Effect of Picking Dates on Physico-Chemical Characteristics of Karonda (*Carissa Carandas* L.) Cultivars

Suneeta Singh* and A.K. Saxena

School of Agricultural Sciences, SGRRU, Dehradun-248 001, Uttarakhand, India.

Received: 16-05-2019  Accepted: 18-07-2019  DOI: 10.18805/IJARe.A-5296

**ABSTRACT**

An experiment was carried out during 2017-18 at Department of Horticulture, School of Agricultural Sciences, District Dehradun, Uttarakhand to see the effect of picking dates on physico-chemical characteristics of Karonda cultivars. The treatments comprised three different dates of picking of berries (40, 60 and 80 Days after fruit set) and three cultivars viz Pant Manohar, Pant Sudarshan and Pant Suvarna. All the 9 treatment combinations were laid out in a 3 x 3 factorial randomized block design with 3 replications. Observations were recorded at three different picking dates. The treatment combination C₃D₃ (Pant Suvarna + 80 Days after fruit set) was found better in terms of moisture, total soluble solids, reducing sugar, non-reducing sugar, total sugar, titratable acidity, ascorbic acid, phosphorous, calcium and iron content i.e. maximum moisture content (89.41%), highest TSS (8.53ºBrix), highest reducing sugar (6.20%), highest non-reducing sugar (2.03%), highest total sugar (8.33%), highest iron (6.74 mg/100g), maximum ascorbic acid (12.06 mg/100g) and lowest titratable acidity (1.74%), followed by C₁D₃ (Pant Manohar + 80 Days after fruit set) and C₂D₃ (Pant Sudarshan + 80 Days after fruit set). The treatment combination C₃D₂ (Pant Suvarna + 60 Days after fruit set) recorded maximum pectin content.

**Key words**: Karonda, Picking date, Ascorbic acid, Pectin.

**INTRODUCTION**

Karonda (*Carissa carandas* L.) is an important evergreen multipurpose horticultural bush which belongs to family Apocynaceae. It is indigenous and popularly known as ‘Christ’s thorn’. Karonda is an important fruit crop of tropical and subtropical regions of the world. In India it is mainly grown in Bihar, West Bengal, South India and plains of Northern India. It is commonly grown as hedge plant on the boundaries of orchards, gardens, park, public and private compounds for beautification which serves as one of the best bio-fencing materials due to presence of thorn and dense foliage. It is also grown as an ornamental plant because of its beautiful Cherry like fruits.

Regular plantation of Karonda is limited. Being hardy plant, Karonda can be used to a great extent to check the soil erosion in arid and semi-arid regions of country. The fruit of karonda is small berry, ellipsoid in shape and held in high esteem in Indian dietary. It is a rich source of essential vitamins and minerals required for adequate human health. Ethnomedically, fruits are used as an astringent, antianaemic, antiasorbutic and as a remedy for biliousness (Jadhav et al. 2004). The fruit varies in quantities of carbohydrates, proteins, sugars, acids, vitamin C, pectin, anthocyanin, iron and is a rich source of energy. In some regions of our country, this less common and highly nutritious fruit is eaten as raw and also cooked as vegetable. Apart from the use of Karonda as fresh fruit, there is a wide scope to prepare excellent quality of value added processed products like pickle, chutney, jam, jelly, RTS, squash, appetizer, coloured wine and candy (Manivasagan et al. 2006). Almost all the available recognized cultivars of Karonda such as Pant Manohar, Pant Sudarshan, Pant Suvarna are sour in taste, less sweet and somewhat having astringent property which renders them unsuitable for fresh consumption. The information on the physico-chemical and nutritional quality of promising Karonda cultivars at different stages of fruit development is very meagre and variable (Joshi et al. 1986). Hence, keeping the above facts in view the present investigation was carried out to study the effect of picking dates on physico-chemical quality of Karonda fruits.

**MATERIALS AND METHODS**

The present experiment was carried out at Research Centre, Department of Horticulture, School of Agricultural Sciences, SGRRU, Dehradun, Uttarakhand, India, during 2017-2018. The treatments comprised three cultivars viz Pant Manohar (C₁), Pant Sudarshan (C₂) and Pant Suvarna (C₃) and three different dates of picking of berries 40 (D₁), 60 (D₂) and 80 (D₃) Days after fruit set. All the nine treatment combinations were laid out in a 3 x 3 factorial randomized block design with 3 replications. From all the three cultivars...
healthy, bruise free and uniform size fruits were collected at 40, 60 and 80 days after fruit set for their physico-chemical analysis. The following physical parameters were determined by using standard procedures, fruit length and diameter by digital vernier callipers, fruit, flesh and seed weight by electronic balance, volume by water displacement method, fruit shape index by dividing fruit length with diameter, specific gravity by dividing fruit weight with volume, number of seeds per fruit by counting number of seeds in twenty fruits and averaged, flesh:seed ratio by dividing flesh weight with seed weight, yield per bush by weighing the fruits at the time of each picking and colour of fruits by comparing fruits with standard colour chart. The chemical composition of Karonda cultivars at different picking dates were determined by using standard procedures. The per cent moisture content was estimated by oven drying a known weight of sample at 65ºC to a constant weight and total soluble solids (TSS) were determined by hand refractometer. Sugars in the form of reducing, non-reducing and total sugars were estimated by using Lane and Eynon (1992) method. The titratable acidity was determined by titrating the clear fruit extract against 0.1 N NaOH using phenolphthalein as an indicator. Ascorbic acid was estimated volumetrically by titrating against 2, 6-dichloroindophenol dye to faint pink coloured end point, which was previously standardized with ascorbic acid solution. Anthocyanin in the ethanolic-HCl extract of fresh fruit was determined by colorimetric procedure, total carotenoids were determined spectrophotometrically at 450 nm and pectin content was determined by methods elucidated by Ranganna (2009). A known amount of dry matter were digested with tri-acid mixture (nitric: sulphuric : perchloric acids; 10 : 1 : 1) and the digested material was used to estimate minerals. Phosphorous content was estimated by vanadomolybdated yellow colour method, calcium by atomic absorption spectrophotometer and iron by orthophenanthroline colorimetric method (Piper 1966).

RESULTS AND DISCUSSION

The maximum fruit length was recorded in Pant Suvarna (2.71 cm) followed by Pant Manohar (2.51 cm) and Pant Sudarshan (2.21). The fruit length was increased from 2.28 to 2.73 cm from 40 to 80 days after fruit set, respectively. The maximum fruit length (3.07cm) was recorded in combination C,D (Pant Suvarna + 80 days after fruit set) and minimum fruit length (2.05cm) was recorded in C,D (Pant Sudarshan + 40 days after fruit set). The maximum fruit diameter was recorded in Pant Suvarna (2.00 cm) followed by Pant Manohar (1.77 cm) and Pant Sudarshan (1.75 cm). The fruit diameter was increased from 1.70 to 2.00 cm from 40 to 80 days after fruit set, respectively. The maximum fruit diameter (2.30 cm) was recorded in combination C,D (Pant Suvarna + 80 days after fruit set) and minimum fruit diameter (1.64 cm) was recorded in C,D (Pant Manohar + 40 days after fruit set (Table 1). The increase in fruit length of cultivars with the increase in picking dates might be due to accumulation of more biochemical compounds. Similar findings were also reported by Misra and Jaiswal (1999) and Manivasagan et al. (2006) in Karonda.

The maximum fruit weight was recorded in Pant Suvarna (5.29g) followed by Pant Manohar (4.27g) and Pant Sudarshan (3.73g). The fruit weight was increased from 3.98 to 4.89g from 40 to 80 days after fruit set, respectively. The maximum fruit weight (5.86g) was recorded in combination C,D (Pant Suvarna + 80 days after fruit set) and minimum fruit weight (3.38g) was recorded in C,D (Pant Sudarshan + 40 days after fruit set). This might be due to the rapid physiological activities taking place in the fruits which bring about cell division and cell enlargement which ultimately lead to increase in fruit weight (Table 1). Similar results were also reported by Awasthi et al. (1988) in local cultivars of Karonda.

The maximum fruit volume was recorded in Pant Suvarna (4.42ml) followed by Pant Manohar (3.27ml) and Pant Sudarshan (3.06ml). The fruit volume was increased from 3.04 to 4.04ml from 40 to 80 days after fruit set, respectively. The maximum fruit volume (5.00ml) was recorded in combination C,D (Pant Suvarna + 80 days after fruit set) and minimum fruit weight (2.75ml) was recorded in C,D (Pant Sudarshan + 40 days after fruit set). Similar results have also been stated by Joshi et al. (1986) in Karonda.

The maximum fruit shape index was recorded in Pant Manohar (1.42) followed by Pant Suvarna (1.36) and Pant Sudarshan (1.25). The fruit shape index was increased
Table 1: Effect of cultivars and picking dates on fruit length (cm), diameter (cm), weight (g), volume (ml), fruit shape index, specific gravity, number of seeds per fruit, flesh weight (g), seed weight (g), flesh:seed ratio, fruit yield per bush (kg) and fruit colour.

| Fruit length (cm) | Fruit diameter (cm) | Fruit weight (g) | Fruit volume (ml) | Fruit shape index | Specific gravity | Number of seeds per fruit | Flesh weight (g) | Seed weight (g) | Flesh:seed ratio | Fruit yield per bush (kg) | Fruit colour |
|-------------------|--------------------|------------------|------------------|------------------|-----------------|-----------------------|-----------------|----------------|-----------------|------------------------|-------------|
| **Cultivars (C)** | **D**<sub>1</sub> | **D**<sub>2</sub> | **D**<sub>3</sub> | **Mean (C)** | **D**<sub>1</sub> | **D**<sub>2</sub> | **D**<sub>3</sub> | **Mean (C)** | **D**<sub>1</sub> | **D**<sub>2</sub> | **D**<sub>3</sub> | **Mean (C)** | **D**<sub>1</sub> | **D**<sub>2</sub> | **D**<sub>3</sub> | **Mean (C)** | **D**<sub>1</sub> | **D**<sub>2</sub> | **D**<sub>3</sub> | **Mean (C)** | **D**<sub>1</sub> | **D**<sub>2</sub> | **D**<sub>3</sub> | **Mean (C)** |
| Pant Manohar (C<sub>1</sub>) | 2.31 | 2.53 | 2.70 | 2.51 | 1.64 | 1.78 | 1.88 | 1.77 | 3.79 | 4.41 | 4.62 | 4.27 | 3.79 | 4.41 | 4.89 |
| Pant Sudarshan (C<sub>2</sub>) | 2.05 | 2.16 | 2.41 | 2.21 | 1.71 | 1.76 | 1.81 | 1.76 | 3.38 | 3.61 | 4.20 | 3.73 | 3.38 | 3.61 | 4.20 |
| Pant Suvarna (C<sub>3</sub>) | 2.47 | 2.60 | 3.07 | 2.71 | 1.75 | 1.96 | 2.30 | 2.00 | 4.78 | 5.23 | 5.86 | 5.29 | 4.78 | 5.23 | 5.86 |
| Mean (D) | 2.28 | 2.43 | 2.73 | 1.70 | 1.83 | 2.00 | 3.98 | 4.41 | 4.89 |

S. Em.± C.D. (P=0.05)

Cultivars (C) 0.049 | 0.149 | 0.034 | 0.102 | 0.134 | 0.404
Picking dates (D) 0.049 | 0.149 | 0.034 | 0.102 | 0.134 | 0.404
Interaction (C x D) 0.086 | 0.258 | 0.058 | 0.176 | 0.233 | 0.699

| Fruit volume (ml) | Fruit shape index | Specific gravity |
|-------------------|-------------------|-----------------|
| **Cultivars (C)** | **D**<sub>1</sub> | **D**<sub>2</sub> | **D**<sub>3</sub> | **Mean (C)** | **D**<sub>1</sub> | **D**<sub>2</sub> | **D**<sub>3</sub> | **Mean (C)** | **D**<sub>1</sub> | **D**<sub>2</sub> | **D**<sub>3</sub> | **Mean (C)** | **D**<sub>1</sub> | **D**<sub>2</sub> | **D**<sub>3</sub> | **Mean (C)** | **D**<sub>1</sub> | **D**<sub>2</sub> | **D**<sub>3</sub> | **Mean (C)** |
| Pant Manohar (C<sub>1</sub>) | 2.82 | 3.21 | 3.78 | 3.27 | 1.40 | 1.43 | 1.44 | 1.42 | 1.34 | 1.38 | 1.23 | 1.32 | 1.34 | 1.38 | 1.23 |
| Pant Sudarshan (C<sub>2</sub>) | 2.75 | 3.07 | 3.36 | 3.06 | 1.20 | 1.23 | 1.32 | 1.25 | 1.23 | 1.18 | 1.25 | 1.20 | 1.32 | 1.23 | 1.20 |
| Pant Suvarna (C<sub>3</sub>) | 3.57 | 4.69 | 5.00 | 4.42 | 1.41 | 1.33 | 1.34 | 1.36 | 1.34 | 1.34 | 1.34 | 1.21 | 1.34 | 1.34 | 1.21 |
| Mean (D) | 3.04 | 3.65 | 4.04 | 1.33 | 1.34 | 1.37 | 1.30 | 1.34 | 1.24 | 1.22 |

S. Em.± C.D. (P=0.05)

Cultivars (C) 0.082 | 0.247 | 0.024 | 0.072 | 0.043 | 0.130
Picking dates (D) 0.082 | 0.247 | 0.024 | 0.072 | 0.043 | 0.130
Interaction (C x D) 0.142 | 0.427 | 0.042 | 0.126 | 0.075 | 0.226

| Number of seeds per fruit | Flesh weight (g) | Seed weight (g) |
|---------------------------|------------------|-----------------|
| **Cultivars (C)** | **D**<sub>1</sub> | **D**<sub>2</sub> | **D**<sub>3</sub> | **Mean (C)** | **D**<sub>1</sub> | **D**<sub>2</sub> | **D**<sub>3</sub> | **Mean (C)** | **D**<sub>1</sub> | **D**<sub>2</sub> | **D**<sub>3</sub> | **Mean (C)** | **D**<sub>1</sub> | **D**<sub>2</sub> | **D**<sub>3</sub> | **Mean (C)** | **D**<sub>1</sub> | **D**<sub>2</sub> | **D**<sub>3</sub> | **Mean (C)** |
| Pant Manohar (C<sub>1</sub>) | 7.33 | 9.33 | 9.00 | 8.55 | 3.56 | 4.20 | 4.36 | 4.04 | 0.19 | 0.37 | 0.44 | 0.33 | 0.19 | 0.37 | 0.44 |
| Pant Sudarshan (C<sub>2</sub>) | 6.33 | 7.00 | 8.67 | 7.33 | 3.02 | 3.24 | 3.93 | 3.40 | 0.22 | 0.30 | 0.37 | 0.30 | 0.22 | 0.30 | 0.37 |
| Pant Suvarna (C<sub>3</sub>) | 6.67 | 8.00 | 8.33 | 7.67 | 4.53 | 4.97 | 5.67 | 5.06 | 0.18 | 0.25 | 0.42 | 0.28 | 0.18 | 0.25 | 0.42 |
| Mean (D) | 6.78 | 8.11 | 8.67 | 3.70 | 4.14 | 4.65 | 0.20 | 0.31 | 0.41 |

S. Em.± C.D. (P=0.05)

Cultivars (C) 0.394 | 1.18 | 0.116 | 0.348 | 0.019 | NS
Picking dates (D) 0.394 | 1.18 | 0.116 | 0.348 | 0.019 | 0.058
Interaction (C x D) 0.682 | 2.04 | 0.201 | 0.603 | 0.33 | 0.98

| Flesh:seed ratio | Fruit yield per bush (kg) |
|------------------|-------------------------|
| **Fruit colour** |                        |

Table 1 Continue........
from 1.33 to 1.37 from 40 to 80 days after fruit set, respectively. The maximum fruit shape index (1.44) was recorded in combination C_1D_3 (Pant Manohar + 80 days after fruit set) and minimum fruit shape index (1.20) was recorded in C_2D_1 (Pant Sudarshan + 40 days after fruit set) (Table 1). This result is also in confirmation with Misra and Jaiswal (1999) in Karonda.

The maximum specific gravity was recorded in Pant Manohar (1.32) followed by Pant Suvarna (1.21) and Pant Sudarshan (1.20). The specific gravity was decreased from 1.30 to 1.22 from 40 to 80 days after fruit set, respectively. The maximum specific gravity (1.38) was recorded in combination C_1D_2 (Pant Manohar + 60 days after fruit set) and minimum fruit shape index (1.12) was recorded in C_3D_2 (Pant Suvarna + 60 days after fruit set). Similar findings were also reported by Singh et al. (1967) in *Carissa grandiflora* and *Carissa bispinosa*.

The maximum number of seeds per fruit was recorded in Pant Manohar (8.55) followed by Pant Suvarna (7.67) and Pant Sudarshan (7.33). The number of seeds per fruit was increased from 6.78 to 8.67 from 40 to 80 days after fruit set, respectively. The maximum number of seeds per fruit (9.33) was recorded in combination C_1D_2 (Pant Manohar + 60 days after fruit set) and minimum fruit shape index (6.33) was recorded in C_2D_1 (Pant Sudarshan + 40 days after fruit set) (Table 1). The difference in number of seeds per fruit might be due to the variation in the genetic constitution of different cultivars. Similar result was also reported by Misra and Jaiswal (1999) in karonda.

The maximum flesh weight was recorded in Pant Suvarna (5.06g) followed by Pant Manohar (4.04g) and Pant Sudarshan (3.40g). The flesh weight was increased from 3.70 to 4.65g from 40 to 80 days after fruit set, respectively. The maximum flesh weight (5.67g) was recorded in combination C_3D_3 (Pant Suvarna + 80 days after fruit set) and minimum flesh weight (3.02g) was recorded in C_2D_1 (Pant Sudarshan + 40 days after fruit set). There was no significant variation in the seed weight of cultivars. The seed weight was increased from 0.20 to 0.41g from 40 to 80 days after fruit set, respectively. The maximum seed weight (0.44g) was recorded in combination C_1D_3 (Pant Manohar + 80 days after fruit set) and minimum flesh weight (0.18g) was recorded in C_1D_3 (Pant Suvarna + 40 days after fruit set) (Table 1). The increase in flesh and seed weight of cultivars with the increase in picking dates might be due to increase in their fruit weight. The results are in agreement with the finding of Misra and Jaiswal (1999).

The maximum flesh:seed ratio was recorded in Pant Manohar (1:21.18) followed by Pant Suvarna (1:19.26) and Pant Sudarshan (1:11.95). The flesh:seed ratio was decreased from 1:19.62 to 1:11.54 from 40 to 80 days after fruit set, respectively. The maximum flesh:seed ratio (1:23.90) was recorded in combination C_3D_1 (Pant Suvarna + 40 days after fruit set) (Table 1).

### Table 1

| Cultivars (C) | Picking dates (D) | Mean (D) | Mean (C) | Interaction (C x D) |
|--------------|------------------|----------|----------|-------------------|
| Pant Manohar | D_1 | 1:21.18 | 1:11.42 | 1:19.26 | 1:23.90 |
| Pant Sudarshan | D_2 | 1:19.62 | 1:11.95 | 1:11.45 | 1:21.18 |
| Pant Suvarna | D_3 | 1:14.24 | 1:12.53 | 1:14.55 | 1:19.62 |
| Mean (D)     |    | 1:20.77 | 1:12.95 | 1:13.74 | 1:19.62 |
| Mean (C)     |    | 1:16.39 | 1:11.50 | 1:14.75 | 1:19.26 |
| Interaction |    | 1:21.18 | 1:11.42 | 1:19.26 | 1:23.90 |

S.Em.± C.D. (P=0.05) 0.49 ± 0.14 (0.49 ± 0.14) 0.85 ± 0.05 (0.85 ± 0.05) 2.55 ± 0.14 (2.55 ± 0.14)
fruit set) and minimum flesh:seed ratio (1:10.01) was recorded in C\textsubscript{D}\textsubscript{1} (Pant Manohar + 80 days after fruit set). This decrease in flesh:seed ratio with the increase in picking dates may be due to increase in seed weight. This finding was in accordance with Singh and Singh (1998).

The maximum fruit yield per bush was recorded in Pant Sudarshan (23.50 kg) followed by Pant Manohar (21.88 kg) and Pant Suvarna (17.87 kg). The fruit yield per bush was increased from 16.18 to 24.95 kg from 40 to 80 days after fruit set, respectively. The maximum fruit yield per bush (27.33 kg) was recorded in combination C\textsubscript{D}\textsubscript{3} (Pant Sudarshan + 80 days after fruit set) and minimum fruit yield per bush (13.83 kg) was recorded in C\textsubscript{D}\textsubscript{1} (Pant Suvarna + 40 days after fruit set). Similar result was also reported by Misra and Jaiswal (1999) in Karonda.

The fruit colour in Pant Manohar (C\textsubscript{1}) at 40, 60 and 80 days after fruit set were observed as white with pink blush, white with dark pink blush and dark maroon, respectively. However, in Pant Sudarshan (C\textsubscript{3}), the fruit colour were observed as white with slight pink blush, white with pink blush and dark maroon at D\textsubscript{1}, D\textsubscript{2} and D\textsubscript{3}, respectively, while Pant Suvarna (C\textsubscript{2}) produced green, green with maroon blush and blackish-maroon coloured fruits at 40, 60 and 80 days after fruit set, respectively. The drastic change in colour from 40 to 80 days after fruit set could be attributed to the biosynthesis of anthocyanin pigments. Similar findings were also reported by Joshi et al. (1986) and Misra and Jaiswal (1999) in Karonda.

The maximum moisture content was recorded in Pant Suvarna (87.56%) followed by Pant Manohar (86.42%) and Pant Sudarshan (86.38%). The moisture content was increased from 85.28 to 88.43% from 40 to 80 days after fruit set, respectively. The maximum moisture content (89.41%) was recorded in combination C\textsubscript{D}\textsubscript{3} (Pant Suvarna + 80 days after fruit set) and minimum moisture content (85.08%) was recorded in C\textsubscript{D}\textsubscript{1} (Pant Manohar + 40 days after fruit set) (Table 2). The increase in moisture with the increase in picking dates could be attributed to the rapid physiological activities taking place in the fruit which bring about cell division and cell enlargement which ultimately lead to increase in size of fruit and absorption of water. Similar result were also reported by Joshi et al. (1986) and Manivasagan et al. (2006) in Karonda.

The maximum TSS was recorded in Pant Suvarna (6.48ºBrix) followed by Pant Manohar (5.85ºBrix) and Pant Sudarshan (5.71ºBrix). The TSS was increased from 4.48 to 7.64 Brix from 40 to 80 days after fruit set, respectively. The maximum TSS (8.53ºBrix) was recorded in combination C\textsubscript{D}\textsubscript{3} (Pant Suvarna + 80 days after fruit set) and minimum TSS (4.33ºBrix) was recorded in C\textsubscript{D}\textsubscript{1} (Pant Manohar + 40 days after fruit set). The increase in TSS content of cultivars with the increase in picking dates may be due to accumulation of more sugars in the fruits due to hydrolysis of starch during the later period of fruit growth. Similar observations were also reported by Awasthi et al. (1988) and Manivasagan et al. (2006) in Karonda.

The maximum reducing sugar was recorded in Pant Suvarna (4.32%) followed by Pant Manohar (3.38%) and Pant Sudarshan (3.26%). The reducing sugar was increased from 2.40 to 5.48% from 40 to 80 days after fruit set, respectively. The maximum reducing sugar (6.20%) was recorded in combination C\textsubscript{D}\textsubscript{3} (Pant Suvarna + 80 days after fruit set) and minimum reducing sugar (2.07%) was recorded in C\textsubscript{D}\textsubscript{1} (Pant Sudarshan + 40 days after fruit set). The maximum non-reducing sugar was recorded in Pant Suvarna (1.75%) followed by Pant Manohar (1.26%) and Pant Sudarshan (1.10%). The non-reducing sugar was increased from 1.19 to 1.58% from 40 to 80 days after fruit set, respectively. The maximum non-reducing sugar (2.03%) was recorded in combination C\textsubscript{D}\textsubscript{3} (Pant Suvarna + 80 days after fruit set) and minimum non-reducing sugar (1.00%) was recorded in C\textsubscript{D}\textsubscript{1} (Pant Sudarshan + 40 days after fruit set). The maximum total sugar was recorded in Pant Suvarna (6.16%) followed by Pant Manohar (4.69%) and Pant Sudarshan (4.42%). The total sugar was increased from 3.66 to 7.15% from 40 to 80 days after fruit set, respectively. The maximum total sugar (8.33%) was recorded in combination C\textsubscript{D}\textsubscript{3} (Pant Suvarna + 80 days after fruit set) and minimum total sugar (3.17%) was recorded in C\textsubscript{D}\textsubscript{1} (Pant Sudarshan + 40 days after fruit set) (Table 2). The increase in sugars content of cultivars with the increase in picking dates might be due to conversion of starch into sugars. Our findings are in conformity with the results obtained by Misra and Jaiswal (1999) in Karonda.

The maximum ascorbic acid was recorded in Pant Sudarshan (3.20%) followed by Pant Manohar (3.11%) and Pant Suvarna (2.30%). The ascorbic acid was decreased from 3.39 to 2.28% from 40 to 80 days after fruit set, respectively. The maximum ascorbic acid (3.79%) was recorded in combination C\textsubscript{D}\textsubscript{3} (Pant Sudarshan + 40 days after fruit set) and minimum ascorbic acid (1.74%) was recorded in C\textsubscript{D}\textsubscript{1} (Pant Suvarna + 80 days after fruit set) (Table 2). The decrease in ascorbic acid might be due to conversion of organic acids into sugars and then utilization as respiratory substrate throughout the growth and development of fruits. These findings are in conformity with the results obtained by Misra and Jaiswal (1999) in Karonda.

The maximum titratable acidity was recorded in Pant Sudarshan (3.20%) followed by Pant Manohar (3.11%) and Pant Suvarna (2.30%). The titratable acidity was decreased from 3.39 to 2.28% from 40 to 80 days after fruit set, respectively. The maximum titratable acidity (3.79%) was recorded in combination C\textsubscript{D}\textsubscript{3} (Pant Sudarshan + 40 days after fruit set) and minimum titratable acidity (1.74%) was recorded in C\textsubscript{D}\textsubscript{1} (Pant Suvarna + 80 days after fruit set) (Table 2). The decrease in titratable acidity might be due to conversion of organic acids into sugars and then utilization as respiratory substrate throughout the growth and development of fruits. These findings are in conformity with the results obtained by Misra and Jaiswal (1999) in Karonda.

The maximum non-reducing sugar was recorded in Pant Suvarna (1.75%) followed by Pant Manohar (1.26%) and Pant Sudarshan (1.10%). The non-reducing sugar was increased from 1.19 to 1.58% from 40 to 80 days after fruit set, respectively. The maximum non-reducing sugar (2.03%) was recorded in combination C\textsubscript{D}\textsubscript{3} (Pant Suvarna + 80 days after fruit set) and minimum non-reducing sugar (1.00%) was recorded in C\textsubscript{D}\textsubscript{1} (Pant Sudarshan + 40 days after fruit set). The maximum total sugar was recorded in Pant Suvarna (6.16%) followed by Pant Manohar (4.69%) and Pant Sudarshan (4.42%). The total sugar was increased from 3.66 to 7.15% from 40 to 80 days after fruit set, respectively. The maximum total sugar (8.33%) was recorded in combination C\textsubscript{D}\textsubscript{3} (Pant Suvarna + 80 days after fruit set) and minimum total sugar (3.17%) was recorded in C\textsubscript{D}\textsubscript{1} (Pant Sudarshan + 40 days after fruit set) (Table 2). The increase in sugars content of cultivars with the increase in picking dates might be due to conversion of starch into sugars. Our findings are in conformity with the results obtained by Misra and Jaiswal (1999) in Karonda.

The maximum ascorbic acid was recorded in Pant Sudarshan (3.20%) followed by Pant Manohar (3.11%) and Pant Suvarna (2.30%). The ascorbic acid was decreased from 3.39 to 2.28% from 40 to 80 days after fruit set, respectively. The maximum ascorbic acid (3.79%) was recorded in combination C\textsubscript{D}\textsubscript{3} (Pant Sudarshan + 40 days after fruit set) and minimum ascorbic acid (1.74%) was recorded in C\textsubscript{D}\textsubscript{1} (Pant Suvarna + 80 days after fruit set) (Table 2). The decrease in ascorbic acid might be due to conversion of organic acids into sugars and then utilization as respiratory substrate throughout the growth and development of fruits. These findings are in conformity with the results obtained by Misra and Jaiswal (1999) in Karonda.
Table 2: Effect of cultivars and picking dates on moisture (%), TSS (°Brix), reducing sugar (%), non-reducing sugar (%), total sugar (%), titratable acidity (%), ascorbic acid (mg/100g), pectin (%), anthocyanin (mg/100g), total carotenoids (mg/100), phosphorous (mg/100g), calcium (mg/100g) and iron

| Cultivars (C)          | D1   | D2   | D3   | Mean (C) | D1   | D2   | D3   | Mean (C) | D1   | D2   | D3   | Mean (C) |
|------------------------|------|------|------|----------|------|------|------|----------|------|------|------|----------|
| Pant Manohar (C1)      | 85.08| 86.18| 87.99| 86.42    | 4.47 | 5.83 | 7.26 | 5.85     | 2.24 | 2.76 | 5.15 | 3.38     |
| Pant Sudarshan (C2)    | 85.13| 86.14| 87.88| 86.38    | 4.33 | 5.67 | 7.13 | 5.71     | 2.07 | 2.16 | 5.10 | 3.26     |
| Pant Suvarna (C3)      | 85.64| 87.63| 89.41| 87.56    | 4.67 | 6.26 | 8.53 | 6.48     | 2.90 | 3.87 | 6.20 | 4.32     |
| Mean (D)               | 85.28| 86.65| 88.43|          | 4.48 | 5.92 | 7.64 |          | 2.40 | 3.08 | 5.48 |          |
| S.Em.± (P=0.05)        | C.D. | S.Em.±(P=0.05) | C.D. |          | S.Em.±(P=0.05) | C.D. |          |
| Cultivars (C)          | 0.196| 0.588|      | 0.128    | 0.385|      | 0.152 | 0.456    |      |      |      |          |
| Picking dates (D)      | 0.196| 0.588|      | 0.128    | 0.385|      | 0.152 | 0.456    |      |      |      |          |
| Interaction (C x D)    | 0.340| 1.019|      | 0.222    | 0.668|      | 0.263 | 0.791    |      |      |      |          |

| Cultivars (C)          | 1.05 | 1.20 | 1.53 | 1.26     | 3.29 | 4.02 | 6.77 | 4.69     | 3.75 | 3.06 | 2.52 | 3.11     |
| Picking dates (D)      | 1.00 | 1.11 | 1.18 | 1.10     | 3.17 | 3.77 | 6.33 | 4.42     | 3.79 | 3.24 | 2.56 | 3.20     |
| Pant Suvarna (C3)      | 1.54 | 1.68 | 2.03 | 1.75     | 4.52 | 5.64 | 8.33 | 6.16     | 2.63 | 2.54 | 1.74 | 2.30     |
| Mean (D)               | 1.19 | 1.33 | 1.58 |          | 3.66 | 4.48 | 7.15 |          | 3.39 | 2.95 | 2.28 |          |
| S.Em.± (P=0.05)        | C.D. | S.Em.± (P=0.05) | C.D. |          | S.Em.± (P=0.05) | C.D. |          |
| Cultivars (C)          | 0.088| 0.265|      | 0.115    | 0.346|      | 0.136 | 0.409    |      |      |      |          |
| Picking dates (D)      | 0.088| 0.265|      | 0.115    | 0.346|      | 0.136 | 0.409    |      |      |      |          |
| Interaction (C x D)    | 0.153| 0.460|      | 0.200    | 0.600|      | 0.236 | 0.708    |      |      |      |          |

| Cultivars (C)          | 15.09| 15.35| 17.88| 16.11    | 0.298| 0.424| 0.392| 0.371    | 0.029| 0.055| 0.071| 0.051    |
| Picking dates (D)      | 15.24| 15.74| 18.81| 16.60    | 0.291| 0.407| 0.389| 0.362    | 0.025| 0.055| 0.068| 0.049    |
| Pant Sudarshan (C2)    | 9.41 | 9.85 | 12.06| 10.44    | 0.366| 0.712| 0.569| 0.549    | 0.009| 0.023| 0.082| 0.038    |
| Mean (D)               | 13.25| 13.65| 16.25|          | 0.318| 0.514| 0.450|          | 0.022| 0.045| 0.074|          |
| S.Em.± (P=0.05)        | C.D. | S.Em.± (P=0.05) | C.D. |          | S.Em.± (P=0.05) | C.D. |          |
| Cultivars (C)          | 0.088| 0.264|      | 0.007    | 0.020|      | 0.002 | 0.005    |      |      |      |          |
| Picking dates (D)      | 0.088| 0.264|      | 0.007    | 0.020|      | 0.002 | 0.005    |      |      |      |          |
| Interaction (C x D)    | 0.153| 0.458|      | 0.011    | 0.035|      | 0.003 | 0.009    |      |      |      |          |

| Cultivars (C)          | 0.413| 0.500| 0.573| 0.495    | 4.57 | 4.90 | 5.61 | 5.02     | 1.74 | 2.27 | 2.49 | 2.17     |
| Picking dates (D)      | 0.386| 0.487| 0.520| 0.464    | 4.49 | 4.89 | 5.45 | 4.94     | 1.62 | 2.12 | 2.48 | 2.08     |

Table 2 Continue.......

fruits. Similar findings were also reported by Awasthi et al. (1988) and Manivasagan et al. (2006).

The maximum pectin was recorded in Pant Suvarna (0.549%) followed by Pant Manohar (0.371%) and Pant Sudarshan (0.362%). The maximum pectin was recorded at 60 days after fruit set (0.514%) followed by 80 days after fruit set (0.450%) and 40 days after fruit set (0.318%). The maximum pectin (0.712%) was recorded in combination C_3D_2 (Pant Suvarna + 60 days after fruit set) and minimum pectin (0.291%) was recorded in C_2D_1 (Pant Sudarshan + 40 days after fruit set) (Table 2). The less pectin content at D_1 was due to insoluble protopectin which was converted into soluble pectin at D_2 leading to increased in pectin and again decrease in pectin at D_3 was due to conversion of soluble pectin into insoluble pectic acid and also due to hydrolysis of these pectic compound into simple sugars and polysaccharides. Similar results were also observed by Manivasagan et al. (2006).

The maximum anthocyanin was recorded in Pant Manohar (0.051 mg/100g) followed by Pant Sudarshan (0.049 mg/100g) and Pant Suvarna (0.038 mg/100g). The anthocyanin was increased from 0.022 to 0.074 mg/100g from 40 to 80 days after fruit set, respectively. The maximum anthocyanin (0.082 mg/100g) was recorded in combination C_3D_3 (Pant Suvarna + 80 days after fruit set) and minimum anthocyanin (0.009 mg/100g) was recorded in C_3D_1 (Pant Suvarna + 40 days after fruit set) (Table 2). The increase in anthocyanin is due to more biosynthesis of anthocyanin pigments. Similar observations have also been reported by Awasthi et al. (1988) and Manivasagan et al. (2006) in Karonda.

The maximum total carotenoid was recorded in Pant Manohar (0.495 mg/100g) followed by Pant Sudarshan (0.464 mg/100g) and Pant Suvarna (0.243 mg/100g). The total carotenoid was increased from 0.303 to 0.481 mg/100g from 40 to 80 days after fruit set, respectively. The maximum total carotenoid (0.573 mg/100g) was recorded in combination C_3D_3 (Pant Suvarna + 80 days after fruit set) and minimum total carotenoid (0.110 mg/100g) was recorded in C_3D_1 (Pant Suvarna + 40 days after fruit set). Similar finding was also reported by Awasthi et al. (1988).

The maximum phosphorous was recorded in Pant Suvarna (5.65 mg/100g) followed by Pant Manohar (5.02 mg/100g) and Pant Sudarshan (4.94 mg/100g). The phosphorous was increased from 4.67 to 5.78 mg/100g from 40 to 80 days after fruit set, respectively. The maximum phosphorous (6.29 mg/100g) was recorded in combination C_3D_3 (Pant Suvarna + 80 days after fruit set) and minimum phosphorous (4.49 mg/100g) was recorded in C_3D_1 (Pant Sudarshan + 40 days after fruit set). The maximum calcium was recorded in Pant Suvarna (2.57 mg/100g) followed by Pant Manohar (2.17 mg/100g) and Pant Sudarshan (2.08 mg/100g). The calcium was increased from 1.75 to 2.64 mg/100g.

| Cultivars (C) | Pant Suvarna (C_3) | Pant Manohar (C_1) | Pant Sudarshan (C_2) | Mean (C) |
|--------------|--------------------|--------------------|---------------------|----------|
| Mean (D)     | 4.88               | 5.12               | 5.28                | 5.17     |
| S.Em.±       | 0.013              | 0.013              | 0.013               | 0.013    |
| Picking dates (D) | 0.019             | 0.019              | 0.019               | 0.019    |
| Interaction (C x D) | 0.022             | 0.022              | 0.022               | 0.022    |

| Cultivars (C) | Pant Suvarna (C_3) | Pant Manohar (C_1) | Pant Sudarshan (C_2) | Mean (C) |
|--------------|--------------------|--------------------|---------------------|----------|
| Mean (D)     | 4.87               | 5.09               | 5.35                | 5.11     |
| S.Em.±       | 0.014              | 0.013              | 0.013               | 0.013    |
| Picking dates (D) | 0.013             | 0.013              | 0.013               | 0.013    |
| Interaction (C x D) | 0.022             | 0.022              | 0.022               | 0.022    |

Table 2 Continue........
100g from 40 to 80 days after fruit set, respectively. The maximum calcium (2.94 mg/100g) was recorded in combination C_3D_3 (Pant Suvarna + 80 days after fruit set) and minimum calcium (1.62 mg/100g) was recorded in C_2D_1 (Pant Sudarshan + 40 days after fruit set). The maximum iron was recorded in Pant Suvarna (5.92 mg/100g) followed by Pant Manohar (5.28 mg/100g) and Pant Sudarshan (5.13 mg/100g). The iron was increased from 4.87 to 6.11 mg/100g from 40 to 80 days after fruit set, respectively. The maximum iron (6.74 mg/100g) was recorded in combination C_3D_3 (Pant Suvarna + 80 days after fruit set) and minimum iron (4.64 mg/100g) was recorded in C_2D_1 (Pant Sudarshan + 40 days after fruit set) (Table 2). The increase in minerals content of cultivars with the increase in picking dates might be due to the rapid physiological activities taking place in the fruits. Similar results were also reported by Awasthi et al. (1988) and Manivasagan et al. (2006) in Karonda.

**CONCLUSION**

Thus it may be concluded that fruits of cultivar Pant Suvarna was found better in terms of moisture (%), total soluble solids (ºBrix), reducing sugar (%), non-reducing sugar (%), total sugar (%), ascorbic acid (mg/100g), anthocyanin (mg/100g), phosphorous (mg/100g), calcium (mg/100g) and iron content (mg/100g) at 80 days after fruit set.

**REFERENCES**

Awasthi C P, Singh I S and Singh A. (1988). Biochemical composition of promising Karonda cultivars. *Progressive Horticulture*. 20 (3-4): 294-296.

Jadav S B, Joshi G D and Garande V K (2004). Studies on preparation and storage of Karonda (*Carissa carandas* Linn.) fruit products. *Beverage Food World*. 31 (5): 46-47.

Joshi G D, Prabhudesai V G and Salvi M J. (1986). Physico-chemical characteristics of Karonda (*Carissa carandas* L.) fruits. *Maharashtra Journal of Horticulture*. 3 (1): 39-44.

Lane J H and Eynon L. (1992). Determination of reducing sugars by means of Fehling’s solution with methylene blue as an indicator. *Journal of Society of Chemistry*. 42 32-37.

Manivasagan S, Rana G S, Kumar S and Joon M S. (2006). Nutritive value of Karonda (*Carissa carandas* Linn.) grown under Haryana conditions. *Haryana Journal of Horticultural Science*. 35 (1-2): 65-66.

Misra K K and Jaiswal H R. (1999). Studies on physico-chemical characteristics of fruits of some selected lines of Karonda (*Carissa carandas* L.) *Haryana Journal of Horticultural Science*. 28 (3-4): 176-178.

Piper C S. (1966). Soil and Plant Analysis. Handbook Publisher, Bombay.

Ranganna S. (2009). Handbook of Analysis and Quality Control of Fruit and Vegetable Products. 2nd Ed. Tata Mc Graw Hill Publishing Company Limited, New Delhi.

Singh S R, Das C O and Srivastava K K. (1967). Physico-chemical studies of three species of genus Carissa. *Allahabad Farmer*. 41 (2): 83-85.