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Evaluation of Bio active Compounds and Antioxidant Activity of Karonda Jam

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A B S T R A C T

The objective of research work was to study bio active compounds and antioxidant activity of Karonda Jam during storage. The Karonda jam with 3.28 pH, 72.23 ^{0}Brix TSS, 0.78% titrable acidity showed the highest overall acceptability (8.07) on 9 point Hedonic scale. Storage studies at ambient temperature showed increasing trend of total and reducing sugars while ascorbic acid, total phenol content, total flavonoids content, antioxidant activity by FRAP and DPPH radical scavenging activity showed significant decrease during storage for six months. There was no bacterial and mould growth during storage for six months. The organoleptic scores remained in acceptable range and overall acceptability in "Like moderately to Like very much range" throughout storage period. The nutritional value, microbial safety and overall acceptability revealed the possibility of processing karonda into jam.

Introduction

Neglected and Underutilized Species(NUS) offer tremendous opportunities for fighting hunger, malnutrition, and poverty and are key resources for rural development (FAO, 2018). The underutilized fruits like aonla, tamarind, karonda, citron, jackfruit, etc. are the main sources of livelihood for the poor and play an important role in overcoming the problem of malnutrition. Most of these fruits can grow under adverse conditions and meet the demands of the health-conscious consumers due to their therapeutic and nutritive value.

Popularisation can be achieved through developing suitable processing and marketing strategies for these underutilized fruits (Gajanana *et al.,* 2010). One such underutilized fruit is karonda (*Carissa carandas* L.). Karonda belongs to the family Apocyanaceae. It is a hardy, evergreen bush, grows well even on marginal and inferior land, where most other fruits either fail to grow or give poor performance. It is found throughout India mainly in the semi arid regions.

Karonda is widely cultivated in the home gardens, fields & orchards as hedge plant to serve as bio fence. It can be grown successfully in tropical and subtropical climate. Karonda can be cultivated in areas with high temperature and arid climate. Karonda can be grown on wide range of soils like laterite, sandy loams, alluvial and calcareous soil. The crop comes up well even in stoney, rocky and less fertile soils (Tripathi *et al.,* 2014).

Karonda is popular in indigenous systems of medicine like Ayurveda, Unani and Homeopathy. It contains several phytochemical constituents belonging to terpenoid category. It has good nutritional value and is useful in treatment of several illnesses such as intestinal worms, diarrhea, skin ailments etc (Kumar *et al.,* 2013). Though karonda shows medicinal, therapeutic and health benefits, it is not a popular table fruit. The fresh karonda fruits are highly acidicand astringent andcannot be consumed in large quantities. Moreover, the storage life of karonda is very short because of its soft flesh and high moisture content. The unripe fruit harvested at maturity can be stored for 5 to 7 days at room temperature, but at ripe stage, it can be stored only up to two days (Srivastava *et al.,* 2017). Incorporation of karonda into various products may add income to rural community. It also offers insurance towards food security and helps to address dietary diversity. The research was conducted to study the feasibility of Karonda (*Carissa carandas* L.) to process into jam and study bioactive compounds and antioxidant activity during storage.

Materials and Methods

The experiment was conducted at Department of Fruit science laboratory, College of Horticulture, Rajendranagar, Hyderabad and Central Instrumentation Cell, PJTSAU. Purple ripe karonda fruits were obtained from Fruit Research Station, Sangareddy, SKLTSHU, for research work and all other ingredients from local market.

Karonda pulp extraction process

Purple ripe karonda fruits without bruises were sorted for further processing. The selected fruits were washed with tap water and subjected to blanching for three minutes. Fruits were cut into halves and seeds were removed using stainless steel knives. Karonda pulp was extracted by adding half litre water to one kilogram fruits and straining the heated material through muslin cloth.

pH

pH was determined using pH meter. pH meter was calibrated with the help of standard buffer solutions (pH 4.0 and 7.0).10g sample was macerated with 100ml distilled water. The mixture was agitated and allowed to stand for 30 minutes. The supernatant was used to determine pH.

TSS (^{0}Brix)

Total soluble solids in samples were recorded using a digital Refractometer (Model: HI 96801 Refractometer 0-85 ^{0}Brix Hanna Instrument).

Total and reducing sugars(%)

The titrimetric method as described by Ranganna (1986) was adopted for the estimation of total and reducing sugars using Fehling A and B.

$$\text{Reducing sugar (\%)} = \frac{\text{Mg of invert sugar} \times \text{dilution} \times 100}{\text{Titre} \times \text{weight of the sample} \times 100}$$

$$\text{Total sugars as invert sugars (\%)} = \frac{\text{Factor x Volume made up x Dilution x 1000}}{\text{Titre value x Weight of sample taken}}$$

$$\text{Non reducing sugars (\%)} = (\text{Total sugars as invert sugars \%}) - \text{Reducing sugars\%}) \times 0.95$$

$$\text{Total sugars \%} = \text{Reducing sugars \%} + \text{Non reducing sugars \%}$$

Titrable acidity (%)

Titrable acidity of the sample was measured by titrating a given sample against a standard alkali solution of known concentration using phenolphthalein as an indicator to a light pink colour. 10g of homogenized sample was taken and made up to 100ml in a volumetric flask. The contents were filtered through Whatman No.1 filter paper. 10ml of aliquot was taken into a conical flask and titrated against standard solution of sodium hydroxide (0.1 N NaOH), using phenolphthalein as an indicator. The acidity was expressed in terms of percent citric acid equivalent adopting the following formula (AOAC, 2000).

$$\text{Titrable Acidity (\%)} = \frac{\text{Titre value} \times \text{normality of alkali} \times \text{volume made} \times \text{equivalent weight of acid} \times 100}{\text{Wt. of sample} \times \text{volume of aliquot} \times 1000}$$

Ascorbic acid (mg/100g)

Ascorbic acid was estimated by 2, 6 dichlorophenol - indophenol visual titration method (AOAC, 2000). The method is based on reduction of 2, 6 dichlorophenol – indophenol dye. The dye, which is blue in alkaline solution and red in acidic solution, is reduced by ascorbic acid to a colourless form. The reduction is quantitative and specific for ascorbic acid in solutions in the pH range of 1.0 - 3.5. 5 ml of 3% metaphosphoric acid extract of the sample was taken in a conical flask and titrated with standard dye. The end point was pink, which existed for at least 15 seconds.

$$\text{Ascorbic acid (mg/100g)} = \frac{\text{Titre value x Dye factor x Volume made x100}}{\text{Aliquot taken x Volume of sample taken}}$$

Total carotenoids

1g (Z) of homogenised sample was saponified with working alcoholic KOH solution and incubated at 37^{o}C for 20 minutes, shaking intermittently. Saponified mixture was then transferred to separating funnel and extracted with petroleum ether. Upper solvent was transferred into separate conical flask and the process of extraction was repeated till a clear white solvent layer was obtained indicating complete extraction. Amount of solvent was measured and noted as "A" ml. OD of solvent was measured as "B" at 450 nm (AOAC, 2000).

$$\text{Total carotenoids (microgram/g sample)} = \frac{4 \times A \times B \times 1000}{Z \text{ mg}}$$

Total phenols

Estimation of total phenolic contents was carried out using Folin-Ciocalteu reagent and absorbance was measured at 750 nm in spectrophotometer The results are expressed as Gallic Acid equivalent mg/100gms (GAE mg /100gm). A 0.2ml methanol extract of sample was taken as an aliquot. To this 0.5ml of Folin-Ciocalteu reagent (Diluted 1:1) was added. 10ml sodium carbonate was added to the sample and the content was made upto

12ml with distilled water and incubated for 60 minutes at 37°C. The resulting blue colour complex was measured at 750 nm on a UV spectrophotometer (Kamalaja and Prashanthi, 2016).

$$\text{Total Phenols (GAE mg/100g)} = \frac{\text{Standard concentration x Sample OD x Volume made up x 100}}{\text{Standard OD x Aliquot taken x sample weight(g) x 1000}}$$

Total flavonoids

Known volume of methanol extract of sample was taken and volume was made up to 5 ml with distilled water. 0.3 ml of sodium nitrite was added. After 5 minutes, 0.6 ml of 10% aluminium chloride was added and mixed. Then 2ml of 1N sodium hydroxide was added to the mixture. This was followed by the addition of 2.1ml of distilled water to it. Then the solution was mixed well. The absorbance of resultant pink colour was measured at 510nm in a UV visible spectrophotometer against blank. (Kamalaja and Prashanthi, 2016).

$$\text{Total Flavonoids (RE mg/100g)} = \frac{\text{Sandard concentration x Sample OD x Total Volume made up x 100}}{\text{Standard OD x Aliquot taken x sample weight(g) x 1000}}$$

DPPH radical scavenging activity

The antioxidant activity was determined by the ability of extract to scavenge DPPH (2, 2-diphenyl-1- picryl-hydrazyl) radical. The reduction of the DPPH radical was determined by measuring the absorption of the resulting oxidised solution at 517 nm against methanol blank. To 1ml of methanol, 3ml of DPPH was added and used as control. Methanol was used as blank. Total Antioxidant capacity of sample by DPPH assay was expressed as Trolox Equivalents mg/100g sample (Kamalaja and Prashanthi, 2016ss).

$$\text{Percent inhibition} = \frac{AC - AE}{AE} \times 100$$

Where, AC - Absorption of control
AE - Absorption of extract or standard

$$\text{TAC by DPPH assay TE mg/100g} = \frac{\text{std. conc. x sample \% inhibition x volume made up x 100}}{\text{Sample \% inhibition x aliquot taken x sample weight(g) x 1000}}$$

Ferric reducing antioxidant power (FRAP) assay

The procedure described by Benzie and Strain (1996) and modified by (Tadhani*et al.,* 2007) was used to evaluate Ferric reducing antioxidant power of karonda and products. The principle of this method is based on the reduction of a ferric-2,4,6-tris (2-pyridyl-s-triazine) complex (Fe^{3}+ -TPTZ) to its ferrous coloured form (Fe^{2}+ - TPTZ) at acidic pH, in the presence of antioxidants. The results are expressed as FRAP Trolox Equivalent mg/100g(TE mg /100g). Known volume of methanol extract of sample was taken and volume was made up to 0.3ml with distilled water. 1.8ml of FRAP reagent was added and allowed to incubate at 37°C for 10 minutes. The blue coloured complex was measured at 593nm using double beam U.V. spectrophotometer. Total antioxidant activity by FRAP was expressed as Trolox equivalents mg/100g (TE mg 100g) (Kamalaja and Prashanthi,2016).

Microbial count

The media used were Nutrient agar (NA) for Total Bacterial Count and Rose Bengal Agar (RBA) for Total Mould count. All media used were prepared according to the manufacturer's instructions.

Total bacterial count

One gram of each sample was homogenized with 9ml of sterilized distilled water.

Thereafter, 1ml homogenized sample was serially diluted for 10 times (10^{-1} - 10^{-10}). From each dilution test tube, one ml liquid was spread on to the Nutrient Agar plate. The inoculated plates were inverted and incubated at 37^{o}C for 48 hr. The bacterial colonies were counted with the help of colony counter. Individual colonies were counted and multiplied with the dilution factor to get the microbial population in gram of sample. The plates giving a range between 30 and 300 colonies were considered to be taken into account. The total colony count, referred as colony forming units (cfu) was calculated as below:

$$\text{cfu} = \frac{y}{dx}$$

Where, y = Number of colonies formed
d = Dilution
x = Volume of sample taken

Total mould count

One gram of food sample was homogenized with 9ml of sterilized distilled water. Thereafter, 1ml homogenized sample was serially diluted for 10 times (10^{-1} - 10^{-10}). From each dilution test tube, one ml sample was spread on to the Rose Bengal agar plate. The inoculated plates were inverted and incubated at 24^{o}C for 3 - 5 days and the number of colonies were counted.

Organoleptic evaluation

Organoleptic scoring was done by a panel of 15 members using a scorecard for sensory acceptability of 9 points hedonic scale with corresponding descriptive terms ranging from 9 'like extremely' to 1 'dislike extremely', for colour, flavour, texture, taste and overall acceptability (Jones, 1955; Marek *et al.*, 2007) developed for the purpose.

Statistical analysis

The analysis of variance of the data obtained was done by using Completely Randomized Design (CRD) and interpreted.

Results and Discussion

Several initial trials were conducted to develop Jam by incorporating karonda pulp from purple ripe fruits. Jam was tried by incorporating karonda fruit pulp and the process was standardised successfully. The process for preparation of karonda Jam was standardised and presented in Plate No. 1. After several initial trials, the best acceptable four variations are subjected to organoleptic evaluation by a panel consisting of 15 members on a 9 point hedonic scale and the results are presented in Table 1 and Table. 2. The best variation was selected based on sensory evaluation data (Table 2).

Karonda Jam prepared as per recipe of Trial-II recorded the highest sensory score for colour (8.33) and differed significantly from Trial-III and Trial-IV, but was on par with Trial-I. Organoleptic evaluation for taste and overall acceptability showed the highest score in Trial-II (8.07 and 8.07 respectively) is in "Like very much range" on 9 point Hedonic scale and differed significantly from other three variations.

The highest overall acceptability of karonda Jam as per Trial-II might be due to best acceptable colour, flavour, texture and taste. The results reveal the possibility of value addition of karonda through Jam preparation.

Storage studies

The best acceptable karonda jam was studied for changes in chemical composition, bioactive compounds and antioxidant activity during storage for six months.

pH

The changes occurred in pH during the storage of karonda jam during six months storage are presented in Table 3.The pH of karonda jam was 3.28 immediately after preparation. A gradual change in pH was recorded during storage, but significant change in pH was observed only during the third month of storage. pH of karonda jam decreased from 3.28 and reached 3.14 at the end of six months. Similar results were reported by Deepa (1996) in different karonda jam recipes, Wani *et al.,* (2013) in karonda jam during storage for eighty days, Kanwal (2017) in guava jam during storage for 60 days and Rahman (2017) in strawberry jam.

Total Soluble Solids (^{0}Brix)

The changes recorded in TSS during the storage of karonda jam during six months storage are presented in Table 3. TSS 72.23 ^{0}Brix was recorded at the beginning of storage, stable upto a month and showed significant increase in TSS throughout later part of storage period (73.93 ^{0}Brix). The increase in TSS content of jam during storage might be due to the degradation of polysaccharides into simple sugars. Similar results were reported by Diwate *et al.*, (2004) in aonla jam, Singh *et al.,* (2009) in pineapple and orange jam, Wani *et al.,* (2013) in karonda jam, Kundu *et al.,* (2017) in plum jam, Kanwal (2017) in guava jam, Brandao *et al.,* (2018) in mixed cerrado fruit jam while Vidhya and Narain, 2011reported no significant change in TSS during the storage of wood apple jam.

Titrable acidity (%)

The titrable acidity during the storage of karonda jam for six months was recorded and presented in Table 3. Titrable acidity of karonda jam showed a significant increase during storage period. Titrable acidity of freshly prepared jam was 0.78% whereas it increased to 0.82 % during storage. However no significant change in titrable acidity was observed during initial five months of storage but significant increase was observed during the later part of storage, which could be due to degradation of pectic substances which was responsible for increase in acidity in fruit products (Bajpai and Vasure, 2017).Similar results were reported by Deepa (1996), Wani *et al.,* (2013) and Bajpai and Vasure (2017) in karonda Jam.

Total sugars (%)

The total sugar content in karonda jam during the storage of six months was recorded and presented in Table 3. At 0 day storage, total sugar content was 63.67%, whereas it was 65.14% at the end of storage period. It was observed that there was no change in total sugar content up to two months storage, but during later period of storage, total sugars increased significantly. The total sugars increased significantly with increase in storage duration, which might be due to hydrolysis of polysaccharides like pectin, starch etc. into simple sugars and inversion of non-reducing sugar to reducing sugars. These findings are in agreement with the earlier workers Kundu *et al.,* (2017) in plum jam, Kanwal (2017) in guava jam, Brandao*et al.,* (2018) in mixed cerrado fruit jam and Sachin *et al.,* (2018) in aonla papaya jam.

Reducing sugars (%)

The reducing sugars during the storage of karonda jam for six months was recorded and presented in Table 3. Reducing sugar content of 43.06 % was recorded in freshly prepared karonda jam and increased significantly from second month of storage till six months (45.14%). The reducing sugars increased significantly with increase in storage duration,

which might be due to hydrolysis of polysaccharides and inversion of non-reducing sugar to reducing sugars. The results are in confirmation with Kundu *et al.*, (2017) in plum jam during 4 months storage, Sachin *et al.*, (2018) in aonla papaya jam for 3 months. Kanwal (2017) reported an increase in reducing sugars in storage but significant difference was not seen in storage for sixty days in guava jam.

Ascorbic acid (mg/100g)

The changes occurred in ascorbic acid content during the storage of karonda jam during storage are presented in Table 4. Ascorbic acid content was highest in karonda jam immediately after preparation (17.36 mg/100g). There is no change upto two months but decreased significantly in the later part of the six months storage period (14.12 mg/100g). Almost 18.67 % of ascorbic acid was lost during storage. This might be due to degradation of ascorbic acid into dehydroascorbic acid as well as to furfural during storage. Similar results were reported by Deepa (1996) in karonda jam recipes, Wani *et al.*, (2013) in karonda jam, Kanwal (2017) in guava jam, Rahman (2017) in strawberry jam, Brandao *et al.*, (2018) in mixed cerrado fruit jam and Sachin *et al.*, (2018) in aonla papaya jam.

Table.1 Standardization trials of Karonda Jam

Ingredients	Trial I	Trial II	Trail III	Trial IV
Karonda pulp	1 kg	1 kg	1 kg	1 kg
Water	1.3 litres	1.3 litres	1.3 litres	1.3 litres
Sugar	1.7 kg	1.7 kg	1.8 kg	1.8 kg
citric acid	10 g	15 g	10 g	15 g
Sodium benzoate	200 ppm	200 ppm	200 ppm	200 ppm
Remarks		Accepted for further study based on organoleptic scores		

Table.2 Organoleptic evaluation of different variations of Karonda Jam during standardization

Karonda Jam Variations	Mean Scores of Sensory evaluation				
	Colour	Flavour	Texture	Taste	Overall acceptability
Trial I - Karonda Jam	8.00	8.20	7.27	6.67	7.13
Trial II - Karonda Jam	8.33	8.27	8.20	8.07	8.07
Trial III - Karonda Jam	7.80	7.73	7.67	7.20	7.53
Trial IV - Karonda Jam	7.73	7.60	7.40	6.87	7.40
SE(m)	0.15	0.12	0.16	0.16	0.15
C.D. at (5%)	0.42	0.34	0.46	0.46	0.44

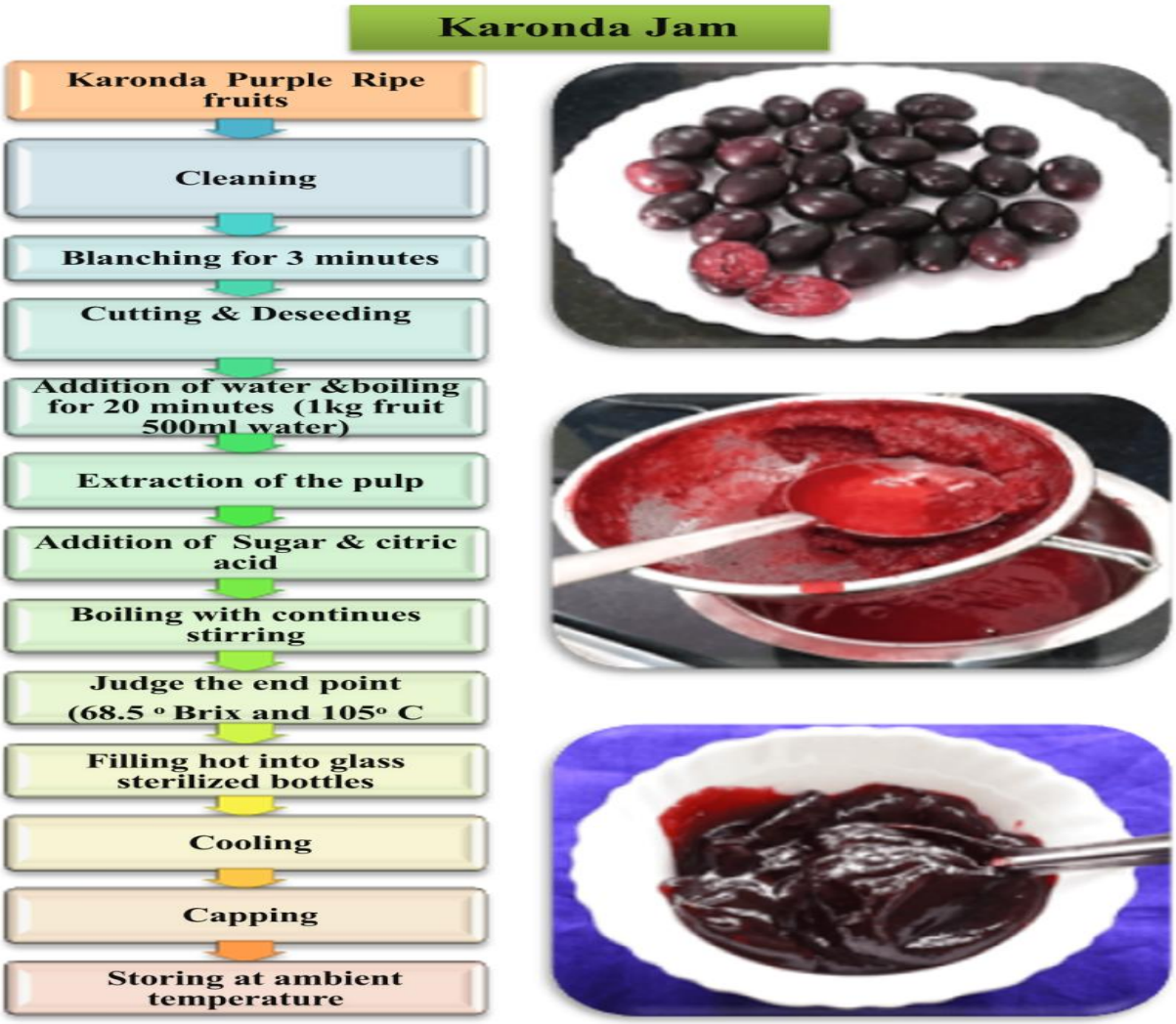
Table.3 Changes in chemical properties of Karonda Jam during storage

Storage Period	Chemical properties of Karonda Jam				
	pH	TSS (^{o} Brix)	Titrable acidity (%)	Total Sugars (%)	Reducing Sugars (%)
0 Months	3.28	72.23	0.78	63.67	43.06
1 Month	3.28	72.33	0.78	63.73	43.16
2 Months	3.26	72.50	0.78	63.81	43.38
3 Months	3.25	72.73	0.79	63.93	43.71
4 Months	3.21	73.07	0.80	64.17	44.19
5 Months	3.19	73.47	0.80	64.70	44.78
6 Months	3.14	73.93	0.82	65.14	45.14
SEm±	0.01	0.08	0.01	0.08	0.04
C.D. at (5%)	0.02	0.24	0.03	0.25	0.11
C.V.	0.27	0.19	1.95	0.22	0.14

Table.4 Changes in Bioactive compounds, antioxidant activity, Microbial count and Overall acceptability of Karonda Jam during storage

Storage Period	Bioactive compounds, antioxidant activity, Microbial count and Overall acceptability of Karonda Jam								
	Ascorbic acid (mg/100 g)	Total Carotenoids (mg/ 100g)	Total Phenols (GAE mg/100g)	Total Flavonoids (RE mg/100g)	FRAP (TE mg/100g)	DPPH (TE mg/100g)	Total Bacterial Count (Log CFU/g)	Total Mould Count (Log CFU/g)	Overall acceptability
0 Months	17.36	0.355	69.84	206.39	28.80	84.90	0.00	0.00	8.07
1 Month	17.08	0.349	69.38	206.18	28.70	84.68	0.00	0.00	8.00
2 Months	16.87	0.342	68.59	204.48	27.56	84.32	0.00	0.00	7.87
3 Months	16.33	0.335	67.81	200.54	26.39	83.29	0.00	0.00	7.73
4 Months	15.70	0.328	66.56	193.39	25.37	82.11	0.00	0.00	7.60
5 Months	15.02	0.311	65.68	183.70	23.64	81.10	0.00	0.00	7.47
6 Months	14.12	0.300	64.42	171.19	21.46	78.08	0.00	0.00	7.33
SEm±	0.20	0.003	0.68	0.83	0.42	0.68	0.00	0.00	0.16
C.D. at (5%)	0.62	0.009	2.09	2.55	1.27	2.09	0.00	0.00	0.44
C.V.	2.17	1.534	1.76	0.74	2.77	1.43	0.00	0.00	7.88

Plate.1 Preparation of Karonda Jam



Total Carotenoids (mg/100g)

The changes recorded in total carotenoids during the storage of karonda jam during six months storage are presented in Table 4. Highest content was recorded in freshly processed karonda jam (0.355 mg/100g). It was observed that total carotenoid content decreased significantly from the second month of storage upto six months. Lowest content was recorded at the end of six months (0.300 mg/100g). This decrease might be due to highly unsaturated chemical structure and auto oxidation of carotenoids. Similar results were reported by Djaoudene (2016) in orange jam after 30 days, Sachin *et al.,* (2018) in aonla papaya Jam recipes for three months and Brandao *et al.,* (2018) in mixed cerrado fruit Jam during storage for 6 months.

Total Phenols (GAE mg/100g)

The changes recorded in total phenols during the storage of karonda jam for six months are presented in Table 4. Highest content was recorded in freshly processed karonda jam (69.84 mg/100g). There was no significant change in total phenol content upto three

months storage period, thereafter decreased significantly upto six months (64.42 mg/100g). Oxidation and polymerization reactions might have resulted in reduction of phenolic content. The results are in agreement with findings of Kanwal (2017) in guava jam stored for sixty days, Brandao *et al.,* (2018) in mixed cerrado fruit jam during storage for 6 months, Sachin *et al.,* (2018) in aonla papaya jam recipes for three months.

Total flavonoids (RE mg/100g)

The total flavonoids during the storage of karonda jam for six months was recorded and presented in Table 4. Highest total flavonoids content (206.39 mg/100g) was recorded in freshly prepared karonda jam and no significant change was observed upto two months storage but significant decrease was observed during later part of storage (171.19 mg/100g).

Ferric reducing Antioxidant Power Assay (FRAP Assay TE mg/100g)

The antioxidant activity was measured using FRAP assay during the storage of karonda jam for six months. The results were recorded and presented in Table 4. Highest FRAP value (28.80 TE mg/100g) was recorded at 0 month and no significant decrease was observed upto three months but decreased significantly from the third month of storage till six months (21.46 TE mg/100g). This decrease might be due to decrease in ascorbic acid, total carotenoids, total phenols and total flavonoids during storage of karonda jam. Similar results were reported by Kanwal (2017) in guava jam.

DPPH (TE mg/100g)

The antioxidant activity was measured using DPPH free radical scavenging activity and expressed as Trolox equivalents, during the storage of karonda jam for six months. The results were recorded and presented in Table 4.Highest antioxidant activity as DPPH radical scavenging activity (84.90 TE mg/100g) was recorded in freshly prepared product and is stable upto three months, but decreased significantly later till six months (78.08 TE mg/100g).Similar results were reported by Kanwal (2017) in guava jam, Brandao *et al.,* (2018) in mixed cerrado fruit jam during storage for 6 months.

Total Bacterial Count (TBC)

Karonda jam was tested for bacterial growth at monthly intervals and presented in Table 4. The results reveal that there was no bacterial growth throughout the study period. High sugar content of jam and hygienic processing and storage conditions might have resulted in microbiologically safe jam.

Total Mould Count (TMC)

Karonda jam was tested for mould growth at monthly intervals and presented in Table 4. The results reveal that there was no mould growth throughout the study period. High sugar content of jam and hygienic processing and storage conditions might have resulted in microbiologically safe jam. Similar results were reported by Singh and Saxena (2019) in karonda jelly and Brandao *et al.,* (2018) in cerrado fruit jam.

Sensory evaluation of Karonda Jam

Microbiological safety of karonda Jam was established through TBC and TMC at monthly intervals. The microbiologically safe karonda jam was subjected to organoleptic evaluation by a panel of 15 members, on a 9 point hedonic scale at monthly intervals and presented in Table 4.Overall acceptability showed decrease during storage, but there was no significant difference up to four months

storage period and later showed significant decrease by sixth month. However, overall acceptability score of Jam (7.33) remained in "Like moderately to Like very much range" throughout the storage period. The organoleptic scores remained in acceptable range even after storage for six months. Similar results were reported by Kanwal (2017) in guava jam, Kundu *et al.*, (2017) in plum jam, Sachin *et al.*, (2018) in aonla papaya jam and Singh and Saxena (2019) in karonda jelly.

Development of products not only helps to extend shelf life of karonda fruits but also for preparation of functional foods. Preparation of acceptable and safe products will create promising opportunities to rural communities to earn sustainable livelihood so as to achieve nutritional and economic security. The results revealed that karonda fruits can be processed into jam that can be stored safely for six months with acceptable sensory score for overall acceptability. The nutritional quality, microbial safety, bio active compounds, antioxidant activity and organoleptic scores revealed the possibility of preparation and storage of karonda jam.

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