.003 thousand hectares, with a production of 899.58 thousand MT and productivity of 7.82 t/ha. The total area under citrus fruit in Chhattisgarh is 13.90 thousand hectares with a total production of 103.44 thousand MT with a productivity of 7.44 t/ha. The total area (in Chhattisgarh) under Nagpur mandarin 0.025 thousand hectares and production of 0.765 thousand MT.

Nagpur mandarin is well known globally for its excellent nutritional benefits and flavor (Carbonell *et al.*, 2006) [6]. These all characteristics get affected during storage due to lack of knowledge & processing techniques. One of the most parameters which decide the quality of fruit juice during storage is cloud stability, which gets affected during storage due to the action of an enzyme named pectin methylesterase. Juices also face low ascorbic acid retention &

antioxidant activity. Therefore, it is necessary to develop and standardize a technology to increase and stabilize the cloud activity, ascorbic acid retention & antioxidant activity with minimum effect on the other parameter of juice like the color, taste, total soluble solid, pH, acidity etc.

Thermal pasteurization is a common method used to destroy the micro-organism and inactivate the enzymes in fruit juice. This heat treatment may cause undesirable changes in the properties of juice such as physical, biological, chemical, and organoleptic (color, flavor, nutrients). Sonication is considered as a prominent technology and a magnificent alternative to the thermal processing for the food processing industry and the most valuable source in less energy and reduced processing time (Aadil *et al.*, 2015a)^[1]. Sonication, when combined with heat is called thermo-sonication (Anaya-Esparza *et al.*, 2017)^[4]. Thermosonication is a treatment that is the combination of ultrasound and heat. The effect of this combination is for the microbial inactivation which is more effective than the sonication without heat treatment (Aadil *et al.*, 2015b)^[2]. It is more effective as lower temperatures are used in comparison to thermal treatment (Anaya-Esparza *et al.*, 2017)^[4]. Thermosonication with ultrasound is an alternative processing technique to enhance the inactivation of enzymes by the formation, growth and explosion of bubbles in liquid (Abdullah & Chin, 2014)^[3]. In ultrasound, a phenomenon called cavitation occurs due to the propagation of sound waves. Cavitation leads to the formation and collapse of bubbles, which in synchronization with heat, promote cell disruption along with bacterial and enzymatic inactivation (Anaya-Esparza *et al.*, 2017)^[4]. The current objective is to check pasteurization and thermosonication treatment on total soluble solid, pH & acidity of Nagpur mandarin juice.

2. MATERIALS AND METHODS

The current experiment was conducted for examining the effect of thermosonication on qualitative parameters of Nagpur mandarin juice at post-harvest management & processing lab under ICAR-Central Citrus Research Institute, Nagpur, Maharashtra, during the year 2019-20. Fully matured, uniform fruits of Nagpur mandarins were harvested from the experimental field under the ICAR-CCRI, Nagpur and used for experiment. Those fruits which were free from mechanical injury were selected for the experiment and the immature, damaged and off type fruits were discarded. For extraction of juice, mandarin fruits were peeled manually. Juice was extracted from fruits using the orange juice extractor. After extraction of juice, it was filtered by the use of sieve & muslin cloth to separate the pulp present in the juice. Juice samples were then thermosonicated & thermally pasteurized at different temperature & frequency for different time interval. Treated juice & control were packed in 200 ml plastic bottles & stored under refrigerator at 4° C. Different studies were conducted to evaluate the effect of treatments on various quality parameters, during the storage period of 0 and 7 days.

The experiment comprised of 9 treatments and three replications designed under CRD at 5 per cent level of significance, includes various thermosonication treatments (50 °C/ 25 minute, 55 °C/ 20 minute, 60 °C/ 15 minute and 63 °C/ 10 minute) at 40kHz frequency and thermal treatments (65 °C/ 80 second, 75 °C/ 60 second, 85 °C/ 40 second and 95 °C/ 20 second) along with control. Data were then subjected to various statistical analysis of variance as given by Gomez & Gomez (1985)^[7]. Juice samples were tested for various chemical parameters after the application of different treatment to juice on 0 day & 7th day of storage. The pH of Nagpur mandarin juice was calculated using digital pH meter. The temperature was kept constant while

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taking all the observations. The total soluble solid of Nagpur mandarin orange juice was directly measured using digital hand refractometer. Reading was taken at room temperature. Titratable acidity of the Nagpur mandarin juice was calculated by taking 5ml of juice & diluting it with 20 ml of distilled water, after than further taking 5 ml of aliquot (from diluted juice sample) & titrating this aliquot against 0.1 N NaOH using phenolphthalein as indicator. End point is denoted by the appearance of light pink color (Ranganna, 1986)^[10]. The acidity is expressed in percent (%) and was calculated using the following formulae: -

$$\text{Acidity} = \frac{\text{Titre} \times \text{Normality of alkali} \times \text{volume made up} \times \text{Equivalent Weight of anthocynin} \times \text{Equivalent Weight of anhydrous citri acid} \times 100}{\text{Volume of sample taken for estimation} \times \text{weight or volume of sample taken} \times 1000}$$

3. RESULT AND DISCUSSIONS

3.1 Total soluble solid

The data revealed that application of different treatments did not exert any significant influence on the total soluble solid (TSS) content of fruit juice (Table 1). The initial data observed for total soluble solid (TSS) ranged between 8.55% to 8.93%. The perusal of data presented in Table 1 showed that juice receiving treatment T₈ (thermal pasteurization at 95 °C for 20 sec) recorded maximum TSS (8.93%) followed by T₇ (Heat Pasteurization at 85 °C for 40 sec), T₆ (Heat Pasteurization at 75 °C for 60 sec) and T₅ (Heat Pasteurization at 65 °C for 80 sec) having total soluble solid (TSS) content of 8.83%, 8.87%, and 8.73% respectively. Whereas, minimum value for total soluble solid (TSS) was observed under treatment T₂ (Thermosonication at 55 °C for 15 min at 40 kHz frequency) and T₁ (Thermosonication at 50 °C for 25 min at 40 kHz frequency) having the TSS 8.55% and 8.57% respectively.

Similarly, after 7 days of storage, different treatments did not influence the total soluble solid (TSS) of Nagpur mandarin juice and total soluble solid (TSS) was statistically non-significant. Total soluble solid (TSS) content after 7 days of storage varied between 8.33% to 8.73%. The maximum TSS (8.73 %) was observed under treatment T₈ (thermal pasteurization at 95 °C for 20 sec) followed by T₇ (Heat Pasteurization at 85 °C for 40 sec), T₅ (Heat Pasteurization at 65 °C for 80 sec), and T₆ (Heat Pasteurization at 75 °C for 60 sec), having the total soluble solid (TSS) content of 8.7%, 8.7% and 8.67% respectively. The minimum total soluble solid (TSS) content (8.33%) was observed under treatment T₂ (Thermosonication at 55 °C for 15 mins at 40 kHz frequency).

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Table 1: Effect of thermosonication and thermal pasteurization treatments on quality attributes of Nagpur mandarin juice during the storage period of 7 days at 4 °C.

Treatments	TSS (%)		pH		Acidity (%)	
	0	7	0	7	0	7
	DAT	DAT	DAT	DAT	DAT	DAT
T ₀ - Control	8.67	8.5	4.06	3.68	0.543	0.516
T ₁ - Thermosonication at 50 °C for 25 min at 40 kHz frequency	8.57	8.43	4.19	3.86	0.577	0.474
T ₂ - Thermosonication at 55 °C for 20 min at 40 kHz frequency	8.55	8.33	4.19	3.76	0.593	0.461
T ₃ - Thermosonication at 60 °C for 15 min at 40 kHz frequency	8.83	8.53	4.11	3.77	0.521	0.512
T ₄ - Thermosonication at 63 °C for 10 min at 40 kHz frequency	8.6	8.55	4.11	3.76	0.561	0.525
T ₅ - Heat Pasteurization at 65 °C for 80 sec	8.73	8.7	4.14	3.72	0.628	0.619
T ₆ - Heat Pasteurization at 75 °C for 60 sec	8.77	8.67	4.13	3.71	0.566	0.563
T ₇ - Heat Pasteurization at 85 °C for 40 sec	8.83	8.7	4.10	3.71	0.614	0.572
T ₈ - Heat Pasteurization at 95 °C for 20 sec	8.93	8.73	4.06	3.68	0.552	0.547
C.D. (p=0.05)	N/A	N/A	N/A	N/A	N/A	N/A

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It is evident from the data that application of different thermosonication and thermal pasteurization treatment do not have any significant effect on the total soluble solid (TSS) of Nagpur mandarin juice as compared to untreated Nagpur mandarin juice (control). These non-significant change in the total soluble solid (TSS) of juice may be attributed to the energy level applied to the samples through thermosonication or thermal pasteurization. Different treatment of thermosonication and thermal pasteurization did not change the molecular structure of high molecular weight associated with total soluble solid (TSS) (Ordonez-santos *et al.*, 2017)^[9]. These results are in agreement with the findings of Tiwari *et al.*, (2008)^[11] in orange juice. However, heat pasteurization was found to be superior over thermosonication. Heat pasteurization at 95 °C for 20 seconds recorded better performance in total soluble solid.

3.2 pH

Initial data depicted in the Table 1 showed that the thermosonication and thermal pasteurization treatment did not influence the pH of Nagpur mandarin juice. Result observed revealed that the data was statistically non-significant. The pH value for Nagpur mandarin juice ranged between 4.06 to 4.19. Among all the treatment, maximum pH (4.19) was observed under the treatment T₁ (Thermosonication at 50°C for 25 min at 40 kHz frequency) which was followed by T₂ (Thermosonication at 55°C for 20 min at 40 kHz frequency), T₅ (Heat Pasteurization at 65 °C for 80 sec), and T₆ (Heat Pasteurization at 75 °C for 60 sec) having the pH value 4.19, 4.14

and 4.13 respectively. Whereas, the minimum pH (4.06) was observed under the treatment T₈ (Thermal Pasteurization at 95°C for 20 sec).

Similarly, data recorded for pH after 7 days of storage for various treatments were also statistically non-significant. The pH values after storage of 7 days ranged from 3.68 to 3.86. Among all the treatments, maximum pH (3.86) was recorded under the treatment T₁ (Thermosonication at 50°C for 25 min at 40 kHz frequency), followed by treatment T₃ (Thermosonication at 60 °C for 15 min at 40 kHz frequency), T₂ (Thermosonication at 55 °C for 20 min at 40 kHz frequency) and T₄ (Thermosonication at 63 °C for 10 min at 40 kHz frequency), having the pH value 3.77, 3.76 and 3.76 respectively. However, the minimum pH (3.68) was jointly recorded under the treatment T₀ (Control) and T₈ (thermal pasteurization at 95 °C for 20 sec).

3.3 Acidity

The data on acidity of the juice in Table 1 revealed that different thermosonication and thermal pasteurization did not exert any significant effect on titratable acidity. The initial data recorded after application of different thermosonication and thermal pasteurization treatments showed that the data was statistically non-significant. The data presented for titratable acidity on Table 1 ranged between 0.521% to 0.628%. Data showed that the maximum value for titratable acidity (0.628%) was record under treatment T₅ (Thermal Pasteurization at 65°C for 80 sec) and followed by T₇ (Heat Pasteurization at 85 °C for 40 sec), T₂ (Thermosonication at 55 °C for 20 min at 40 kHz frequency), and T₁ (Thermosonication at 50 °C for 25 min at 40 kHz frequency) having the acidity 0.614%, 0.593% and 0.577% respectively. The minimum value for titratable acidity (0.521%) was recorded under the treatment T₃ (Thermosonication at 60°C for 15 min at 40 kHz frequency).

Correspondingly, data pertaining to the effect of various treatments on titratable acidity after 7 days of storage, as depicted in Table 1, did not significantly affect the titratable acidity of juice. The titratable acidity of juice varied between 0.461% to 0.619%. Highest titratable acidity (0.619%) was recorded under the treatment T₅ (Thermal Pasteurization at 65°C for 80 sec) which was followed by T₇ (Heat Pasteurization at 85 °C for 40 sec), T₆ (Heat Pasteurization at 75 °C for 60 sec), and T₈ (Heat Pasteurization at 95 °C for 20 sec) having the titratable acidity 0.572%, 0.563%, and 0.547% respectively. Whereas, the minimum value for titratable acidity (0.461%) was recorded under treatment T₂ (Thermosonication at 55°C for 20 min at 40 kHz frequency).

A non-significant change on the acidity of juice was seen in the thermosonicated and thermally pasteurized juice of Nagpur mandarin after the application of various treatments as compared to control (untreated Nagpur mandarin juice). The juice did not show any significant change even after sonication up to 63 °C and pasteurization up to 95 °C. These may be attributed to the energy level applied to the samples through thermosonication or thermal pasteurization, did not change the molecular structure of high molecular weight associated with titratable acidity. These results were in collaboration with Bhat *et al.*, (2011)^[5] on Kasturi lime juice, Aadil *et al.*, (2015a)^[1] in grapefruit juice and Tiwari *et al.*, (2008)^[11] on orange juice.

4. CONCLUSION

The quality parameters, need to be restored for making high-end value-added products. It is important to maintain the total soluble solid, pH & titrable acidity of juice during storage. However, the treatments have not responded for the parameter viz, total soluble solid, pH and titrable acidity. Total soluble solid (TSS) of Nagpur mandarin fruit juice was not significantly influenced by the application of different thermosonication and thermal pasteurization treatments. Among all the treatments the application of treatment T₈ (Thermal Pasteurization at 95 °C for 20 sec) showed maximum total soluble solid (TSS). pH of Nagpur mandarin fruit juice was not influenced significantly by the application of different thermosonication and thermal pasteurization treatments. Among all the treatments the application of treatment T₁ (thermosonication at 50 °C for 25 min at 40 kHz frequency) showed maximum pH value. The minimum pH value was observed by application of treatment T₈ (Thermal Pasteurization at 95 °C for 20 sec). Titrable acidity of Nagpur mandarin juice was not influenced significantly by the application of different thermosonication and thermal pasteurization treatments.

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