International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
www.chemijournal.com
IJCS 2021; 9(1): 2867-2871

Received: 01-10-2020
Accepted: 10-12-2020

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Effect of process parameters on quality of carbonated Kinnow juice

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DOI: https://doi.org/10.22271/chemi.2021.v9.i1an.11666

Abstract
One of the new strategies for enhancing palatability and extending the shelf life of juice without incorporating any synthetic flavours and additives is carbonation. The experiment was designed to study the effect of salt addition in carbonation at different levels of temperature and pressure. Kinnow fruit juice was carbonated at 4 °C to 8 °C and pressure of 80 psi to 120 psi. TSS and pH followed inverse relation with carbonation conditions and acidity followed direct relation. Antioxidant activity, total phenols transposes as ascorbic acid and observed highest at 80 psi and 4 °C. Reducing sugar and colour of carbonated kinnow juice remains unaffected at different carbonation conditions. In a nutshell, higher degree of carbonation can be achieved at higher pressure and lower temperature increasing juice acceptability without affecting physical quality. Salt-addition does not have significant effect on its nutritional parameters. Though the nutritional parameters found to be decline, the deviation observed was minimum.

Keywords: Carbonation, kinnow, antioxidant activity, total phenol, ascorbic acid

1. Introduction

India is the 5th largest producer of citrus fruits. Considering Indian terrain, 10% of the total land under fruit cultivation is tenanted with citrus crops followed by mango and banana (Mahawar, Jalgaonkar *et al*. 2019) [7]. Kinnow comes under '*Mandarin*' group of citrus which was breaded from cross between 'King' (*Citrus nobilis*) and 'Willow leaf' (*Citrus deliciosa*) mandarin which is considered to be high quality variety (Mahawar, Jalgaonkar *et al*. 2019) [7]. The mandarin has proved to be high yielding and disease tolerant compared to other citrus fruits grown in India when it was brought to Regional Fruit Research Station, Abhor in 1959 by Punjab Agricultural University. It has been found that it can be cultivated well in Punjab, Himachal Pradesh, Rajasthan, Uttarakhand, Jammu and Kashmir, Uttar Pradesh and Maharashtra states. Unlike other citrus variety, harvesting of kinnow is done based on internal parameters such as TSS (Total soluble solids) is 11◦Brix and acidity is 0.8%. Delay in harvesting can lead to decrease in juice content and the keeping quality of fruit (Mahawar, Jalgaonkar *et al*. 2019) [7].

The reason for wastage of kinnow and inability of post-harvest processing is lack of proper marketing channels and poor post-harvest management practices. Kinnow cannot be transported in gunny bags unlike other citrus fruits. Continuous and bulk production lead to truckloads in transportation causing damage to fruits. Increase in consumption of unprocessed kinnow escalate the wastage and discarding of low grade fruits. However, direct discarding in open surrounding may lead to environmental damage. This paves an opportunity for kinnow processing of the fruits which can reduce the waste and enhances the economic returns to kinnow producers (Mahawar, Jalgaonkar *et al*. 2019) [7]. The kinnow fruits are processed as drink such as RTS, squash, nectar, fermented products, juice powder, *etc*. The kinnow juice undergoes process of bittering with time if not processed after extraction which enables the need of immediate processing for it. In general, consumers prefer haze free juices of citrus fruits making it a suitable commodity for carbonation (Mahawar, Jalgaonkar *et al*. 2019) [7].

Carbonation means dissolving the CO_2 into water under high pressure. Carbonated drink gives good taste because it shows tingling effect which is the main reason of popularity of carbonated drink along with this it has thrust quenching and refreshing properties

(Solanke, Sontakke *et al*. 2017) [13]. Carbonated drinks are generally acidic in nature consists of pH 2.5 to 4 and CO_2 volume 1.5 to 4%. Low pH attained by acidulants inhibits the growth of microbes which further is assisted by preservative action of CO_2 making carbonated drinks self-stable (Azeredo, Alvarenga *et al*. 2016) [3]. Moreover, conventional carbonated drinks shows various health issues such as increased blood sugar, obesity and tooth erosion (Rajeev, Lewis *et al*. 2020) [10].

Traditional and commercial carbonated beverages are prepared from syrup or cola type which lacks the nutritional profile. Though the fruit juices are good source of various macro and micro nutrients, they lack in self-stability. Inclusion of fruit juices in carbonated drinks at commercial level is very limited and has lot of scope to become a major part, commercially. Carbonation of fruit juice not only imparts characteristics colour, flavour, taste, aroma but also allows to work without artificial colour and flavours (Verma 2018) [15].

In present work, a comparative study was conducted between carbonated kinnow drink with salt and without salt addition at different temperatures and pressure levels. The physiochemical and nutritional properties were considered to decide the optimized temperature and pressure suitable for carbonation of kinnow fruit juice.

2. Materials and Methods

2.1 Raw materials

Kinnow fruits used for the experiment were procured from orchard in Bhatinda, Punjab and medium size fully matured fruits were selected for the experiments. Remaining materials were purchased from Thanjavur Consumer Co-operative Warehouse (Thanjavur, Tamil Nadu, India) and food grade additives *viz.* acid regulators and preservative were purchased from Himedia (Himedia, Nashik, India).

2.2 Preparation of carbonated kinnow fruit drink

The kinnow fruits were sorted based on maturity. The selected fruits were washed using bubble washer and juice was extracted by using citrus-juice extractor (Accelor Food Tech., Coimbatore, India) from kinnow fruits. The extracted juice was filtered through plate and frame filter press. The fruit juice was maintained at, total soluble solid 15%, acidity 1.5% and preservative 60 ppm and further used for preparation of kinnow fruit nectar. The standardised dilution factor K50 (kinnow: water, 50:50) was considered for further experiment of carbonation. The kinnow fruit juice dilution factor of K50 was prepared and subjected to pasteurization at 115±0.5 °C for 2 sec seconds followed by instant cooling at 25±2 ^{0}C and stored at refrigeration condition at 4 ^{0}C (Eagerman and Rouse 1976) [6].

After cooling, the pasteurized kinnow fruit nectar subjected to carbonation and the detailed flow chart is given in figure 1. The experiment was performed to compare the effect of temperature and pressure on kinnow juice with salt and without salt. The developed formula was chilled and carbonation was done at 4 ^{0}C, 6 ^{0}C and 8 ^{0}C temperature in the pressure range of 80 psi, 90 psi, 100 psi, 110 psi and 120 psi by using carbonation unit (Spectra Plast India, Coimbatore, India). Carbonation was carried with addition of 0.5% salt and. The prepared kinnow drinks were filled in 250ml bottles and sealed tightly by using capping machine and it was stored at refrigeration condition at 4 ºC for further evaluation of physicochemical and phytochemical properties.

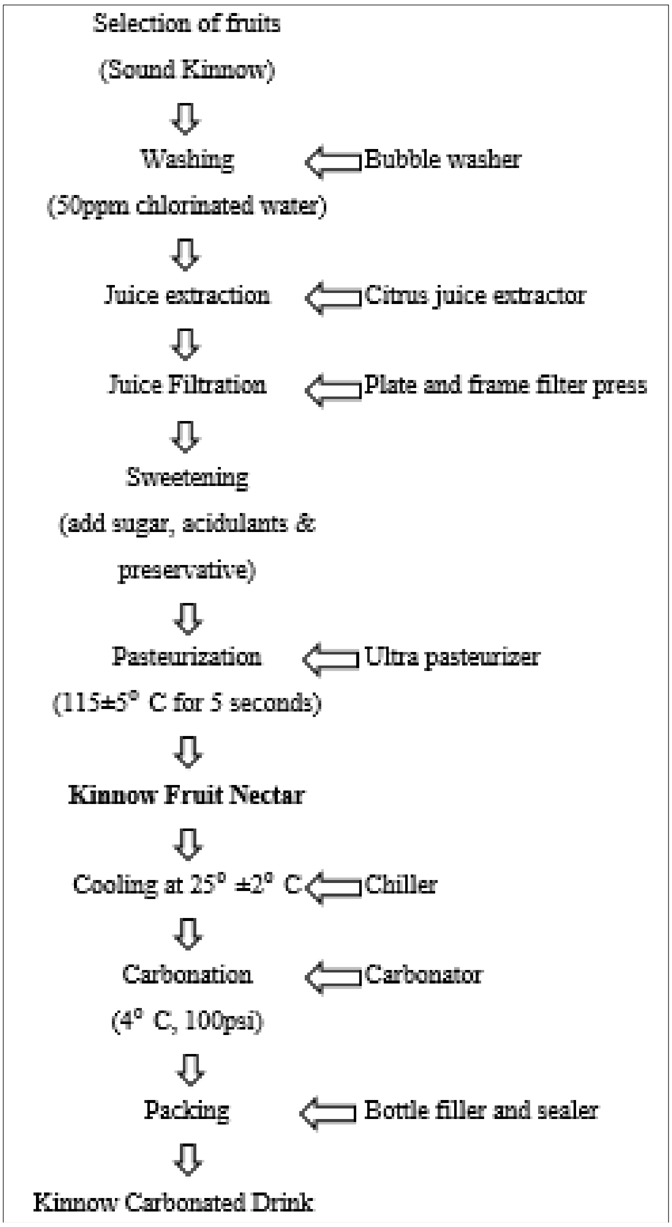


Fig 1: Flow Sheet for the Processing of Carbonated Kinnow Fruit Drink

2.3 Quality analysis

2.3.1 Total soluble solids

Total Soluble Solids (TSS) was measured using the digital refractometer (ATAGO PAL-LOOP, Fukaya, Japan). A one or two drops of carbonated kinnow drink was placed on digital refract meter. The TSS value was expressed as °Brix (Mohapatra, Yuvraj *et al*. 2016) [9].

2.3.2 pH

The pH of the fresh fruit juice was determined by using digital pH meter (pH Tutor, Eutech Instruments, Singapore). The pH meter was calibrated with commercial buffer solutions at pH 9.0, 7.0 and 4.0 before measurement. About 10 ml sample was taken in glass container and pH electrode was inserted the pH value was recorded after stabilization (Agarkar, Aggarwal *et al*. 2019) [1].

2.3.3 Titrable acidity

The 10 ml sample of kinnow juice was diluted with water at ratio 1:10. From that 25 ml of solution was taken in beaker and 2 to 3 drops of phenolphthalein indicator was added and titrated against 0.1N NaOH till color changed to pink. Then the values were noted and acidity was determined by the following formula (Ranganna 1986) [11].

$$\text{Titrable acidity (\%)} = \frac{Titratevalue \times acidfactor \times 100}{volume\ of\ aliquot} \quad \ldots 1$$

2.3.4 Ascorbic acid
Ascorbic acid was determined by titrating the sample against 2-6, dichlorophenol indophenol with sodium carbonate in which sample preparation include 5 ml of sample with 100 ml 4% oxalic acid further centrifuged. 5 ml of supernatant was collected and mixed with 10 ml of 4% oxalic acid and the titrated against dye. Amount of vitamin C was calculated by equation 3.

$$\text{Amount of ascorbic acid mg/100ml sample} = \frac{0.5\ mg}{V_1 ml} \times \frac{V_2}{5\ ml} \times \frac{100\ ml}{Sample\ volume} \times 100 \ldots 2$$

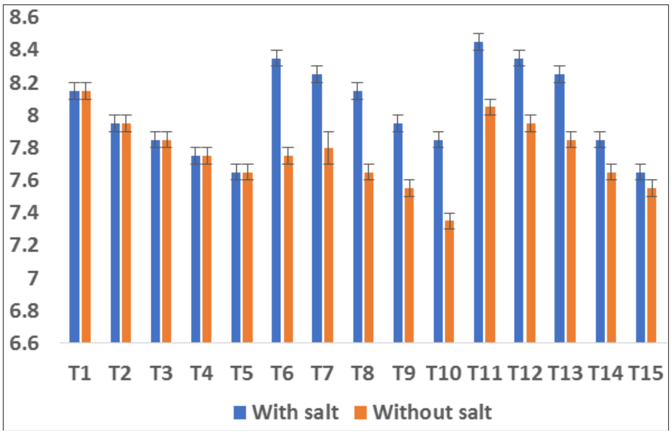
2.3.5 Antioxidants
Total antioxidant activity was determined by 2, 2' diphenylpicrylhydrazyl (DPPH) assay reported by (Zubia and Dizon 2019) and (Darsana, Bhosale Yuvraj *et al*. 2016) with slight modification. 300 µl of sample was taken and added with 4 ml of methanolic solution of DPPH with 0.004% concentration. The mixed solution was kept in dark for half an hour and absorbance was recorded at 517 nm against the reagent blank. Results were expressed in terms of the percent inhibition of free radicals and it was calculated by following equation:

$$\%\ Inhibition = \frac{(A_{blank} - A_{sample})}{A_{blank}} \times 100 \quad \ldots 3$$

Where A_{blank} was absorbance of DPPH radical in methanol and A_{sample} was absorbance of DPPH radical mixed with sample.

2.3.6 Total phenol content
By using Folin-Ciocalteu method, the total phenol content of sample was determined as reported by (Theagarajan, Malur Narayanaswamy *et al*. 2019) [14] with slight changes on procedure. 300 µl of juice was mixed with 1 ml of Folin-Ciocalteu reagent prepared 1:10 with distilled water and it was mixed vigorously. 1 ml of 10% Na_2CO_3 was added and final volume was made up to 5 ml with distilled water. The dispersion was left for half an hour at room temperature and absorbance was measured at 765 nm using UV–Vis Spectrophotometer (UV-1800, Shimadzu, Japan). The total phenol content was expressed as mg gallic acid equivalents per ml of juice.

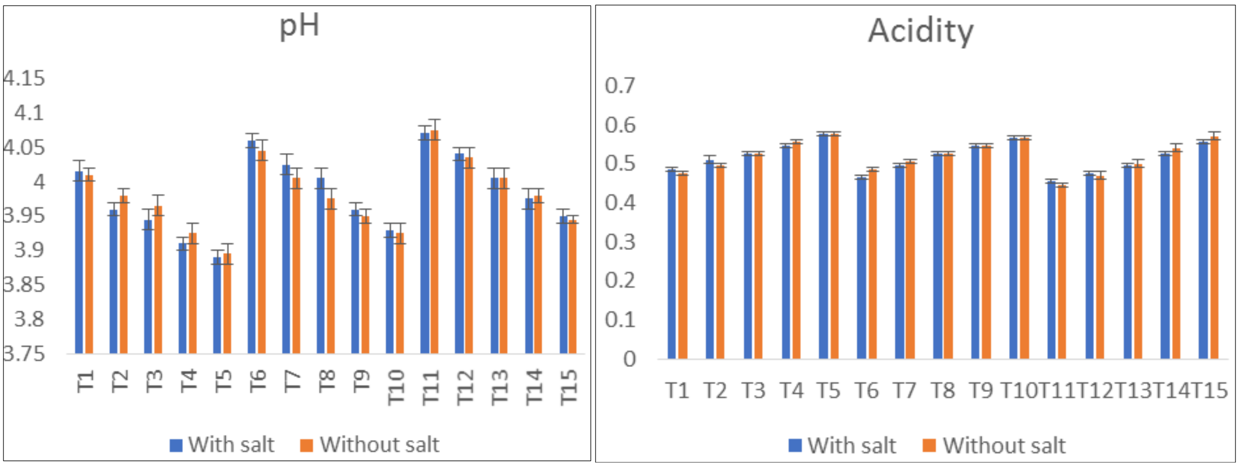
3. Result and Discussion
3.1 Total soluble solids
Observational data shows very negligible changes in TSS after carbonation. There is a decrease in TSS with the rise in pressure at constant temperature, (Aggarwal, Bajaj *et al*. 1992) [2] recorded that TSS remained the same with negligible changes in carbonated peach nectar. Kinnow juice carbonation has no major effect on the TSS of juice. Maximum TSS 8.15±0.07°Brix observed at 80 psi pressure and 4°C temperature in sample containing salt and without salt. Minimum value of TSS 7.65±0.07°Brix was observed for sample with salt at 120 psi and 8°C and found lowest for without salt sample 7.55±0.07°Brix at same processing conditions. TSS values for sample with salt and without salt found statistically non-significant. During thermal processing, complex polymeric carbohydrates break down into simple soluble sugars and this may be the explanation why total soluble solids in pasteurized juice kinnow juice increase (Margean, Lupu *et al*. 2020) [8]. Following graph shows the decrease in TSS-



T1-80psi & 4 °C, T2-90psi & 4 °C, T3-100psi & 4 °C, T4-110psi & 4 °C, T5-120psi & 4 °C, T6-80psi & 6 °C, T7-90psi & 6 °C, T8-100psi & 6 °C, T9-110psi & 6 °C, T10-120psi & 6 °C, T11-80psi & 8 °C, T12-90psi & 8 °C, T13-100psi & 8 °C, T14-110psi & 8 °C, T15-120psi & 8 °C

Fig 2: Effect of carbonation temperature and pressure on TSS

3.2 pH and acidity
Increased pressure induces reduced pH at each carbonation temperature, which is not significant, although with the rise in pressure, acidity shows significant changes. Effective carbonation is caused by increased pressure and shows more acidity supported by (SILER, MORRIS *et al*. 1993) [12] as they stated that carbonated juices produce higher titratable acidity and this rise in acidity was defined during titration with dissociation of carbonic acid. Maximum pH was observed at 80 psi pressure and 4°C temperature. Sample with salt had 4.015±0.02 and without salt sample had 4.01±0.01 which were non-significant. Minimum pH value for with salt sample was 3.95±0.01 and without salt sample contains 3.945±0.007 which was found non-significant at 120 psi pressure and 8 °C temperature. Vice-versa Acidity found lowest at 80 psi pressure and 4 °C temperature. For sample with salt, it was 0.485±0.007% and for without salt sample it was 0.475±0.007%. Highest acidity was found at 120 psi pressure and 8 °C temperature. For sample with salt it was 0.56±0.007% and sample without salt had 0.57±0.01% which were non-significant. pH and acidity of drink was represented graphically below-



(a) (b)

Fig 3: Effect of carbonation temperature and pressure on pH and Acidity

3.3 Ascorbic acid

As the carbonation pressure rises, the vitamin C content of kinnow juice was observed to decrease with minor variance. The headspace inside the bottle is packed with CO2, which inhibits ascorbic acid aerobic oxidation and maintains the stability of vitamin C (Zhao, Qin *et al*. 2018) [16]. Maximum retention of ascorbic acid was observed at 80 psi pressure and 4 °C temperature for sample with salt 34.63±1.16 mg/100ml and in sample without salt it was observed at 31.29±1.64 mg/100ml which are significantly different. Ascorbic acid found lowest during carbonation at 120 psi pressure and 8°C temperature, for sample with salt it was 24.48±0.95 mg/100ml and sample without salt it was found to be at 24.44±1.79 mg/100ml. Change in ascorbic acid was represented graphically below-

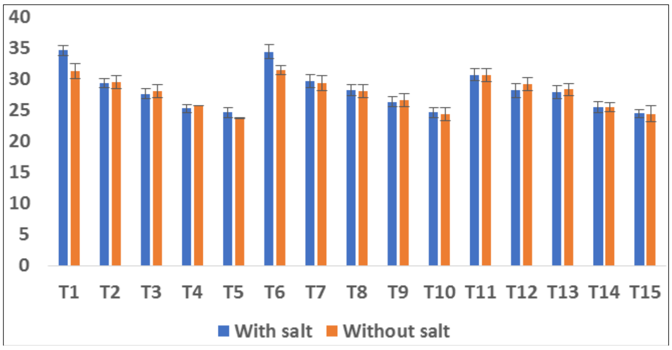


Fig 4: Effect of carbonation temperature and pressure on Ascorbic acid

3.4 Antioxidants

With the rise in pressure for carbonation, antioxidants appear to be decreased in the experiment. Oxidation of some bioactive ingredients such as vitamin C, carotenoids and phenolic compounds with the help of activation of certain enzymes, including peroxidase, polyphenol oxidase, may clarify this loss of antioxidant function after carbonation (De Ancos, Rodrigo *et al*. 2020) [5]. Maximum antioxidant activity was found at 80 psi pressure and 4 °C temperature. Sample with salt had 55.15±0.42% activity while sample without salt had 58.7±1.06% activity which is significantly different. Minimum activity was observed at 120 psi pressure and 8 °C temperature. For sample with salt it was at 43.3±1.37% and for sample without salt it was observed at 40.65±1.42% activity. Decrease with pressure in antioxidant activity was graphically represented below-

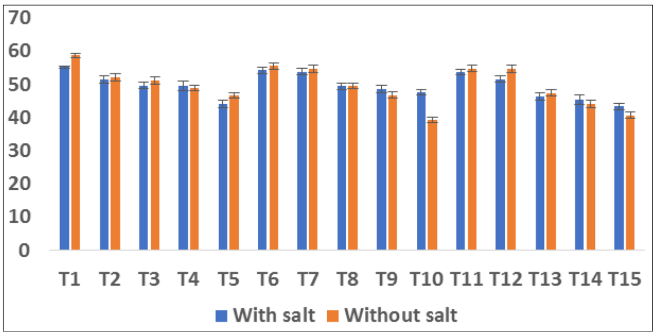


Fig 5: Effect of carbonation temperature and pressure on Antioxidants

3.5 Total Phenol

The dissolved CO2 can have an effect on enzymes because it helps to shift the ionic equilibrium and affect the activity under high pressure. Bubbling refers to enzyme inactivation during carbonation and de pressurization. These enzymes are responsible for reaction that cause the depletion of phenols (Zhao, Qin *et al*. 2018) [16]. Maximum retention of total phenol was observed at 80 psi pressure and 4 °C temperature for sample with salt 1.675±0.07mg/100ml and in sample without salt it was observed at 1.67±0.01 mg/100ml which are not significantly different. Total phenol found lowest during carbonation at 120 psi pressure and 8 °C temperature, for sample with salt it was 1.47±0.01 mg/100ml and sample without salt it was found to be at 1.43±0.02 mg/100ml.

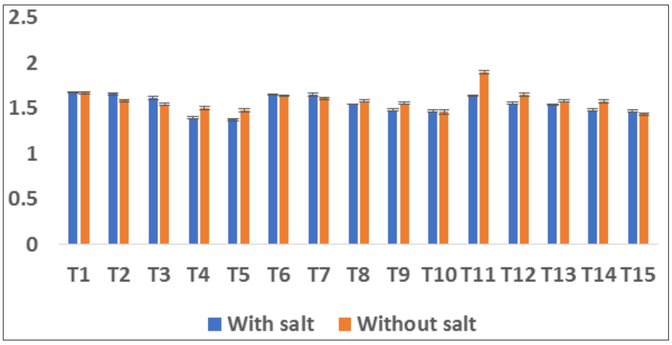


Fig 6: Effect of carbonation temperature and pressure on Total phenols

4. Conclusion

Carbonation of kinnow juice enhances the organoleptic properties with its mouth feel, tingling effect, imposes refreshing quality with healthy natural taste of fruit. The present study describes that the addition of salt into drink does not have significant effect on its palatability as well as its physicochemical and phytochemical parameters. After carbonation phytochemical properties showed good retention. Carbonation of fruits has further potential application and can be major part for replacing sugar based soft drink. Kinnow is the underutilized fruit, which has greater health benefits and nutrient-rich benefits. In this section, further scope is enriched carbonated kinnow drink with a variety of flavours to enhance consumer preference, which leads to increased demand for kinnow fruit to support farmers and processors 'economic status.

5. References

1. Agarkar BS *et al*. Preparation of carbonated sugarcane juice beverages blended with fruit juices. 2019;56(1):124-133.
2. Aggarwal P *et al*. Comparative studies on the suitability of Shan-i-Punjab and Flordasun peach varieties for processing 1992;8:77-80.
3. Azeredo DR *et al*. An overview of microorganisms and factors contributing for the microbial stability of carbonated soft drinks 2016;82:136-144.
4. Darsana K *et al*. effect of aril browning on Physicho-chemical properties of pomegranate 2016;5:1116-1126.
5. De Ancos B *et al*. Effect of high-pressure processing applied as pretreatment on carotenoids, flavonoids and vitamin C in juice of the sweet oranges' Navel'and the red-fleshed'Cara Cara' 2020;132:109105.
6. Eagerman B, Rouse AJJoFS. Heat inactivation temperature-time relationships for pectinesterase inactivation in citrus juices 1976;41(6):1396-1397.
7. Mahawar MK *et al*. Post-harvest processing and valorization of Kinnow mandarin (*Citrus reticulate* L.): A review 2019, 1-17.
8. Margean A *et al*. An overview of effects induced by pasteurization and high-power ultrasound treatment on the quality of red grape juice 2020;25(7):1669.
9. Mohapatra A *et al*. Physicochemical changes during ripening of red banana 2016;5(3):1340-1348.
10. Rajeev G *et al*. A time based objective evaluation of the erosive effects of various beverages on enamel and cementum of deciduous and permanent teeth 2020;12(1):e1.
11. Ranganna S. Handbook of analysis and quality control for fruit and vegetable products, Tata McGraw-Hill Education 1986.
12. Siler A *et al*. Quality effects of carbonation and ethyl maltol on venus and concord grape juices and their grape-apple blends 1993;44(3):320-326.
13. Solanke ND *et al*. Study on effect of carbonation on the properties of fruit juices 2017;4:2426-2432.
14. Theagarajan R *et al*. Valorisation of grape pomace (cv. Muscat) for development of functional cookies 2019;54(4):1299-1305.
15. Verma SJIJCMAS. Fruit Based Carbonated Soft Drinks for Nutritional Security and Value Chain Development– A Review 2018;7(11):3084-3095.
16. Zhao L *et al*. Novel application of CO2-assisted high pressure processing in cucumber juice and apple juice 2018l;96:491-498.
17. Zubia C, Dizon EJIFRJ. Physico-chemical, antioxidant and sensory properties of artificially-carbonated fruit wine blends 2019;26(1):217-224.