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RESEARCH ARTICLE

Physiochemical and rheological characteristics of sorbitol based low sugar cherry jam

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ABSTRACT

Production of low – sugar cherry jam was investigated by substituting sucrose with sorbitol in different ratios. The treatments were 101 (100% sucrose), 102 (100% sorbitol), 103 (75% sorbitol), 104 (50% sorbitol) and 105 (25% sorbitol). All the five treatments were examined for physicochemical properties, sensory properties and rheological properties. The TSS and pH observed were in the range of 66.43-66.46°B and 3.3.49-3.51 respectively in different treatments while as acidity calculated in these treatments were maximum in sample 102 and minimum in101. Color parameters showed that lightness and yellowness increases in the range of 22-36 and 31-37 while as redness decreases in the range of 18-14. Rheological properties of cherry jam were evaluated by using rheometer that showed the G′ value is higher than G″ value which indicates that the jam with different sorbitol concentrations shows more elastic behavior. However, viscosity decreases with increase in shear rate. Also, organoleptic characteristics like (Flavour, taste, texture, color and appearance) were examined by trained panellist using 9-points Hedonic Scale. It was observed that the organoleptic score of the sample 103 was the highest.

Keywords: Cherry, sorbitol, rheology, physical attributes, sensory evaluation

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INTRODUCTION

The most crucial Ingredients in the human diet are fruits and fruit products as their nutritive value is high and contains functional ingredients which are very important and beneficial for human health (Liu et al., 2011; Martin et al., 2002) Cherry is a fruit which belongs to the Rosacea family. Reports given by (Food and Agriculture Organisation, in 2011) stated that the total production of cherry around the world was about 2.2 million tonnes. J&K is the main producer of cherry as 95% of worlds production is alone supplied by J&K (Anonymous, 2018). Cheery is nutritionally rich fruit and is also rich in functional ingredients important for human health (Usenik et al., 2008; Serra et al., 2010; Usenik et al., 2010; Liu et al., 2011; Serradilla et al., 2011; Ballistreri et al., 2013). Cherry is a highly perishable fruit therefore huge quantities of cherry fruit is lost due to lack of efficient post harvest system, however at the same time loss can be minimized by converting cherry into different cherry products like cheery jam, cherry juice and other related products (Ahmad et al., 2013). The most common fruit preservation is conversion of fruit into jam (Kansci et al., 2003.Nowadays the main problematic diseases associated with people are diabetes, obesity and metabolic syndromes in order to avoid above mentioned diseases consumers prefer low sugar food products M. (Krystyjan et al., 2015). Thus, jams having low sugar content or the jams in which sweeteners (e.g. sorbitol, xylitol, or steviol glycosides) instead of sucrose are used are in great demand nowadays (DeSouza et al., 2013). It well known fact that

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consistency behavior of the fruit products are mainly affected by the amount of ingredients especially sugar, gelling agent, type of fruit and processing temperature (Glicksman and Farkas, 1966; Saravacos, 1970). Nowadays consumers are apprehensive about the quality attributes of processed food product therefore it is necessary to have understanding of physicochemical changes and rheological parameters as processing can modify the characteristic parameters of processed product (Nindo et al., 2007). Keeping in consideration the above facts the study was undertaken with the following objectives: Preparation and Characterization of sorbital cherry jam, to study the Rheological characteristics of sorbitol substituted cherry jam and effect of sugar: sorbitol Concentrations, on the Sensorial Properties of cherry jam.

MATERIALS AND METHODS

The present investigation entitled “Physio-chemical and rheological characteristics of modified sorbitol cherry jam” was carried out in the Department of Food Technology Islamic University of Science and technology, Awantipora. The materials used, experimental details & Techniques employed in the investigation are furnished in this chapter.

Procurement of raw material

Fresh, ripe and sound fruits of cherry cultivar (Double cherry) devoid of any microbial infection or mechanical fissures were procured from local market of Srinagar and then bought to the Food Processing and Training Centre of Islamic University of Science and Technology, Awantipora for further processing.

Fruit weight

A representative sample was taken and weighed on an electric balance and average fruit weight calculated in grams.

Fruit length

Fruit length was recorded on representative samples of five randomly selected fruits and replication was measured with the help of Vernier caliper, expressed in millimeters (mm).

Development of cherry jam

The jam was prepared from the cherry fruit and was sorted, washed, and grounded using lab mixer-cum –grinder. Desired amount of sucrose, sorbitol, and pectin (on pulp basis) were added to the pulp and mixture was transferred in an open stainless steel pan. Jam was prepared using formulations as (basis 100g pulp, 0.3%citiric acid and 0.7% pectin). Five levels of sucrose substitution (0%, 25%, 50%, 75% and 100%) were carried out with sorbitol and coded as 101, 102, 103, 104, and 105 respectively. TSS in jam samples were measured as Degree Brix (ºB) with a portable hand Refractometer ranging from 60-90ºB (Atago, Japan).

Table 1: Experimental plan on cherry jam preparation with sorbitol at different concentration

Treatments	%Sucrose replaced	Amount of Sucrose	Amount of Sorbitol (g)
101	0	100	0
102	25	75	21.42
103	50	50	42.85
104	75	25	64.28
105	100	0	85.7

Total soluble solids

Three hand refractometers of ranges (0-30and 0-90ºB) (Atago Japan) was used to determine total soluble solids of fresh fruit samples and products respectively. The values were corrected at 20°C (Rangana, 1996).

Titratable acidity

Acidity was determined by taking a known weight of fruit jam and making a known volume of it by adding distilled water. Then a known volume of this liquid was treated against 0.1 N sodium hydroxide using phenolpthalin as an indicator. Titrable acidity was expressed as percentage malic acid as per equation mentioned below:

$$Acidty\,\% = \frac{Titre\ value\ X\ Normality\ of\ alkali\ X\ Vol\ made\ up\ X\ Equivalent\ wt.of\ acid\ X\ 100}{volume\ of\ Sample\ taken\ for\ estimation\ X\ wt\ or\ vol.of\ sample\ X\ 1000X100}$$

pH

The pH of the apple pulp was determined using digital pH meter (the pH meter, mod. Cyberscan 510). The calibration of pH meter was done before sample analysis, then the required amount of sample was taken and reading was taken.

Rheological analysis

The rheological properties were studied using Rheometer Physica MCR 101 (Anton Paar, 116 Ostfildern, Germany). The parallel plate geometry with 0.5 mm gap was used, and tests were conducted at a constant temperature of 25°C. To evaluate visco-elastic characteristics (loss modulus, G" and storage modulus, G'), the dynamic oscillatory frequency sweep test with a frequency range of 0.1 to 100 rad s^{-1} at a strain value of 2% (within the linear visco-elastic 120 region) was conducted. Following parameters were observed 1. Storage modulus (G') 2. Loss modulus (G") 3. Shear Stress 4. Shear rate 5. Apparent viscosity.

Colour and sensory evaluation

The colour of the peach puree samples was determined by colour-spectrophotometer (Colorflex, 113 Hunterlab), the equipment was calibrated before using.

Sensory quality attributes such as colour, flavour, taste and overall acceptability of antidiabetic cherry jam was evaluated by semi-trained panel of 10 members drawn from staff members. The panelists were provided with sample of cherry jam and were requested to assign scores on the basis of colour, flavour, taste and overall acceptability using 5 point scale.

Statistical analysis

The data were analyzed by analysis of variance (ANOVA) using statistical software SPSS 16. A multiple comparison procedure of the means was performed by Post Hoc Test. Significance of the differences was defined at ($p \le 0.05$).

RESULTS AND DISCUSSION

Physical characteristics of cherry fruit before processing

Cherry fruit was analyzed for its physical characteristics i.e. skin color, fruit weight(g), fruit length (mm), fruit width (mm), seed weight (g) and stalk weight (g) presented in Table 2. It was found that the average fruit dimensions were 19.2 mm (width) and

26.4mm (length) while average weight was 5.2 g. There was an overall increase over time in fruit width, length, weight, due to increase in maturity of fruit.

Table 2: Physical parameters of fruit sample

Quality Attributes	Cherry
Skin color	Red
Fruit weight (g)	5.02
Fruit length (mm)	23.8
Fruit width (mm)	19.6
Fruit thickness (mm)	17.0
Seed weight (g)	2.5

Chemical composition

The effect of using sorbitol instead of sugar in low sugar cherry jam on chemical properties of the product has shown in Table 3. From table 3 the sorbital substituted cherry jam with sorbitol shows that TSS, Titratable acidity, pH values are not significantly different compared to the standard recipe. Similar findings were reported by (Kerdsup and Naknean, 2012) that the pH, total acidity values of low sugar mango jam in which sucrose was replaced with sorbitol had no significant differences. Similar trend was observed by (Park, 2007) in strawberry jam.

Rheological properties

Frequency test

The mechanical spectra obtained from frequency sweep tests for cherry jam is shown in figure1 and 2. Elastic modulus G′ was higher than viscous modulus G″ indicating that the sorbital substituted cherry jam is more elastic in nature as compared viscous nature, therefore product can be classified as a weak gel. Similar behavior has been reported for other food products, such as jabuticaba pulp (Sato et al.,2004),acai pulp (Tonon et al., 2009). Jam samples 25, 50, 75 shows approximately straight lines with different slopes which indicate different nature of chemical bonding in the samples as shown in figure1and 2 The graphical representation G′ and G″ for the samples 100% sucrose and 100% sorbitol shows greater slope for G′ and G″ which indicates solid like behavior of the two above cited samples. Similar responses were observed by; ovalbumin gel (Nakamura et al., 1997), jam and yoghurt (Gabriele et al.,2001), starch gel (Rosalina and Bhattacharya, 2001), and lactoglobulin gel (Goncalves et al., 2004). Figure 1 and 2 shows the frequency dependence of G′ and G″ of cherry jam at different sucrose levels. The storage and loss modulli is highest for 100% sorbitol jam while the G′ and G″are lower for 100% sucrose jam sample. The reason behind this can be explained by the fact that pectin and water forms fibrillary network and at the same time sucrose can behave as dehydrating agent which will affect the equilibrium existing between water and pectin (Evageliou et al.,2000).

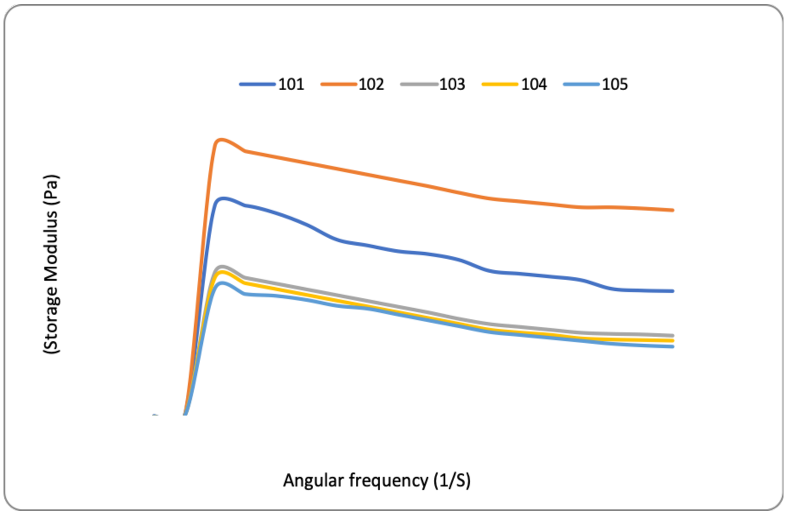

Figure 1. Frequency sweep test of storage modulus of sorbitol modified cherry jam

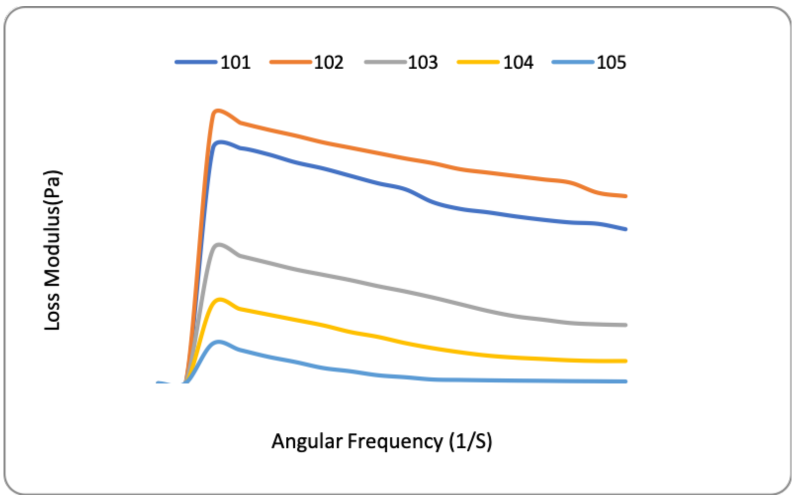

Figure 2. Frequency sweep test of loss modulus of sorbitol modified cherry jam

Table 3: Physio chemical properties of sorbitol substituted cherry jam

Product Code	TSS (°Brix)	pH	Titratable acidity (%)
101	66.43±1.69^{aC}	3.48±0.09^{aB}	0.76±0.01^{aA}
102	66.46±2.00^{aC}	3.51±0.01^{aB}	0.0.8±0.00^{aA}
103	66.44±1.59^{aC}	3.49±0.16^{aB}	0.77±0.01^{aA}
104	67.44±1.21^{aC}	3.49±0.02^{aB}	0.78±0.01^{aA}
105	66.45±1.21^{eC}	3.50±0.09^{aB}	0.79±0.00^{aA}

Values are mean ± standard deviation (n = 3).
A-B: Within a row, different letters indicate significant differences among different physiochemical parameters ($p < 0.05$).
a-b: Within a column, same letters indicate nonsignificant differences among different Treatments ($p < 0.05$).

Apparent viscosity of sucrose sorbitol jam

From figure 3, it was shown that viscosity decreases with increase in shear rate and the apparent viscosity decreased linearly for all the samples showing shear thinning behavior. The viscosity decreases due to pectin forms a network of fibrils with water and sugar acts as dehydrating agent, which disturbs the equilibrium existing between water and pectin. The network formation is more pronounced with increasing level of sugar leading to softening of the product. The 100% sucrose substituted jam showed the higher viscosity followed by 100% sorbitol substituted jam. Among the sorbitol substituted jams the viscosity decreased linearly with the increase in shear rate as the percentage of sorbital substitution decreased.

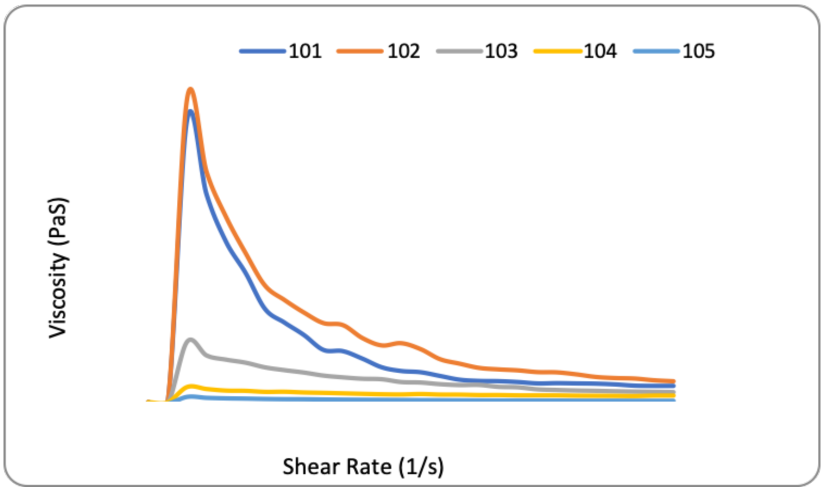

Figure 3. Apparent viscosity of sorbitol modified cherry jam

Color parameters of sorbitol substituted cherry jam

The intense color was observed for jam with no sorbital while as fade color was observed for jam with the highest amount of sorbital added. While the color and solubility of two sugars is almost similar, this may be accounted a little to the increased percentage of sorbital as the sugars may differ in their crystalline nature as shown in Table 4.

The l*, a* and b* values were observed in the order of 102< 103<104<105, 105>104>103>102 and 102>103>104>105, respectively. Colour changes were attributed due to Mailards reaction during the manufacture of cherry jam that contains sugar and amino acids and was associated with color change of flavors too. Similar results were declared for white hard grape pekmez by Tosun (2003). With increase in sorbitol concentration, lightness and yellowness increases while as redness decreases which could be associated with the degradation of anthocyanins pigments (Wicklund et al., 2005).

Anthocyanins are natural pigments of cherry and are unstable with degradation of the pigments during processing. The anthocyanins structure is transformed through ring opening to the pale yellow or colorless chalcone form. These findings are similar with (Francis, 1989).

Table 4: Color values (l,*a,*b*) of sorbitol substituted cherry jam

Product code	L*	a*	b*
101	22.34±0.00^{aB}	18.15±0.10^{eA}	31.22±0.14^{aC}
102	36.01±0.01^{eB}	14.94±0.10^{aA}	37.88±0.11^{eC}
103	32.55±0.14^{dB}	15.62±0.10^{bA}	36.61±0.01^{dC}
104	27.54±0.14^{cB}	16.33±0.07^{cA}	35.56±0.30^{cC}
105	25.38±0.56^{bB}	17.59±0.20^{dA}	34.81±0.54^{bC}

Values are mean ± standard deviation (n = 3).

A-B: Within a row, different letters indicate significant differences among colour parameters ($p < 0.05$).

a-b: Within a column, different letters indicate significant differences among different Treatments ($p < 0.05$).

Sensory properties of sucrose - sorbitol cherry jam

The colour values ranged between 4.25 for 105 to 5.00 for 101as shown in table5. The intense color was observed for jam with no sorbital while as fade color was observed for jam with the highest amount of sorbital added. While the color and solubility of two sugars is almost similar, this may be accounted a little to the increased percentage of sorbital as the sugars may differ in their crystalline nature.

Table 5: Sensory Scores of Sorbitol substituted Cherry Jam

Product code	Colour	Flavor	Taste	Texture	Overall acceptability
101	5.00±0.00	4.33±0.51	4.25±0.52	4.08±0.20	4.33±0.25
102	4.08±2.20	4.16±0.25	4.50±0.31	4.16±0.25	4.41±0.20
103	4.91±0.20	4.83±0.25	4.75±0.27	4.41±0.20	4.66±0.25
104	4.5±0.54	4.25±0.27	4.25±0.27	4.25±0.27	4.25±0.27
105	4.25±0.27	4.25±0.27	4.25±0.41	4.33±0.40	4.25±0.27

The flavor ranged between 4.16 for 102 to 4.83 for 103 and flavor of the jam was not changed much with the increased percentage of sorbital or decreased amount of sucrose, so it can be said that the two sugars had little or negligible effect on the flavor of the tested jams. The taste of the jams also didn’t differ much as it ranged between 4.25 to 4.75. Like flavor there was not any such big difference found as far as the varying concentrations of two sugars is concerned. Texture as perceived by senses too was similar between the varying amounts of sugar concentrations and show an increased trend for first three samples with increased amount of sorbital but thereafter it again decreased for higher amounts of sorbital and lesser amounts of sucrose. So it can be said that texture too had a little or nonlinear effect on the tested jams. The overall acceptability scores ranged from 4.33, 4.41, 4.66, 4.25 and 4.25 for 101, 102, 103, 104 and 105 respectively. The overall acceptability was seen a little higher for 103 with 75% sorbitol substitution.

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