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Effect of Thermosonication on Total Soluble Solid, pH and Titrable Acidity of Nagpur Mandarin Juice

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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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 ℃. Result indicated that thermosonication and thermal pasteurization treatments on total soluble solid, pH and titrable

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acidity showed non-significant effect. However, heat pasteurization was found to be superior over thermosonication. Heat pasteurization at 95℃ for 20 seconds recorded better performance in total soluble solid, pH & acidity compared to other treatment.

Keywords: Thermosonication; thermal pasteurization; juice quality; pectin methylesterase.

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 [1]. 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 [2]. 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 [3]. Sonication, when combined with heat is called thermo-sonication [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 [5]. It is more effective as lower temperatures are used in comparison to thermal treatment [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 [6]. 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 [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 than 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 [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 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 [8]. The acidity is expressed in percent (%) and was calculated using the following formulae: -

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

3. RESULTS AND DISCUSSION

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 T_8 (thermal pasteurization at 95℃ for 20 sec) recorded maximum TSS (8.93%) followed by T_7 (Heat Pasteurization at 85℃ for 40 sec), T_6 (Heat Pasteurization at 75℃ for 60 sec) and T_5 (Heat Pasteurization at 65℃ 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 T_2 (Thermosonication at 55℃ for 15 min at 40 kHz frequency) and T_1 (Thermosonication at 50℃ 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 T_8 (thermal pasteurization at 95℃ for 20 sec) followed by T_7 (Heat Pasteurization at 85℃ for 40 sec), T_5 (Heat Pasteurization at 65℃ for 80 sec), and T_6 (Heat Pasteurization at 75℃ 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 T_2 (Thermosonication at 55℃ for 15 mins at 40 kHz frequency).

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) [9]. These results are in agreement with the findings of Tiwari et al. [10] in orange juice. However, heat pasteurization was found to be superior over thermosonication. Heat pasteurization at 95℃ for 20 seconds recorded better performance in total soluble solid.

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℃

Treatments	TSS (%)		pH		Acidity (%)	
	0 DAT	7 DAT	0 DAT	7 DAT	0 DAT	7 DAT
T_0 - Control	8.67	8.5	4.06	3.68	0.543	0.516
T_1- Thermosonication at 50 ℃ for 25 min at 40 kHz frequency	8.57	8.43	4.19	3.86	0.577	0.474
T_2- Thermosonication at 55 ℃ for 20 min at 40 kHz frequency	8.55	8.33	4.19	3.76	0.593	0.461
T_3- Thermosonication at 60 ℃ for 15 min at 40 kHz frequency	8.83	8.53	4.11	3.77	0.521	0.512
T_4- Thermosonication at 63 ℃ 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 ℃ for 80 sec	8.73	8.7	4.14	3.72	0.628	0.619
T_6- Heat Pasteurization at 75 ℃ for 60 sec	8.77	8.67	4.13	3.71	0.566	0.563
T_7- Heat Pasteurization at 85 ℃ for 40 sec	8.83	8.7	4.10	3.71	0.614	0.572
T_8- Heat Pasteurization at 95 ℃ 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

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 T_1 (Thermosonication at 50℃ for 25 min at 40 kHz frequency) which was followed by T_2 (Thermosonication at 55℃ for 20 min at 40 kHz frequency), T_5 (Heat Pasteurization at 65℃ for 80 sec), and T_6 (Heat Pasteurization at 75℃ 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 T_8 (Thermal Pasteurization at 95℃ 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 T_1 (Thermosonication at 50℃ for 25 min at 40 kHz frequency frequency), followed by treatment T_3 (Thermosonication at 60℃ for 15 min at 40 kHz frequency), T_2 (Thermosonication at 55℃ for 20 min at 40 kHz frequency) and T_4 (Thermosonication at 63℃ 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 T_0 (Control) and T_8 (thermal pasteurization at 95℃ 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 T_5 (Thermal Pasteurization at 65℃ for 80 sec) and followed by T_7 (Heat Pasteurization at 85℃ for 40 sec), T_2 (Thermosonication at 55℃ for 20 min at 40 kHz frequency), and T_1 (Thermosonication at 50℃ 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 T_3 (Thermosonication at 60℃ 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 T_5 (Thermal Pasteurization at 65℃ for 80 sec) which was followed by T_7 (Heat Pasteurization at 85℃ for 40 sec), T_6 (Heat Pasteurization at 75℃ for 60 sec), and T_8 (Heat Pasteurization at 95℃ 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 T_2 (Thermosonication at 55℃ 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℃ and pasteurization up to 95℃. 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. [11] on Kasturi lime juice, Aadil et al. [3] in grapefruit juice and Tiwari et al. [10] on orange juice [12].

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 aciditity 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 T_8 (Thermal Pasteurization at 95℃ 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 T_1 (thermosonication at 50 ℃ for 25 min at 40 kHz frequency) showed maximum pH value. The minimum pH value was observed by application of treatment T_8 (Thermal Pasteurization at 95℃ for 20 sec). Titrable acidity of Nagpur mandarin juice was not influenced significantly by the application of different thermosonication and thermal pasteurization treatments.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. NHB. National Horticulture Board; 2020. Available:http://nhb.gov.in/StatisticsViewer.aspx?enc=FdhWKi1URA5yNAM+4mV5hQpJDviTxMmPkSfD97hsCEQ+Z+J1lzLFolcG88JyPsUQ.
2. Carbonell JV, Contreras P, Carbonell L, Navarro JL. Pectin methylesterase activity in juices from mandarins, oranges and hybrids. European Food Research and Technology. 2006;222(1–2):83–87.
3. Aadil RM, Zeng X, Abbasi MS, Khan MS, Khalid S, Jabbar S, Abid M. Influence of power ultrasound on the quality parameters of grapefruit juice during storage. Science letters. 2015a;3:6-12.
4. Anaya-Esparza L M, Velázquez-Estrada R M, Roig AX, García-Galindo HS, Sayago-Ayerdi SG, Montalvo-González E. Thermosonication: An alternative processing for fruit and vegetable juices. Trends in Food Science & Technology. 2017;61:26–37.
5. Aadil R M, Zeng X, Zhang Z, Wang M, Han Z, Jing H, Jabbar S. Thermosoniation: A potential technique that influence the quality of grapefruit juice. International Journal of Food Science and Technology. 2015;50:1275-1282.
6. Abdullah N, Chin NL. Application of Thermosonication treatment in processing and production of high quality and safe-to-drink fruit juices. Agriculture and Agricultural Science Procedia. 2014; 2:320–327.
7. Gomez K A and Gomez A A. Statistical procedure for agricultural Research. Edn 2, John Wiley & Sons New York. 1984;241-271.
8. Rangana S. Handbook of analysis and quality control for fruit and vegetable products. Tata McGraw Hills Pub, New Delhi. 1986;23(1):346-369.
9. Ordonez-Santos LE, Martinez-Giron J, Arias-Jaramilo ME. Effect of ultrasound treatment on visual color, vitamin C, total phenols, and carotenoids content in cape gooseberry juice. Food Chemistry. 2017;233:96-100.
10. Tiwari BK, Muthukumarappan K, Donnell CPO, Cullen PJ. Effect of sonication on the kinetics of orange juice quality parameters. Journal of agricultural and food chemistry. 2008;56:2423-2428.
11. Bhat R, Kamaruddin NSBC, Min-Tze L, Karim AA. Sonication improves kasturi lime

(*Citrus microcarpa*) juice quality. Ultrasonics sonochemistry. 2011;18: 1295-1300.

12. Vercet A, Burgos J, López-Buesa P. Manothermosonication of foods and food-resembling systems: effect on nutrient content and nonenzymatic browning. Journal of Agricultural and Food Chemistry. 2001;49(1): 483-489.

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