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Comparison of Different Preservation Techniques on Quality Storability of Sugarcane Juice

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ABSTRACT

Sugarcane juice is also an important component in the beverage industry. Different pre-treatments such as conventional heating, Ohmic heating, UV treatment Ozone and nisin treatments were adopted to check the quality of sugarcane juice. The study results revealed keeping PPO inactivation, colour change and microbial reduction of the treated samples into consideration, ohmic heating of sugarcane juice at 70 ^{0}C for 3 min holding time was found to be optimum. Hence, highest microbial reduction was observed in ohmic heating treatment. So, the thermal treatments were observed to be having more microbial reduction potential as compared to the non-thermal treatments. The overall acceptability score of sugarcane juice was highest in ohmic heated sample followed by nisin treated sample

Key words: *Sugarcane, Ohmic Heating, UV-C Treatment, Ozonation, Nisin*

INTRODUCTION

Sugarcane juice is also an important component in the beverage industry. Due to the high sugar content in sugarcane, fresh sugarcane juice undergoes fermentation immediately after extraction and also turns brown as a result of polyphenol oxidase activity. All these negative changes limit the processing and marketing of sugarcane juice. Conventional heat processing imparts the taste of jaggery and the delicate flavour of juice is adversely affected. Polyphenol oxidase is the major enzyme involved in the discoloration of sugarcane juice which can be improved by heat inactivation of enzyme. Addition of citric acid or ascorbic acid to juice also gave good pleasant dull orange colour to juice. Addition of lemon and ginger followed by pasteurization and preservation with sulphur dioxide also reduced physico-chemical changes during storage of ready-to-serve bottled sugarcane juice. However enzymatic browning and spoilage by microorganisms due to the presence of simple sugar after extraction are responsible for its short shelf life. So preservation of sugarcane juice for long period for trading to the consumer is a great challenge. The juice can be marketed as delicious beverages by preventing the spoilage of juice using appropriate methods. Over the years, sugarcane juice has been investigated for its shelf life by blending it with curd, lime juice and other preservatives[17].

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Pasteurization at 80-90^{0}C is mostly used for preservation of sugarcane juice by inactivating the microbes and enzymes. Thermal processing causes off-flavor development and discoloration in the processed juice. Ohmic heating has gained wide popularity as an alternate thermal treatment as it causes volumetric heating of the sample which leads to consistent and rapid heat generation in liquid foods. Ohmic treatment was found to inhibit PPO enzyme activity in a shorter processing time than conventional treatment. The influence of acidity on ohmic heating compared to conventional heating for inactivation of food-borne pathogens in orange juice. They observed that the overall quality of orange juice subjected to ohmic heating was not greatly affected at any pH level. Therefore, increasing pH can also be considered effective ways to optimize pasteurization of orange juice when using ohmic heating.In recent times, a great deal of interest has been shown by the food industry and academia towards the development of alternative food processing technologies that utilize minimal heat treatment or preservatives. The increase in consumer demand for fresh products has induced research in non-thermal preservation techniques, which effect minimal losses in the organoleptic properties of products. In 2000, the FDA approved UV-light as alternate treatment to thermal pasteurisation of fresh juice products. UV light has considerable promise to reduce the levels of microbial contamination for a wide range of liquid foods and beverages[18]. Ozone is an effective sanitizer with strong disinfecting properties. Ozone rapidly decomposes into oxygen leaving no toxic residues making it environmental friendly[38]. There are a number of food preservatives but those of natural origin such as nisin seem more attractive. Nisin is a bacteriocin produced by Lactococcuslactis subsp. lactis which is synthesized ribosomally and has abroad spectrum of antibacterial activity against microbial foodborne pathogens and spoilage organisms.

MATERIAL AND METHODS

Preparation of sugarcane juice

Fresh sugarcane was used for the extraction of sugarcane juice. Sugarcane stems were washed then the stems were peeled and Sugarcane juice were extracted by motor grinder (Make: Krishna) filtered through the sieve and muslin cloth to remove the extraneous matter and obtain a clear filtrate which was used for the study.

Application of different preservation techniques

Ohmic heating of sugarcane juice

The ohmic heating of sugarcane juice was carried out at 70°C(48 V/cm) electric field strengths. The sample was placed in the chamber and connected to the electrical circuit. A digital temperature indicator was used to record and maintain the temperature of the sugarcane juice during treatment. The samples were heated and held at 70^{o}C for 1, 2 and 3 min holding time during ohmic heating (Fig. 1).The samples were stored in sterilized HDPE bottle for further analysis.

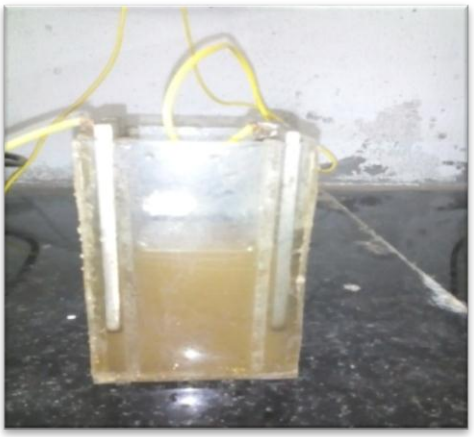

Fig. 1: Ohomic Heating set up

UV-C treatment

Development of UV-C treatment set up

A UV treatment set up was developed for conducting the experiment on sugarcane juice . Three UV treatment barrels fitted with 6 W lamp (which are used in normal water purifiers) were connecting in series and fixed on a vertical stand. A water pump (18 W) was connected for circulating the sugarcane juice through the unit.

UV-C treatment of sugarcane juice

About 2 lit of sugarcane juice were taken in a stainless steel feed tank and the juice was pumped through the UV treatment barrel. The juice was recirculated and treated for the required time period of 10, 20 and 30 min. The UV treatment doses were found to be 5.4, 10.8 and 16.2 J/ml. The treated samples after the desired time period was collected and stored in HDPE bottle for further analysis and storage.

Ozone treatment

An Ozonator (Kent Make) having ozone generation rate of 200 mg/h from air through pulse corona discharge and 13 W dissipation energy was used for the study. It was operated by 230 V electricity.About 500 ml of sugarcane juice was taken in a glass beaker and the ozone discharge head was inserted to it with constant shaking. The ozonator was tuned on and the ozone from the head was allowed to bubble through the juice. Samples of juice were collected after 10, 20 and 30 min ozone exposure time and packed in sterile HDPE bottle for further analysis and storage. The ozone treatment dose was calculated to be 0.066, 0.133 and 0.199 mg/ml for 10, 20 and 30 min exposure.

Nisin treatment

About 200 ml of sugarcane juice was taken in a beaker and mixed thoroughly with accurately weighed amount of nisin at three different rates of 12, 20 and 28 mg for 60, 100 and 140 ppm treatment level. The treated sample was analyzed and packed in sterilized HDPE bottle for further analysis during storage.

Storage study

Samples processed by different treatments were packed in sterile HDPE bottle and stored under refrigerated conditions of storage for 20 days. The physico-chemical and microbial parameters of the stored sugarcane juice were conducted at 5 days storage interval for assessment of shelf life by different preservation techniques.

Determination of quality parameters

Polyphenol oxidase (PPO) enzyme assay

The assay of the enzyme was carried out as described by Ozoglu and Bayindirli[27] .One ml of 0.2 mol/L Catechol solution was added to mixture of 0.5 ml of sugarcane juice and 2 ml of phosphate buffer (pH 6.5). The absorbance was measured at 420 nm at every 1 min interval by spectrophotometer (Make: Systronics; Model: 106). The enzyme activity was estimated from the linearportion of the curve of absorbance v/s time. One unit of PPO activity was defined as 0.001A420/min. Enzyme activity was expressed in U/mL with one unit equivalent to a variation of 0.001 absorbance per minute per mL of sample. The equation 1 was applied to calculate the enzyme activity:

$$Activity(U/ml) = \frac{(Ab_{sample} - Ab_{blank})}{0.001 \times t} \qquad (1)$$

Where Ab_{sample} is the sample absorbance; Ab_{blank} is the blank absorbance; and t the incubation time of sample with reagents (min).

The activity of the samples was expressed as % Residual PPO Activity (RA) as given in Eq. (2):

$$\% RA = \frac{\text{Current Enzyme Activity}}{\text{Initial Enzyme Activity}} \times 100 \qquad \text{----------(2)}$$

Physicochemical tests

Physico-chemical parameterssuch as Hunter colour value, total soluble solid (TSS), titrable acidity, reducing sugar content of treated sugarcane juice were performed as determined by AOAC International[1].

TSS

The total soluble solids content of sugarcane juice (expressed as °Brix) was determined using portable digital refractometer (Make: ATAGO. Model: REF113).

Measurement of color

Colour of the sugarcane juice samples was measured by colour reader CR-20 (Konica Minolta, INC, Japan). The total color change (ΔE) was calculated using Eq 3.[2] L_0, a_0 and b_0 are the colour values of control sample.

$$\Delta E = \sqrt{(L - Lo)^2 + (a - a0)^2 + (b - bo)^2} \quad \text{------ (3)}$$

Titrable acidity

Titrable acidity was estimated by y manual titration (AOAC, 1995) and was calculated as percent titrable acidity by Eq. (4).

$$\text{Acidity, \%} = \frac{\text{Eq.wt.of acid} \times \text{Titre value} \times \text{Normality of NaOH}}{10 \times \text{vol. of sample taken}} \quad \text{----- (4)}$$

Reducing sugar content

Reducing sugar content was determination by DNS (Dinitro salicylic Acid) method. And also were analysed by the method[23] using glucose as the standard reducing sugar and dinitrosalicylic acid as the developer.The amount of reducing sugar present in the sample was determined from the standard curve.

Microbiological tests

The sugarcane juice samples was analysed for their commercial sterility. Total Plate Count (TPC) was determing using Nutrient Agar (NA) after incubation, and for 48 h at 30°C. Yeast and molds (YMC) were estimated with the help of acidified potato dextrose agar (PDA) .TPC and YMC were counted in series dilution method. Results were expressed as colony forming units per milliliter.

The unit for calculation is **CFU= (Number of colony ×dilution factor)/volume plated in mL**

Sensory tests

Sensory evaluation of sugarcane juice processed by different treatments was carried out, using a nine-point hedonic scale, as described by Dutcosky[9]. The attributes like colour, flavour and taste were evaluated by 10 panelists and consumers. The juice was served at a temperature of about 12°C. The overall acceptability of sugarcane juice was calculated by composite scoring giving 40, 20 and 40% weightage to colour, flavour and taste score.

Statistical analysis

The experimatal data were analysed by Analysis of variance (ANOVA) using MS EXCEL 2007at 5% confidence level for comparison.

RESULTS AND DISCUSSION

Ohmic heating

Effect processing conditions on quality of sugarcane juice

The effect of different processing temperature and time on residual PPO activity (% RA), colour change, titrable acidiy, reducing sugar content, TSS and total plate count during ohmic heating of sugarcane juice with 48 V/cm field strength is shown in Table 1. It was observed that residual PPO activity decreased significantly ($p<0.05$) with increase in treatment temperature and processing time during ohmic heating. The residual PPO activity was less with less colour change in ohmic heated samples treated with 70^0 C for 3 min holding time. At higher temperature and holding time the colour change was observed to be more. The reducing sugar and titrable acidity were not changing significantly and the slight increase may be attributed to some biochemical processes that might have been accelerated by the treatment. The TSS increased with processing temperature which might be due to evaporation of water by thermal effect during ohmic heating. Saxena reported that higher field strength of 48 V/cm resulted in a significant reduction in % RA and higher degree of microbial reduction probably due to the combined effect of heat as well as electric current.So keeping PPO inactivation, colour change and microbial reduction of the treated samples into consideration, ohmic heating of sugarcane juice at 70 ^{0}C for 3 min holding time was found to be optimum.

Table 1: Physico-chemical and microbial properties of sugarcane juice at different processing temperature and time during ohmic heating at 48 V/cm

Ohmic heating Temperature (^{0}C)	Holding time (min)	RA%	Colour change	Titrable acidity (g/100ml)	Reducing sugar (g/100 ml)	TSS (^{0} Brix)	TPC (log cfu/ml)
70	1	69.1±2.3	3.2±0.2	0.136±0.004	0.463±0.004	19.2±0.3	4.70±0.009
	2	49.42±2.2	3.6±0.2	0.132±0.002.	0.468±0.005	19.4±0.31	4.61±0.008
	3	**21.4**±2.1	**4.2**±0.3	**0.130**±0.001	**0.462**±0.004	**19.7**±0.4	4.25±0.003
Control				0.130±0.008	0.460±0.007	18.1±0.4	6.30±0.009

Other non-thermal methods

The effect of different non-thermal treatments on residual PPO activity (% RA), colour change, titrableacidiy, reducing sugar content, TSS and total plate count is shown in Table 2. No significant change in residual PPO activity, titrable acidity, reducing sugar, TSS and total plate count were observed at different doses of UV-C, Ozone and Nisin treatment. However, colour change was found to be more in ozone and less in nisin treatment. The variations of these parameters were found to be insignificant with treatment dose. So, the highest dose of UV-C (16.2 J/ml), ozone (0.199 mg/ml) and nisin treatment (140 ppm) taken in the study were accepted as the optimum treatment.Kaya and Unluturk[16] reported that soluble solids and pH of grape juice samples were not affected by UV-C treatment and the colour did not show visual difference compared to the untreated sample. Sew showed that proteolytic activity were affected by mild heat treatment but not with UV dosage. Silva studied the combination effect of ozone and heat treatment on sugarcane juice and reported that use of ozone in clarification of sugarcane juice is a viable alternative as ozonation reduces the colour indexes and turbidity significantly. Ozonation did not change the pH, TSS and RS content of sugarcane juice. Ozone reacts with the organic components of sugarcane juice as an electrophilic or nucleophilic agent and the reaction was with unsaturated compounds such as alkynes and aromatic rings. Bi studied the inactivation of E. Coli by high pressure carbon dioxide combined with nisin and reported that inactivation rate increased in the presence of nisin with shortening of time for complete inactivation and acid solution dissolving nisin played a prominent role in the combination effect.

Table 2: Physico-chemical and microbial properties of sugarcane juice treated with different non-thermal processing methods

Treatment	Dose	RA%	Colour change	Titrable acidity (g/100ml)	Reducing sugar (g/100 ml)	TSS (^{0} Brix)	TPC (log cfu/ml)
UV-C treatment (J/ml)	0.54	61.5±2.2	4.09±0.3	0.131±0.004	0.461±0.003	18.2±0.2	5.95±0.09
	10.8	60.5±2.2	4.40±0.3	0.128±0.003	0.465±0.005	18.5±0.3	5.86±0.08
	16.2	58.1±2.1	4.10±0.3	0.131±0.004	0.469±0.009	18.4±0.2	5.73±0.07
Ozone treatment (mg/ml)	0.067	68.5±2.8	5.8±0.5	0.134±0.005	0.468±0.008	18.4±0.2	6.02±0.09
	0.133	66.2±2.6	5.5±0.4	0.132±0.004	0.465±0.005	18.7±0.4	5.96±0.09
	0.199	63.1±2.2	5.41±0.3	0.134±0.005	0.463±0.004	18.8±0.4	5.92±0.08
Nisin treatment (ppm)	60	63.1±2.2	2.30±0.1	0.130±0.003	0.467±0.007	18.2±0.1	5.90±0.08
	100	58.2±2.1	2.45±0.1	0.138±0.008	0.465±0.004	18.3±0.1	5.74±0.06
	140	55.0±2.0	2.2±0.1	0.138±0.008	0.465±0.004	18.2±0.1	5.64±0.05
Control				0.130±0.006	0.460±0.005	18.1±0.3	6.30±0.09

Comparison of different thermal and non-thermal treatments

The comparison of different thermal and non-thermal method of preservation on physico-chemical and microbial quality of sugarcane juice is presented in Table 3 and Fig. 2 through Fig.8 The residual PPO activity was found to be less i.e. 19.4 % in ohmic heating treatment at 70^{o}C for 3 min holding time which was probably due to the combination of both electrical and thermal effect. However, highest colour change was observed in ozone treated sample due to clarification of juice during the treatment. Torres *et al*.[22] reported that apple juice samples were observed to be lighter in colour with increased L and b value and distinct overall colour change indicating major changes in appearance of apple juice colour during ozonation. Tran and farid[40] reported that UV processing does not inactivate enzyme pectin methylestearase and conventional UV treatment used for water treatment can not be used for treating juices which were opaque to UV due to the presence of high suspended solids in them. Soluble solids, pH and titrable acidity values of pomegranate juice did not change significantly after UV-C and heat treatment compared to untreated sample . The titrable acidity and reducing sugar value did not change significantly among different methods. TSS of thermally treated samples was higher compared to the non-thermal methods. Highest microbial reduction was observed in ohmic heating treatment followed by conventional heating treatment. So, the thermal treatments were observed to be having more microbial reduction potential as compared to the non-thermal treatments. The lower value of microbial reduction in UV-C (16.2 J/ml), Ozone (0.199 mg/ml) and Nisin (140 ppm) treatment was probably due to the lower dose of treatments taken in the present study as against 37.4 -62.3 J/ml UV-C treatment to pomegranate juice[28] 0.23 mg/ml ozone3treatment to orange juice and 100-400 ppmnisin in different studies for cucumber, carrot and cantaloupe juice[34,44]. The overall acceptability score of sugarcane juice was highest in ohmic treated sample followed by nisin treated sample. The conventional heated sample and ozone treated samples were not accepted by the sensory panel. The effect of nisin may not be prominent in the study as the solubility and stability of nisin increases with lowering of pH in the range of 2.0-3.0. Zhao *et al.*[44] observed that nisin with high pressure processing or thermal pasteurization had a synergestic effect on the inactivation of total aerobic bacteria. Sarkar *et al*.[34] found that use of emulsion greatly reduce the proteolytic degradation of nisin leading to prolonged antibacterial efficacy.

Table 3: Comparison of quality parameters of sugarcane juice obtained from different thermal and non-thermal treatments

Treatment	RA%	Colour change	Titrable acidity (g/100ml)	Reducing sugar (g/100 ml)	TSS (^{0} Brix)	TPC (log cfu/ml)	Composite Overall acceptability score
Control	100±3.0	**0**	0.130±0.001	0.460±0.004	18.1±0.3	6.3±0.09	7.96±0.32
OH (70^{0}C 3 min)	19.4±2.1	4.2±0.3	0.130±0.001	0.462±0.004	19.7±0.4	4.25±0.003	7.16±0.28
UV-C (16.2 J/ml)	58.1±2.1	4.10±0.3	0.131±0.004	0.469±0.009	18.4±0.2	5.73±0.07	6.96±0.29
Ozone (0.199 mg/ml)	63.1±2.2	5.41±0.3	0.134±0.005	0.463±0.004	18.8±0.4	5.92±0.08	6.76±0.26
Nisin (140 ppm)	55.0±2.0	2.2±0.1	0.138±0.008	0.465±0.004	18.2±0.3	5.64±0.05	7.08±0.3

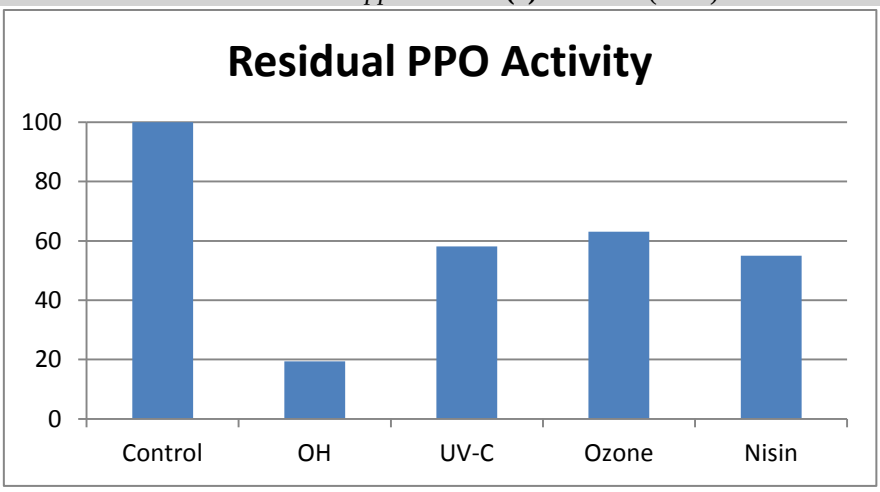

Fig. 2: Effect of different processing methods on residual PPO activity of sugarcane juice

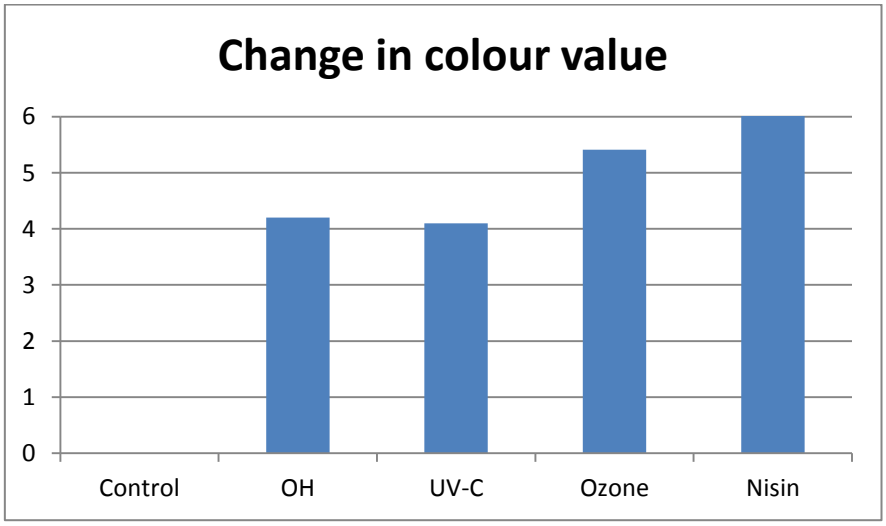

Fig. 3: Effect of different processing methods on change in colour of sugarcane juice

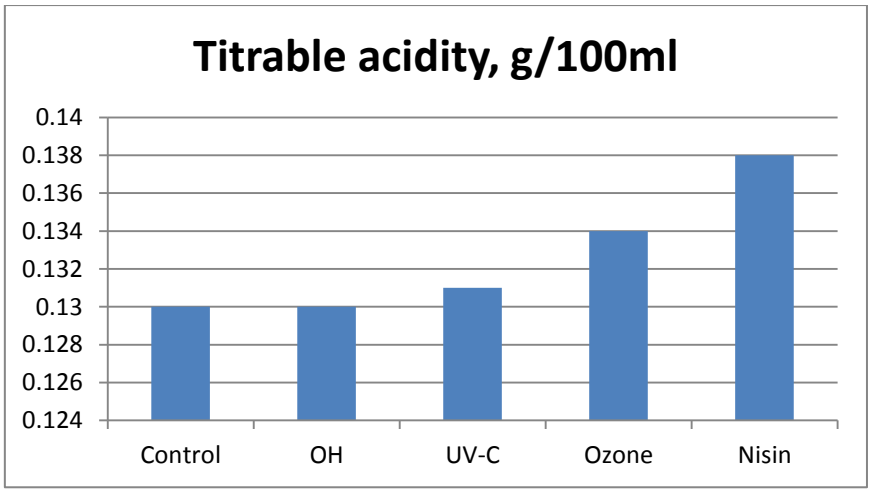

Fig. 4: Effect of different processing methods on titrable acidity of sugarcane juice

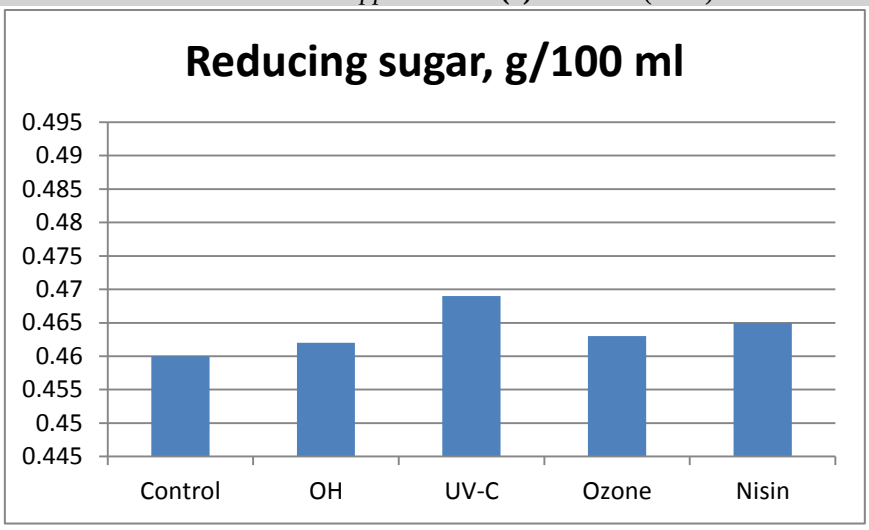

Fig. 5: Effect of different processing methods on reducing sugar of sugarcane juice

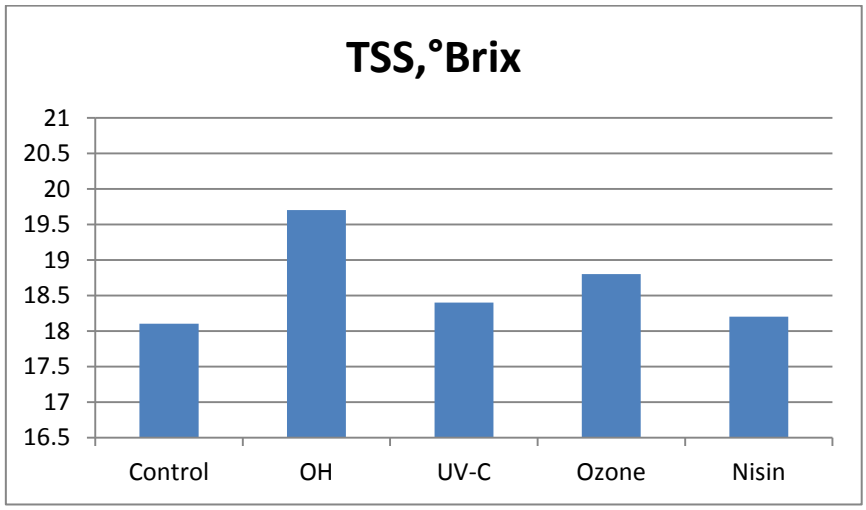

Fig. 6: Effect of different processing methods on total soluble solidof sugarcane juice

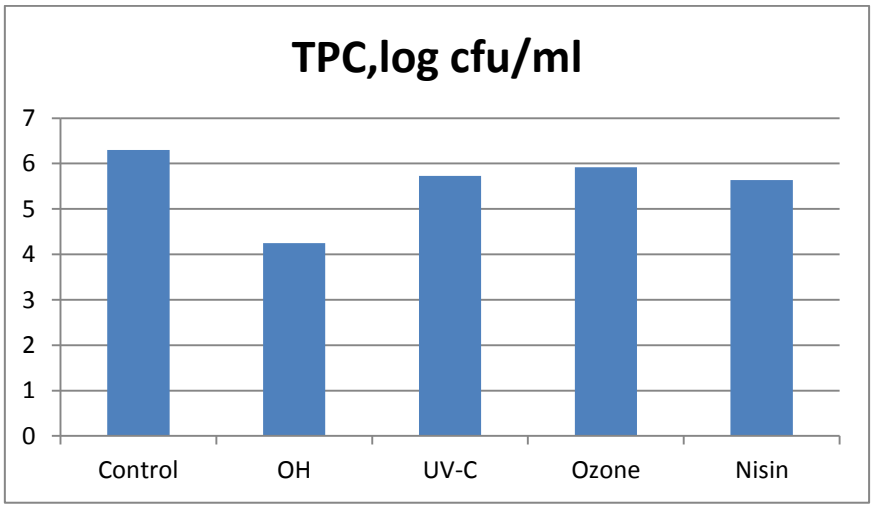

Fig. 7: Effect of different processing methods on total plate count of sugarcane juice

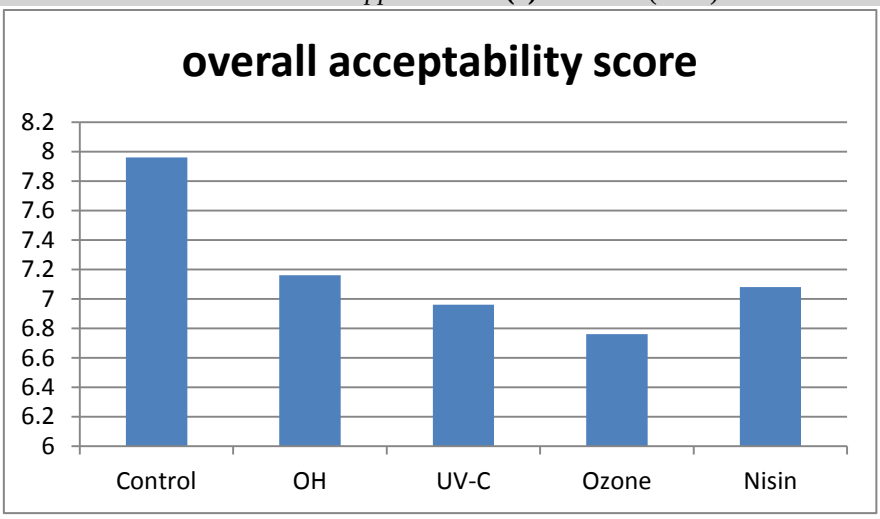

Fig. 8: Effect of different processing methods on overall acceptability score of sugarcane juice

Storage study

The sugarcane juice treated with different methods at optimum dose was stored in sterile HDPE bottle under refrigerated condition. The quality parameters such as titrable acidity, reducing sugar, colour change and microbial load of the samples were determined after 5 days interval.

Titrable acidity

The TA of sugarcane juice increased significantly ($p < 0.05$) with storage period (Fig. 9). The TA of untreated and UV-C treated juice increased from 0.13 to 1.43 which might be due to the conversion of sugar. The increase in TA of ohmic heated sample from 0.13 to 0.78 g/100 ml was less among all the treatments indicating better storability (Table 4). The acidity of ohmic heated juice increased to 0.37 after 10 days of storage under ambient condition with acceptable odour.

Table 4: Titrable acidity (g/100 ml)of sugarcane juice treated with different methods during storage

Treatments	Storage period, days				
	0	5	10	15	20
Control	0.13±0.004	0.55±0.004	0.86±0.005	1.13±0.008	1.43±0.008
OH	0.130±0.004	0.23±0.005	0.36±0.004	0.56±0.005	0.78±0.004
UV-C	0.13±0.004	0.37±0.006	0.56±0.004	0.86±0.007	1.21±0.008
Ozone	0.134±0.005	0.34±0.006	0.49±0.003	0.69±0.006	0.98±0.007
Nisin	0.138±0.005	0.36±0.006	0.51±0.004	0.79±0.007	1.01±0.007

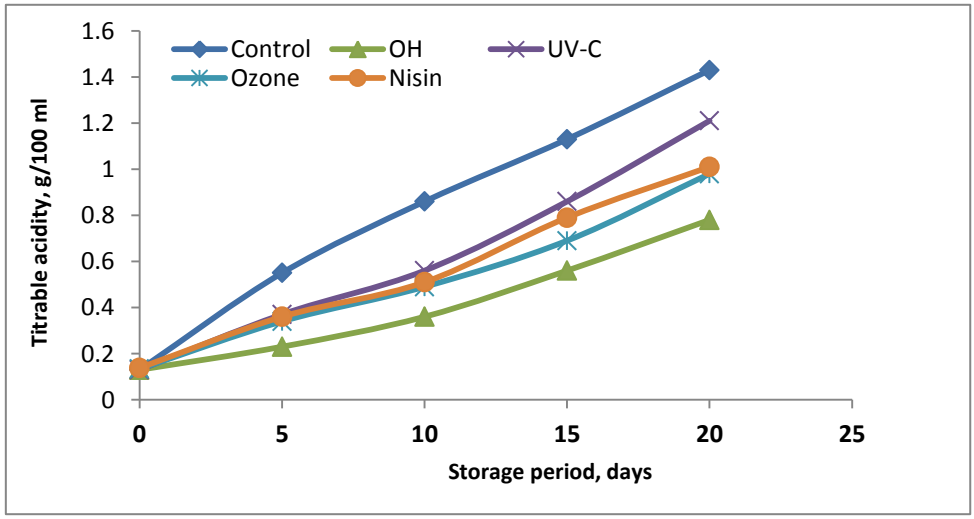

Fig. 9: Change in titrable acidity of sugarcane juice processed by different treatments during storage

Reducing sugar

The RS content for untreated juice increased significantly ($p < 0.01$) from 0.46 to 0.66 after 20 days of storage (Table 5 and Fig. 10). The increase was less in thermal treated and nisin treated sample indicating the effect of heat and preservative on decrease in microbial activity. Increase in reducing sugar during storage of sugarcane juice was also reported by Saxena. The increase in reducing sugar during storage was probably due to the action of dextransucrase on sucrose releasing RS molecule.

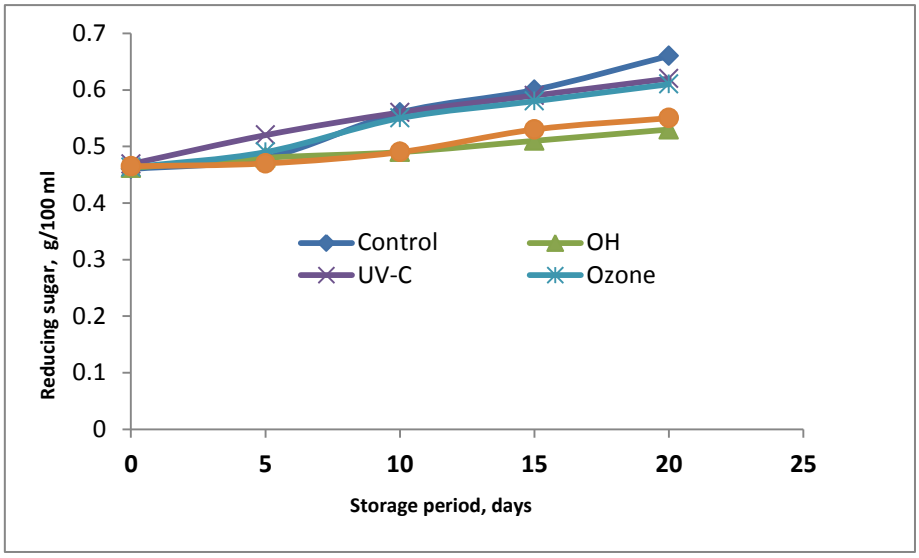

Fig. 10: Change in Reducing sugar of sugarcane juice processed by different treatments during storage

Table 5: Reducing sugar content (g/100 ml) of sugarcane juice treated with different methods during storage

Treatments	Storage period, days				
	0	5	10	15	20
Control	0.460±0.004	0.48±0.005	0.56±0.006	0.60±0.007	0.66±0.009
OH	0.462±0.004	0.48±0.005	0.49±0.005	0.51±0.004	0.53±0.004
UV-C	0.469±0.004	0.52±0.007	0.56±0.004	0.59±0.006	0.62±0.008
Ozone	0.463±0.003	0.49±0.006	0.55±0.005	0.58±0.006	0.61±0.008
Nisin	0.465±0.005	0.47±0.005	0.49±0.005	0.53±0.005	0.55±0.007

Change in colour

The change in colour during storage of sugarcane juice treated with different processing conditions is given in Table 6. The colour change was found to be more in heat treated samples i.e. ohmic heatingas compared to non-thermal treated samples (Fig. 11). Thedifference in colour change value of UV-C and nisin treated samples was not significant as compared to control sample. The higher colour change in thermal treated samples was probably due to non-enzymatic browning and formation of viscous jelly like substance called dextran by the action of enzyme.

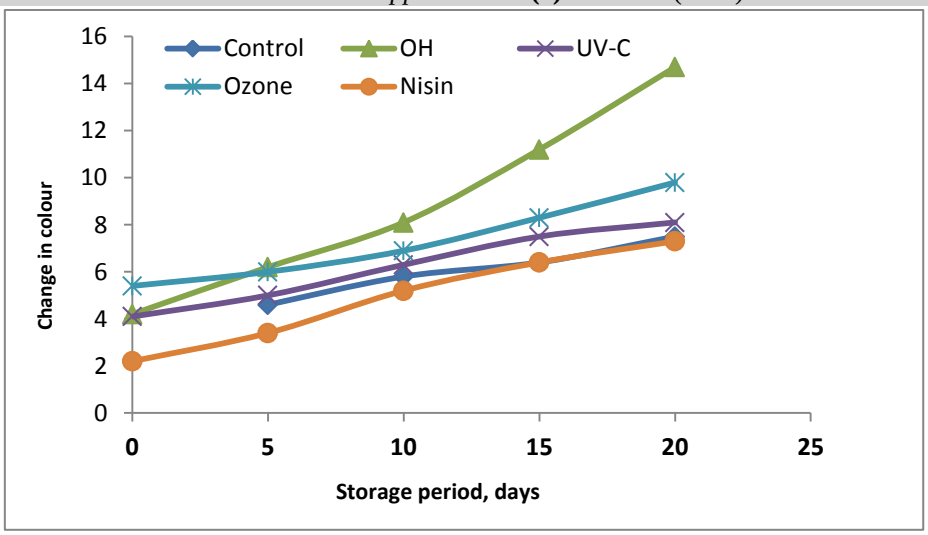

Fig. 11: Change in Change in colour of sugarcane juice processed by different treatments during storage

Table 6: Colour change value of sugarcane juice treated with different methods during storage

Treatments	Storage period, days				
	0	5	10	15	20
Control		4.6±0.3	5.8±0.38	6.4±0.47	7.5±0.49
OH	4.2±0.2	6.2±0.33	8.1±0.41	11.2±0.47	14.7±0.5
UV-C	4.1±0.22	5.0±0.35	6.3±0.42	7.5±0.49	8.1±0.49
Ozone	5.4±0.24	6.0±0.36	6.9±0.44	8.3±0.49	9.8±0.5
Nisin	2.2±0.26	3.4±0.38	5.2±0.44	6.4±0.5	7.3±0.48

Microbial load

The microbiology parameters were investigated to observe the quality of thermal as well as non-thermal treated samples. Total plate count (TPC) value increased significantly ($p<0.05$) with storage period. The increase was highest in control sample and lowest in ohmic heated sample (Fig. 12). The microbial count in control sample increased from 6.3±0.06 to 7.23±0.088 after 20 days of storage under refrigerated storage (Table 7). Ohmic heated sample could be stored up to 10 days having TPC value less than 10^5.The mechanism of microbial destruction by heat is well known and higher degree of inactivation by OH treatment was due to the combined effect of heat as well as electric current. Microbial inactivation by electric field has been reported to be majorly by electroporation[41]. but some researchers have also suggested the formation of microbicidal agents such as chlorine, hydrogen peroxide etc., due to electric discharge in liquid media, that alter the DNA and cytoplasmic activity of the cells[13].It is noteworthy that the growth of aerobic microbes remained insignificant for UV-C, ozone and nisin treated samples after 20 days of refrigerated storage.

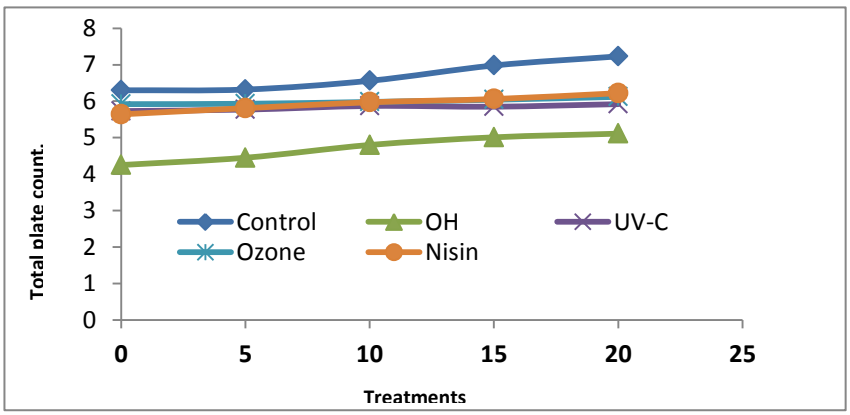

Fig. 12: Change in Microbial Load of sugarcane juice processed by different treatments during storage

Table 7 Total plate count (log cfu/ml) of sugarcane juice treated with different methods during storage

Treatments	Storage period, days				
	0	5	10	15	20
Control	6.30±0.06	6.32±0.07	6.56±0.079	6.98±0.08	7.23±0.088
OH	4.25±0.064	4.45±0.077	4.80±0.078	5.01±0.084	5.11±0.089
UV-C	5.73±0.064	5.77±0.078	5.87±0.077	5.85±0.086	5.92±0.090
Ozone	5.92±0.066	5.93±0.079	5.98±0.077	6.04±0.087	6.12±0.090
Nisin	5.64±0.067	5.81±0.077	5.97±0.08	6.06±0.081	6.22±0.088

CONCLUSIONS

PPO activity decreased significantly with increase in treatment temperature and processing time during ohmic heating. The reducing sugar and titrable acidity were not changing significantly during ohmic heating..Ohmic heating of sugarcane juice at 70 ^{0}C for 3 min holding time was found to be optimum. No significant change in residual PPO activity, titrable acidity, reducing sugar, TSS and total plate count were observed at different doses of UV-C, Ozone and Nisin treatment. However, colour change was found to be more in ozone and less in nisin treatment.The residual PPO activity was found to be less i.e. 19.4 % in ohmic heating treatment at 70^{o}C for 3 min holding time. TSS of thermally treated samples were higher compared to the non-thermal methods. Highest microbial reduction was observed in ohmic heating treatment.The overall acceptability score of sugarcane juice was highest in ohmic heated sample followed by nisin treated sample. The ozone treated samples were not accepted by the sensory panel.The titrable acidity, reducing sugar, colour change and microbial load increased with storage period in all the treatments under refrigerated storage at 4^{o}C and the increase was more in control sample.The acidity of ohmic heated juice increased to 0.37 after 10 days of storage under ambient condition with acceptable odor. Ohmic heated sample could be stored up to 10 days having TPC value less than 10^5.

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