



Characterization of karonda (*Carissa carandus*) genotypes under Punjab conditions

HARSIMRAT K BONNS¹ and AMANDEEP PAUL²

Punjab Agricultural University, Ludhiana, Punjab 141 001 India

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Karonda (*Carissa carandus* L.) is an evergreen, hardy and thorny fruit shrub with immense nutraceutical value which belongs to family Apocyanaceae. It is best suited for growing in arid tropics and subtropics with minimum management and higher yields. It can also be grown successfully in marginal lands and wastelands and is mainly grown in Maharashtra, Karnataka, Bihar, Madhya Pradesh, Rajasthan and West Bengal. It is used as live bio-fence around orchards besides providing attractive edible fruits. The fruits are a rich source of protein (1.1-2.25%), Vitamin C (1.6-17.9 mg/100g), iron (39.1 mg/100g), calcium (21 mg/100g and phosphorous (38 mg/100g) (Anon 1950, Anon 1979, Kumar and Singh 1993). Both ripe and unripe fruits of karonda are beneficial. Unripe fruits are generally used for vegetable purposes, sauces and pickles. The ripe fruits are dark purple, very acidic to fairly sweet with juicy pulp are also used as toppings on cakes, puddings and ice-creams.

Karonda fruits can be successfully used for preparation of processed products like ready to serve beverage, nectar, squash, pickle and jam (Hiregoudra 2012). The fruits are used for treating arthritis, cardiac diseases, piles and nerve disorders. The roots are useful in stomach disorders, intestinal worms, scabies, diabetes and ulcers.

The phyto-therapeutic importance of karonda fruits has been partly studied by Maheshwari *et al.* (2012) but yet much remains to be studied. Little information is available on morphological and nutritional value of fruits under central zone of Punjab with subtropical climate (30.9010°N and 75.8573°E). The physico-chemical parameters are prime step for processing industries. The present investigation was therefore undertaken in central zone of Punjab to study prospects of karonda fruits for processing purpose.

Four genotypes of Karonda planted at 4 m × 4 m in

college orchard PAU, Ludhiana were evaluated for plant vigour, morphological characters of leaves, stipules and fruits. The study was done during 2018–19 and the fruits were harvested in the month of September-October from each genotype and used for estimating physico-chemical parameters. Ten randomly selected leaves and stipules were taken for measurement of leaf length, diameter and other morphological parameters. Chlorophyll content of leaves was measured with Chlorophyll meter SPAD 502. Canopy volume of plant was determined by using formula ($0.524 \times \text{plant height} \times \text{plant diameter}^2$). Fruit size (Length and diameter) was measured with help of digital Vernier caliper while fruit weight and pulp weight was recorded by digital top pan balance. Fruit size index was calculated by dividing length with width of fruit. Seed weight was calculated from fruit weight and pulp weight by computing their difference. Number of seeds per fruit was counted manually and average was taken. TSS was recorded by hand refractometer and acidity, ascorbic acid, and total sugars were analyzed by procedure given by AOAC (2005). Total proteins and phenols were estimated by methods given by Lowry *et al.* 1951 and Swan and Hills (1959) respectively. Iron content was determined by procedure described by Ranganna (1986) whereas total starch was estimated by Dubois *et al.* (1956). The treatment means were analysed statistically using LSD ($P \leq 0.05$).

The results of morphological characterization of karonda genotypes are presented in Table 1. The karonda genotypes varied significantly with regard to all the characters except plant height which varied from 2.5-4 m. The canopy volume varied from 10.53-32.70 m³. The genotypes with purple blush on green background (G-2 and G-3) were having higher canopy volume as compared to pink blush on white background (G-1 and G-4). Leaf length and diameter varied from 5.65-7.65 cm and 3.0-4.1 cm, respectively. Chlorophyll content varied from 12.30-14.72 SPAD values. Leaf arrangements in all the genotypes were two leaves opposite at one notch. The stipule length varied from 1.65–2.65 cm and stipule diameter was 0.35 cm to 0.45 cm, respectively. Megowal *et al.* (2014) also observed leaf length, leaf diameter and stipule length in

¹Senior Fruit Scientist (harsimratpau@pau.edu), Department of Fruit Science, ²Ph D Scholar (amoo.ap@gmail.com), Department of Botany, CoBS & H, Punjab Agricultural University, Ludhiana.

Table 1 Growth characteristics of different genotypes of karonda plant

Genotype	Plant height (m)	Leaf length (cm)	Leaf diameter (cm)	Stipule length (cm)	Stipule diameter (cm)	Chlorophyll content SPAD value	Canopy volume (m ³)	Leaf arrangement
G-1	2.50	7.42	4.1	2.65	0.40	14.72	10.53	Two leaves Opposite at one notch
G-2	3.50	5.85	3.0	2.35	0.35	14.02	32.70	Two leaves Opposite at one notch
G-3	4.00	5.65	3.9	2.30	0.45	12.30	29.96	Two leaves Opposite at one notch
G-4	3.00	7.65	3.8	1.65	0.35	12.68	12.30	Two leaves Opposite at one notch
LSD (P≤0.05)	NS	0.35	2.01	NS	0.28	NS	2.51	

eight karonda genotypes at CAZRI Jodhpur and found that it varied from 5.73-6.52 cm, 3.03-4.26 cm and 1.45-2.31 cm, respectively.

The data related to physical parameters of fruits of genotypes is presented in Table 2. Fruit length and diameter decreased from unripe to ripe stages in all the genotypes. The maximum fruit length (23.71 cm and 21.56 cm) and fruit diameter (21.34 cm and 18.26 cm) in both the stages i.e. unripe and ripe fruit stage was observed in genotype-2 and minimum in genotype-1. These results are in confirmation with Hiregoudra (2012) who also observed decrease in fruit size from unripe to ripe stage. The average fruit weight decreased from unripe to ripe stage due to degradation processes and loss of moisture. Similar results were observed by Dalal *et al.* (2010) in karonda fruit. Among all the genotypes, fruit weight differed significantly with each other. Maximum fruit weight was in unripe (6.35 g) as well as ripe (4.32 g) stage in genotype-2 and minimum fruit weight was at unripe stage in genotype-4 (4.32 g) and ripe stage in genotype-1. Pulp weight differed significantly with each other. Maximum pulp weight in unripe (6.33 g) as well as ripe (4.30 g) stage was observed in genotype-2 and minimum fruit weight was at unripe (4.04 g) and ripe (3.24 g) stage in genotype-1. Fruit size index was non-significant among different genotypes at both the stages. There was

little increase in seed weight from unripe to ripe stages in all the genotypes as seed became heavier from maturity to ripening. The seed number in fruits varied from 4.33 to 6.0 in different genotypes.

The data related to bio-chemical parameters is presented in Table 3. Increasing trend was observed in total soluble solids, ascorbic acid, total soluble proteins, iron content, and total soluble sugars from unripe to ripe stages. Total soluble solids increased significantly from unripe to ripe stage. Maximum total soluble solids were observed in genotype 3 in both unripe (8.76%) and ripe (10.33%) and minimum in genotype-2 in both unripe (6.04%) and ripe (8.03%) fruits. The results were in confirmation with findings of Dalal *et al.* (2010). Due to loss of moisture, solutes of fruits concentrated which might have resulted in increase in total soluble solids of ripened fruits. Ascorbic acid significantly increased from unripe to ripe stage with maximum ascorbic acid in genotype - 3 at ripe stage (15.20 mg/100g) and unripe stage (7.03 mg/100g) in genotype - 2. Minimum ascorbic acid was observed in genotype-3 at unripe (5.21 mg/100g) and ripe (12.48 mg/100g) stage in genotype-4. These results are in confirmation with results of Hiregoudra (2012) who also observed significant increase in ascorbic acid from unripe to ripe stage. Slight increase in total soluble proteins was observed from unripe to ripe

Table 2 Physical parameters of different genotypes of karonda fruits

Genotype	Stages	Fruit colour	Fruit length (mm)	Fruit diameter (mm)	Fruit weight (g)	Pulp weight (g)	Fruit size index	Seed weight (g)	Average number of seeds/fruit
G-1	Unripe	White with pink blush	21.70	18.03	4.64	4.04	1.20	0.023	5.00
	Ripe	purple	19.77	16.55	3.27	3.24	1.19	0.041	5.00
G-2	Unripe	Green with purple blush	23.71	21.34	6.35	6.33	1.11	0.019	6.00
	Ripe	purple	21.56	18.26	4.32	4.30	1.18	0.029	6.00
G-3	Unripe	Green with purple blush	23.04	19.95	5.46	5.46	1.15	0.08	6.33
	Ripe	purple	21.19	17.31	4.27	4.26	1.22	0.017	6.33
G-4	Unripe	White with pink blush	21.97	18.32	4.42	4.41	1.19	0.016	4.33
	Ripe	purple	21.47	17.79	4.03	4.01	1.20	0.019	4.33
LSD (P≤0.05)			0.57	0.70	0.046	0.058	0.36	0.096	

Table 3 Biochemical parameters of fruits of karonda genotypes

Genotype	Stages	TSS (%)	Acidity (%)	Ascorbic acid (mg/100 g pulp)	Total Soluble Proteins (mg/100 g pulp)	Phenol (mg/100 g pulp)	Iron Content (mg/100 g pulp)	Total Starch (mg/100 g pulp)	Total Soluble sugars (%)
G-1	Unripe	8.278	4.18	6.89	0.60	7.03	4.18	9.60	3.56
	Ripe	10.30	3.12	13.76	0.71	2.45	5.24	5.42	4.86
G-2	Unripe	6.048	3.77	7.03	0.66	6.54	3.86	7.54	2.50
	Ripe	8.033	2.68	14.33	0.73	5.35	6.51	4.26	5.20
G-3	Unripe	8.76	2.17	5.21	0.56	5.64	6.24	7.81	3.96
	Ripe	10.33	2.01	15.20	0.71	2.47	6.88	6.32	5.28
G-4	Unripe	7.42	4.62	6.25	0.62	4.48	2.68	9.48	2.96
	Ripe	10.5	3.71	12.48	0.72	3.45	4.31	5.32	4.60
	LSD ($P \leq 0.05$)	1.25	0.93	0.65	0.83	0.46	1.03	0.52	0.65

fruit which was non-significant; it may be due to loss of moisture. Significant increase in iron content was observed from unripe to ripe stage in genotype-2 and genotype-4 with maximum iron content in genotype-3 at both unripe (6.24 mg/100g) and ripe (6.88 mg/100g) stages. The iron content was minimum in genotype-4 at unripe (2.68 mg/100g) and ripe (4.31 mg/100g) stages. Similar results were observed by Hiregoudra (2012). Significant increase in total soluble sugars was observed from unripe to ripe stage with maximum total soluble sugars in genotype-3 at unripe (3.96%) and ripe (5.28%) stage. These results are in confirmation with Dalal *et al.* (2010), observed increasing trend in total soluble sugars from unripe to ripe stages.

Loss in acidity with ripening process was recorded in all the karonda genotypes. Minimum acid content was observed in genotype-3 at both unripe (2.17%) and ripe (2.01%) stage, whereas maximum acid content in both stages, unripe (4.62%) and ripe (3.71%) was recorded in genotype- 4. Decrease in acidity with ripening might be due to mobilization of organic acid and loss of carboxylic group in the process of respiration. These results are in accordance with those of Sethi and Anand (1977). Starch content also decreased due to conversion of starch into sugars during ripening. Maximum starch content was in genotype-1 at unripe (9.60 mg/100g pulp) stage and at ripe (6.32 mg/100g pulp) stage in genotype-3. Minimum starch was observed in genotype-2 at both unripe (7.54 mg/100g) and ripe (4.26 mg/100g) stages. These results are in confirmation with Awasthi *et al.* (1986). Significant decrease in phenols from unripe to ripe stage was recorded which may be due decrease in astringency with ripening of fruits. Minimum phenols were recorded in genotype-4 at unripe (4.48 mg/100g) whereas at ripe (2.45 mg/100g) stage in genotype - 1 which were at par with genotype 3. Maximum phenols were observed at unripe (7.03 mg/100g) in genotype-1 whereas at ripe (5.35 mg/100g) stage in genotype-2.

SUMMARY

Karonda is rich source of iron, ascorbic acid,

anthocyanins and other antioxidants. As karonda fruit is astringent and sour in taste and not used for desert purpose. Both ripe and unripe karonda fruits are used to prepare various value added products. On the basis of chemical composition, ripe fruits were better with desirable characters, hence G-3 appears to be the best among all the tested karonda genotypes i.e. more total soluble solids, total soluble sugars, ascorbic acid, total soluble proteins and iron content with low acidity and phenols. While, the physical parameters, viz. fruit colour, fruit diameter, fruit length, seed number, seed weight and pulp weight were observed maximum in G-2 followed by G-3 genotypes which can be useful for processing industries for preparation of value added products.

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