Evaluation of Physico-Chemical characters of Karonda (*Carissa carandas* L.) fruits of different genotypes.

Abstract

The current study was conducted in 2021–2022 at the Post Graduate Laboratory of the Department of Horticulture, School of Agriculture, ITM University Gwalior (M.P.)The present study was entitled to Study onCollection and Evaluation of Karonda (*Carissa carandas* L.) Genotypes in Gwalior and Etawah Region. In the present study, 20 Karonda genotypes were collected from two region *viz.* Gwalior and Etawah. The experiment was laid out in Complete Randomized Block Design (CRD) with three replications. The results highlighted that, the genotype GKr_9 produced maximum ~~Fruit~~ fruit ~~Weight~~ weight (3.96 g), ~~Fruit~~ fruit ~~Width~~ width (18.47 mm) and ~~Fruit~~ fruit ~~Length~~ length (24.84 mm). The genotype GKr_{10}, GKr_{11}, GKr_{12}, EKr_{19} and EKr_{20} produced highest number of seed per fruit (3.0) and seed weight (0.50 g). However, the genotype EKr_{14} had maximum total soluble solids (6.17°Brix). ~~However~~Whereas, the genotype EKr_{19} produced highest TSS: acid ratio (4.95) and ascorbic acid (40.76 mg/100g). The genotype GKr_{12} and GKr_{13} had maximum pH of the juice (6.43) and acidity (2.44%). Whereas, the genotype GKr_8 had maximum reducing sugar (16.64%) and total sugar (45.20%). Thus, on the basis of present study it may be concluded that the genotype GKr_8, GKr_9 GKr_{10}, GKr_{11}, GKr_{12}, GKr_{13}, EKr_{14}, EKr_{19} and EKr_{20} were found superior among all the genotypes.

1. INTRODUCTION

Karonda (*Carissa carandas* L.) of family Apocynaceae and having chromosome number 2n=2x=22, is an underutilized fruit plant which thrives well throughout tropical and subtropical climate. It is native to India and also grown widely in other parts of world like Nepal, Afghanistan, South Africa, Malaysia, Indonesia, Sri Lanka and Australia etc. In India, itgrows wild in states of Bihar, West Bengal, Uttar Pradesh, lower, outer and middle Himalayas, Uttarakhand, Maharashtra, Rajasthan and parts of southern India (Malik *et al.,* 2010).The genus *Carissa* comprises of more than 25 species . It is an evergreen, spiny shrub which is found growing wild in India, Sri Lanka, Indonesia, Myanmar, Pakistan, Malaysia and South Africa. It is a hardy,

Comment [A1]: Write references according to journal format

drought-tolerant species which does well in a wide range of soil conditions. This crop is well adapted for arid tropics and sub-tropics since it can withstand high temperatures thrive well as a rainfed crop, and gives yield with the minimum management.

The flowers are pentamerous, white coloured star shaped. Inflorescence is terminal corymbose cyme. Flowering and fruiting takes place twice a year. The primary blooming season occurs in March-April, and fruit matures in August-September, allowing the plants to benefit the most from monsoon rain. The second flowering season is during October-November.The mature fruits are consumed which have taste varying from acidic to sweet, containing a high amount of pectin which makes it useful for the preparation of different products such as jelly, jam, squash, sauce and syrup. Sour and astringent unripe fruits are traditionally used for preparation of pickles and chutney.

Karonda is a very hardy shrub and it is successfully cultivated in tropical and sub-tropical climatic conditions. However, heavy rainfall and waterlogged conditions are harmful. Soil is not a limiting factor for its cultivation. It can be grown on a wide range of soils including saline and sodic soils (Bose et al., 1999). In karonda, on the basis of fruit colour, three categories are recognized: pink-white, greenish pink and reddish purple. The fruits of pink variety are white and change to pink at maturity. The colour of reddish-purple fruits is green at immature stage, which changes to reddish purple at maturity.

2. Materials and methods

Twenty samples of karonda fruit taken from two different places i.e, Gwalior and Etawah. After accession to record observation on fruit physical perametersi.e; fruit weight, number of seeds per unit and fruit chemical parameters i.e; Total Soluble Solids (TSS°Brix), Tritable acidity (%), Ascorbic acid (mg/100).

2.1 List 1 : Details of Genotype used for the study

Sr. No.	Genotypes Name	Symbol Used
1	Gwalior Karonda 1	GKr_1
2	Gwalior Karonda 2	GKr_2
3	Gwalior Karonda 3	GKr_3
4	Gwalior Karonda 4	GKr_4
5	Gwalior Karonda 5	GKr_5
6	Gwalior Karonda 6	GKr_6
7	Gwalior Karonda 7	GKr_7
8	Gwalior Karonda 8	GKr_8
9	Gwalior Karonda 9	GKr_9
10	Gwalior Karonda 10	GKr_{10}
11	EtawahKaronda 11	EKr_{11}
12	EtawahKaronda 12	EKr_{12}
13	EtawahKaronda 13	EKr_{13}
14	EtawahKaronda 14	EKr_{14}
15	EtawahKaronda 15	EKr_{15}
16	EtawahKaronda 16	EKr_{16}
17	EtawahKaronda 17	EKr_{17}
18	EtawahKaronda 18	EKr_{18}
19	EtawahKaronda 19	EKr_{19}
20	EtawahKaronda 20	EKr_{20}

2.2 Statistical analysis

The experiments were conducted in three replication and the statistical analysis of data was done by computer software “SPSS” for the analysis of variance as the method describe by Panse and Sukhatme, (1985) for Completely Randomized Design.

Comment [A2]: Write references according to journal format

3. Result and discussion

3.1 Physical parameters of karonda

3.1.1 Fruit weight (g)

The individual fruit weight of three fully matured fruits was recorded with the help of electronic balance and data were subjected to statistical analysis. Mean weight of Karonda fruits have been present in Table .1 and Fig..1. The significant variation in individual fruit weight was observed in all twenty genotypes of Karonda which were collected from Gwalior and Etawah. However, the individual fruit weight ranged from 2.25g to 3.96g was observed from 20 genotypes of Karonda. The maximum (3.96 g) individual fruit weight was observed from genotypes GKr_9. It was at par with the genotypes EKr_{17}. However, the minimum (2.25g) individual fruit weight was observed from the genotypes EKr_{17}.

Table.1 Average individual fruit weight (g) and weight of three fruits (g) of different Karonda (*Carissa carandas* L.) genotypes

Genotypes	Fruit weight (g)	Weight of three fruits (g)
GKr_1	2.82	8.80
GKr_2	2.86	8.60
GKr_3	3.17	9.49
GKr_4	3.83	11.50
GKr_5	3.88	11.66
GKr_6	3.29	9.91
GKr_7	3.68	11.07
GKr_8	2.71	8.15
GKr_9	3.96	11.90
GKr_{10}	3.04	9.15
EKr_{11}	3.02	9.90
EKr_{12}	2.73	10.23
EKr_{13}	3.22	9.10
EKr_{14}	3.67	9.84
EKr_{15}	2.86	9.82
EKr_{16}	2.66	9.68
EKr_{17}	2.25	11.13
EKr_{18}	2.75	10.63
EKr_{19}	3.16	11.70
EKr_{20}	3.20	10.70

SED	**0.35**	**0.91**
SEM(±)	**0.43**	**1.12**
CD (at 1%)	**0.97**	**2.48**

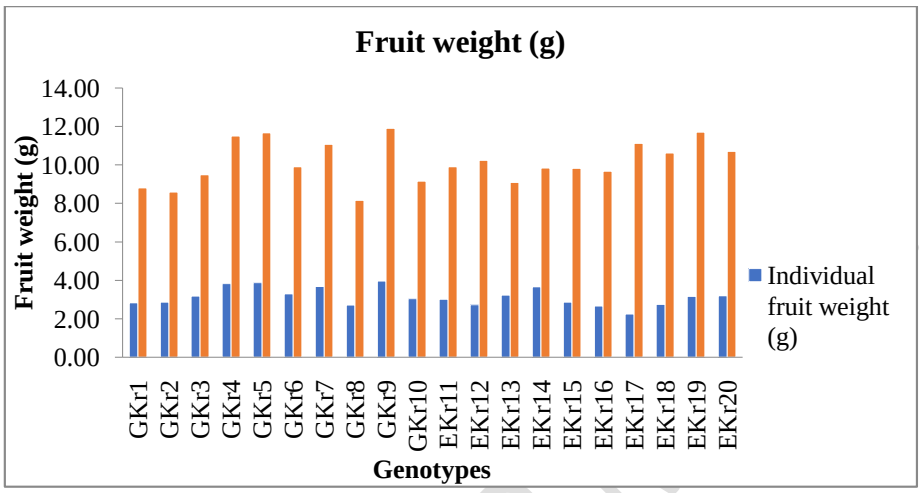

Fig 1 : Graphical presentation showing fruit weight variation in different genotypes

3.1.2 Number of seeds per fruit

The number of seed per fruit of three fully matured fruits was counted manually after the cutting of fruits and data was subjected to statistical analysis. Average value of number of seeds per fruit for the twenty genotypes under evaluation has been presented in Table 2 and Fig. 2 The significant variation in number of seeds per fruit of Karonda was observed in all twenty genotypes which were collected from Gwalior and Etawah. However, the number of seeds per fruit ranged from 2.00 to 3.00 was observed from 20 genotypes of Karonda. It was observed that the genotypesEKr_{10}, EKr_{11}, EKr_{12}, EKr_{19}, and EKr_{20}, had maximum (3.00) number of seeds per fruit. It was at par with the genotypes, GKr_2, EKr_3, EKr_7, EKr_8, EKr_9, EKr_{13} and EKr_{14} respectively. However, the minimum (2.00) number of seeds per fruit was observed from the genotypes GKr_2, EKr_3, EKr_7, EKr_8, EKr_9, EKr_{13} and EKr_{14} respectively.

Table.2. Average number of seed per fruit and seed weight (g) of different Karonda (*Carissa carandas* L.) genotypes

Genotypes	Number of seed per fruit	Seed weight (g)
GKr_1	2.67	0.43
GKr_2	2.00	0.33
GKr_3	2.00	0.30
GKr_4	2.33	0.33
GKr_5	2.67	0.33
GKr_6	2.33	0.20
GKr_7	2.00	0.30
GKr_8	2.00	0.30
GKr_9	2.00	0.23
GKr_{10}	3.00	0.50
EKr_{11}	3.00	0.37
EKr_{12}	3.00	0.43
EKr_{13}	2.00	0.30
EKr_{14}	2.00	0.43
EKr_{15}	2.33	0.27
EKr_{16}	2.67	0.27
EKr_{17}	2.33	0.23
EKr_{18}	2.33	0.23
EKr_{19}	3.00	0.37
EKr_{20}	3.00	0.43
SED	**0.29**	**0.07**
SEM(±)	**0.36**	**0.09**
CD (at 1%)	**0.81**	**0.21**

3.2 Fruit chemical parameters

3.2.1 Total Soluble Solids (°Brix)

The total soluble solids of Karonda fruits were observed with the help of digital refractometer from three randomly selected fully matured fruits and data were

subjected to statistical analysis. The mean value of total soluble solids of twenty Karonda genotypes has been present in Table 3 and Fig. 3. The significant variation in total soluble solids of Karonda fruits were observed in all twenty genotypes of Karonda which were collected from Gwalior and Etawah. However, the total soluble solids of Karonda fruits were ranged from 4.63°Brix to 6.17°Brix was observed from 20 genotypes of Karonda. The maximum (6.17°Brix) seed weight was observed from genotypes EKr_{14}. It was at par with rest of the genotypes. However, the minimum (4.63°Brix) seed weight was observed from the genotypes GKr_{15}.

3.2.2 Titrable acidity (%)

The titrable acidityof Karonda fruits were observed from three randomly selected fully matured fruits and data were subjected to statistical analysis. The mean value of titrable acidity of twenty Karonda genotypes has been present in Table 3 and Fig. 3. The significant variation in titrable acidityof Karonda fruits were observed in all twenty genotypes of Karonda which were collected from Gwalior and Etawah. However, titrable acidity of Karonda fruits were ranged from 0.95 % to 2.80 % was observed from 20 genotypes of Karonda. The maximum (2.80 %) titrable acidity was observed from genotypes EKr6. It was at par with the genotypes EKr16, EKr_{17}, EKr_{18}, EKr_{19} and EKr_{20} respectively. However, the minimum (0.95 %) titrable acidity was observed from the genotypes EKr_{19}.

3.2.3 TSS: Acid ratio

The TSS: Acid ratio of Karonda fruits were observed by dividing total soluble solids by titrable acidity and data were subjected to statistical analysis. The mean value of TSS: Acid ratio of twenty Karonda genotypes has been present in Table 3 and Fig. 3. The significant variation in TSS: Acid ratio of Karonda fruits were observed in all twenty genotypes of Karonda which were collected from Gwalior and Etawah. However, TSS: Acid ratio of Karonda fruits were ranged from 1.78 to 4.85 was observed from 20 genotypes of Karonda. The maximum (4.85) TSS: Acid ratio was observed from genotypes EKr_{6}. It was at par with the genotypes GKr6 and GKr_{8}. However, the minimum (1.78) TSS: Acid ratio was observed from the genotypes GKr_{6}.

Table 3. Average total soluble solids (°Brix), titrable acidity (%) and TSS:acid ratio of different Karonda (*Carissa carandas* L.) genotypes

Genotypes	Total Soluble Solids	Titrable acidity	TSS:Acid ratio

	(TSS°Brix)	(%)	
GKr_1	5.33	2.17	2.46
GKr_2	5.00	2.00	2.50
GKr_3	4.93	1.87	2.63
GKr_4	4.90	2.08	2.36
GKr_5	4.93	2.15	2.29
GKr_6	5.00	2.80	1.78
GKr_7	4.77	1.69	2.81
GKr_8	4.93	2.58	1.91
GKr_9	4.97	2.16	2.30
GKr_{10}	4.93	2.11	2.34
EKr_{11}	4.87	2.12	2.29
EKr_{12}	4.90	1.93	2.54
EKr_{13}	4.90	2.44	2.01
EKr_{14}	6.17	2.00	3.08
EKr_{15}	4.63	2.37	1.96
EKr_{16}	4.83	1.00	4.85
EKr_{17}	4.77	1.04	4.58
EKr_{18}	4.87	1.56	3.12
EKr_{19}	4.70	0.95	4.95
EKr_{20}	4.67	1.25	3.73
SED	**0.22**	**0.43**	**1.36**
SEM(±)	**0.27**	**0.53**	**1.11**
CD (at 1%)	**0.60**	**1.17**	**3.01**

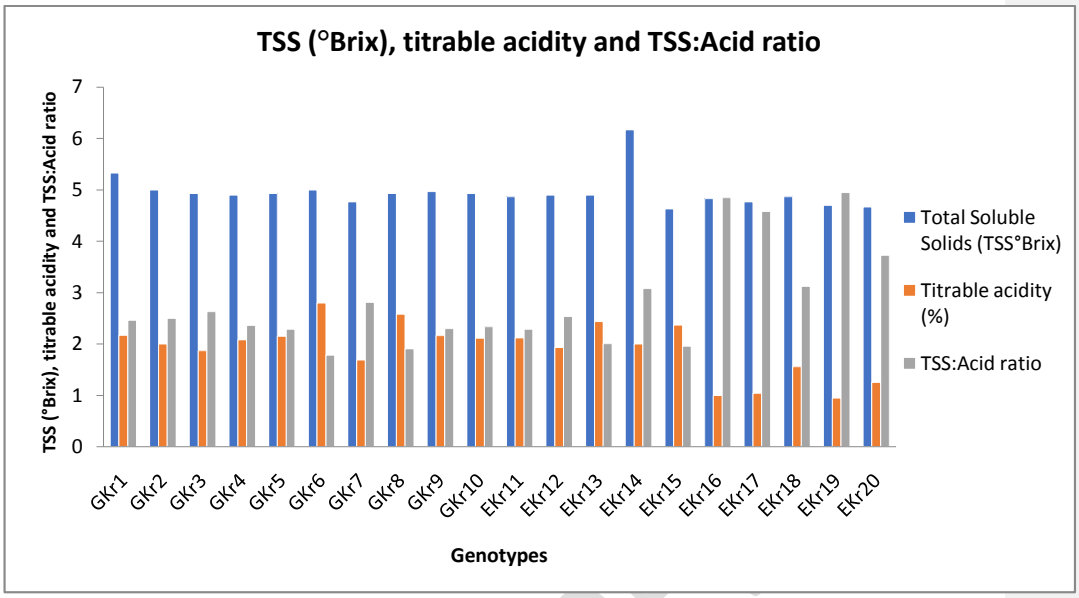

Fig 2 Average total soluble solids (TSS°Brix), titrable acidity (%) and TSS: ratio of different Karonda (*Carissa carandas* L.) genotypes

3.5 pH of the juice

The pH of the juice of Karonda fruits were observed by using litmus paper and data were subjected to statistical analysis. The mean value of pH of the juice of twenty Karonda genotypes has been present in Table 4and Fig. 4. The significant variation pH of the juice of Karonda fruits were observed in all twenty genotypes of Karonda which were collected from Gwalior and Etawah. However, pH of the juice of Karonda fruits were ranged from 5.60 to 6.43 was observed from 20 genotypes of Karonda. The maximum (6.43) pH of the juice was observed from genotypes EKr_{12}. It was at par with the morphotype EKr_{17}. The minimum (5.60) pH of the juicewas observed from the genotypes EKr_{17}.

3.6 Ascorbic acid (mg/100)

Data was observed on ascorbic acid and presented in Table 4and Fig. 4 The significant variation was observed in 20 genotypes of Karonda fruits. However, the ascorbic acid of Karonda fruits was ranged from 31.30 mg/100g to 40.76 mg/100g. The maximum (40.76 mg/100g) ascorbic acid was observed in genotypes GKr_9. It was at par with the rest of the genotypes. The minimum (31.30 mg/100g) ascorbic acid was observed in the genotypes GKr_5.

Table 4 Average pH of the juice and ascorbic acid (mg/100) of different Karonda (*Carissa carandas* L.) genotypes

Genotypes	pH of the juice	Ascorbic acid (mg/100)
GKr_1	6.23	33.38
GKr_2	5.83	34.36
GKr_3	6.30	31.98
GKr_4	5.87	35.45
GKr_5	6.37	31.30
GKr_6	6.40	32.14
GKr_7	6.13	35.32
GKr_8	6.13	36.38
GKr_9	6.40	40.76
GKr_{10}	6.17	34.55
EKr_{11}	6.37	34.33
EKr_{12}	6.43	32.34
EKr_{13}	6.30	31.41
EKr_{14}	6.17	33.07
EKr_{15}	6.07	32.20
EKr_{16}	6.30	37.57
EKr_{17}	5.60	35.59
EKr_{18}	6.33	36.24
EKr_{19}	6.27	32.45
EKr_{20}	6.40	32.80
SED	**0.27**	**0.88**
SEM(±)	**0.33**	**1.08**
CD (at 1%)	**0.74**	**2.40**

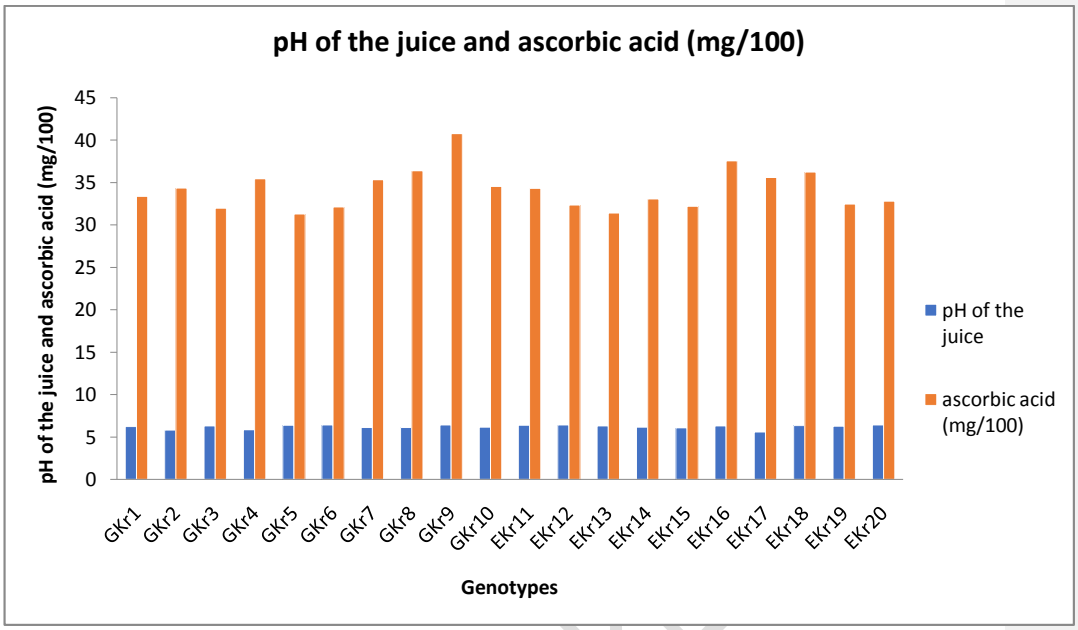

Fig 3.Average pH of the juice and ascorbic acid (mg/100) of different Karonda (*Carissa carandas* L.) genotypes

4. Discussion

~~On the basis of the findings, an attempt has been made in this chapter to explain the possible reasons of variations obtained. The result has been discussed in the light of literature available for the different characters under study. The experiment was laid out in the Completely Randomized Block Design with three replications and each replication was comprised of twenty Karonda genotypes which were collected from Gwalior and Etawah.~~

~~The findings are briefly discussed and interpreted in support of the findings of the previous research work pertaining to "Studies on collection and evaluation of Karonda (*Carissa carandas* L.) genotypes in Gwalior and Etawah Region". During the course of discussion an effort has been made to establish relationship between various physical parameters (*viz.*,individual Fruit weight (g), number of seeds per fruit and seed weight (g)), chemical parameter (*viz.*, Total Soluble Solids (TSS°Brix), titrable acidity (%) TSS:acid ratio, pH of the juice, ascorbic acid (mg/100). However, the results on thesis aspects given in the preceding chapter are being discussed as under:~~

4.1 Evaluation of morphological characters of Karonda (*Carissa carandas* L.) fruits of different genotypes

Morphological characterization is the primary step useful in identification, assessment and subsequent selection of elite forms. The prime advantages of morphological traits are simplicity and rapid, inexpensive assays, even from herbarium specimens and other dead tissues (Kishor *et al.,* 2019). In most cases, morphological traits are evaluated manually and are thereby subjective and do not define the potential use of any genotype, even though these traits have long been the means of studying variability among populations in fruit crops. Quantitative and qualitative fruit traits have been found useful in identification and assessment of variability and selection of elite forms for fruit production on a large scale.

In the present study, genotypes also exhibited diversity in individual fruit weight, weight of three fruits, fruit width, fruit length, number of seeds per fruit and seed weight different genotypes of Karonda showing large differences between maximum and minimum values. It is clear from the results that the Karonda accessions varied significantly with regard to the majority of the morphological characters. The results of morphological characterization of Karonda genotypes are presented in Table 4 and 5. The Karonda genotypes varied significantly with ranged to all the fruit morphological characters except individual fruit weight which varied from 2.25 g to 3.96 g and maximum (3.96 g) individual fruit weight was observed from the mophotypesEKr_{17}. The weight of three fruits varied from 8.60 g to 11.90 g and maximum (11.90 g) in the genotypes GKr9. The similar variation in Karonda fruit were observed by Dalal *et al.* (2010). The fruit width varied from 15.44 mm to 18.47 mm and the maximum (18.47 mm) fruit width recorded in the genotypes GKr9. However, the fruit length varied from 18.77 mm to 24.84 mm and the maximum (24.84 mm) fruit length was noted from the mophotypesGKr_9. These results are in confirmation with Hiregoudra (2012) who also observed significant variation in the size of Karonda fruits.Differences in fruit size may be primarily due to plant vigour, competition among fruits in the inflorescence, number and size of developed achenes, differences in activity among the achenes in the production of growth material, climatic conditions, irrigation and plant nutrients (Kishor *et al.,* 2019). The number of seeds per fruit ranged from 2.00 to 3.00 and the highest (3.00) number of seeds per was observed under the mophotypesEKr_{10}, EKr_{11}, EKr_{12}, EKr_{19}, and EKr_{20}. Whereas, the seed weight of Karonda fruits varied from 0.20 g to 0.50 g and the

Comment [A3]: Write references according to journal format

maximum (0.50 g) seed weight was observed from the genotypes EKr13. These results were conformity with the results of Dalal *et al.* (2010) in Karonda. Greater variability among the jamun genotypes were also reported by Prakash *et al*. (2010). Similar observations on fruit length, width and weight of jamun were reported by (Shahnawaz and Sheikh, 2011). Further they stated these length and diameter are the two important factors ultimately decide whether fruit has completely grown and ready for harvest. In many countries fruit girth is taken in to account to judge the maturity status of fruits through ring tests. Weight on the other hand is an important factor in judging its compactness, maturity, juice content and level of chemical constituents (Babu *et al.,* 2019). Meghwal *et al.* (2014) also reported significant variations in fruit length, weight, volume, diameter, number of seeds, and vitamin C content in karonda genotypes collected from different regions of Rajasthan, Gujarat and Uttaranchal.

Further, selection and correct identification of genotypes is essential for any breeding and improvement effort, is difficult, inefficient and inaccurate when based on morphological traits alone. Even though a high number of descriptors are used (Thomas *et al*., 1994), this due to some phenotypic traits are difficult to describe, and phenotypic data may be influenced by environmental factors and growing conditions, in addition to quantitative inheritance, or partial and complete dominance often confound the expression of genetic traits. Vasugi *et al*. (2012) considering the difficulties involved in the traditional divergence studies based on morphological characterization; microsatellites were successfully used for genetic diversity analysis of the unique indigenous mango accessions. The disadvantages of morphological characterizations are their low polymorphism, heritability and sensitivity to changes in environmental conditions. Having effective means of intracultivar variability identification and verification, therefore, is important. Reliable gene markers should be identified.

To find out the best quality karonda (*Carissa carandas* L.) genotypes

Qualitative characteristics provide quite useful information particularly from nutritional and biochemical point of view. The main factors responsible for variation in fruit composition are climatic and nutritional conditions and fruit load on plants.

In a previous study by Patil *et al.* (2017) significant difference among the Karonda genotypes were reported with respect to quality parameters such as titratable acidity,

Comment [A4]: Write references according to journal format

Comment [A5]: Write references according to journal format

Comment [A6]: Write references according to journal format

Comment [A7]: Write references according to journal format

Comment [A8]: Write references according to journal format

Comment [A9]: Write references according to journal format

Comment [A10]: Write references according to journal format

Comment [A11]: Write references according to journal format

reducing sugar, non-reducing sugar and total sugar which was attributed to the genetic makeup of genotypes and the prevailing climatic conditions.

In the present study the chemical parameters are presented in the Table.4&5 .The content of total soluble solids in Karonda genotypes fruit varied from 4.63°Brix to 6.17°Brix. However, these findings partially agreed with the result of Bhuyan and Guha (1995), who also reported TSS from 16.22 to 24.14 ºBrix in 14 mango germplasm under the climatic conditions of Rajshahi. Similar variation in TSS (16.11 to 23.00 ºBrix) is also reported by Singh (2002).Thetitrable acidity percentage ranged from 0.95 % to 2.80 %. The similar results observed by Awasthi et al. (1986) who observed significant variation in acid content of Karonda fruits.The ascorbic acid ranged from 31.30 mg/100g to 40.76 mg/100g. These results are in confirmation with result of Hiregoudra (2012) who observed significant variation in ascorbic acid content of Karonda fruits.However, th**e** TSS:Acid ratio varied from 1.78 to 4.85, pH of the juice ranged from 5.60 to 6.43carandas accessions developed at field genebank in CAZRI. Variations in the germplasm of Karonda with regard to physico-chemical characters, maturity period and yield components have also been reported from Punjab (Bal, 2003).

Comment [A12]: Write references according to journal format

Comment [A13]: Write references according to journal format

Comment [A14]: Write references according to journal format

Comment [A15]: Write references according to journal format

Conclusion

On the basis of present study entitled “Studies on collection and evaluation of karonda (*Carissa carandas*L.) genotypes in Gwalior and Etawah Region” it may be concluded that the genotype GKr_9 produced maximum Individual Fruit Weight (3.96 g), Weight of three Fruits (11.90 g), Fruit Width (18.47 mm) and Fruit Length (24.84 mm). The genotype GKr_{10}, GKr_{11}, GKr_{12}, EKr_{19} and EKr_{20} produced highest number of seed per fruit (3.0) and seed weight (0.50 g). However, the genotype EKr_{14} had maximum total soluble solids (6.17°Brix). However, the genotype EKr_{19} produced highest TSS:Acid ratio (4.95) and ascorbic acid (40.76 mg/100g). The genotype GKr_{12} and GKr_{13} had maximum pH of the juice (6.43) and acidity (2.44%). Whereas, the genotype GKr_8 had maximum reducing sugar (16.64%) and total sugar (45.20%).

References

Comment [A16]: Write references according to journal format

Bose, T. K., Mitra, S. K., Farooki, A. A and Sadhu, M. K (1999). Karonda In: Sub-Tropical Horticulture. *Naya Prokash, Kolkata*, (2): p.721-723.

Kanupriya, C., Tripathi, P. C., Singh, P., Venugopalan, R and Radhika, V (2019). Analysis of morphological, biochemical and molecular diversity in karonda (*Carissa carandas* L.) germplasm. *Fruits*, 74(3):130–140.

Kumar, A. K and Tirumala, R (2015). Assessment of genetic variability in Indian Karonda (*Carissa opaca* L.) accessions using DNA based inter simple sequence repeat (ISSR) Markers. *Intl. J. Engg. Sci. Adv. Res*., 1(4), 17–22.

Maheshwari, R., Sharma, A and Verma, D (2012). Phytotherapeutic significance of Karunda. *J. Environ. Pharmacol. Life Sci.*, 1(12): 34–36.

Malik, S. K., Chaudhury, R., Dhariwal, O. P and Bhandari, D. C (2010). Genetic Resources of Tropical Underutilized Fruits in India. *NBPGR, NewDelhi*, p.168.

Rahmatullah, M., Noman, A., Hossan, M. S., Harun Or-Rashid, M., Rahman, T., Chowdhury, M. H., and Jahan, R (2009). A survey of medicinal plants in two areas of dinajpur district, bangladesh including plants which can be used as functional foods. *American-Eurasian Journal of Sustainable Agriculture*, 3(4): 862-876.

Rajasekaran, A., Jeyasudha, V., Kalpana, B and Jayakar, B (1999). Preliminary phytochemical and antipyretic evaluation of *Carissa carandas*. *Indian Journal ofNatural Product*, 15(1): 27-29.

Ramanjinappa, V., Arunkumar, K. H., Hugar, A and Shashibhaskar, M. (2011). Genetic ariability studies in Okra (*Abelmoschus esculentum* L. Moench). *Plant Arvhive*, 11(1): 435-437.

Sawant, B. R., Desai, U. T., Ranpise, S. A., More, T. A and Sawant, S. V (2002). Genotypic and phenotypic variability in Karonda (*Carissa carandas* L.). *J. Maharashtra Agric. Univ.*, 27(3): 266–268.

Sawant, R. S and Godghate, A. G (2013). Comparative studies of phytochemical screening of *Carissa carandas* L. *Asian J. Plant Sci. Res.,* 3(1): 21-25.

Singh, A. K. and H. Ravishankar (2010). Prospects of production of quality planting material of underutilized fruits. In: National Conference on Production of Quality Seeds and

Planting Material – Health Management in Horticultural Crops. *New Delhi*, p. 149-150.

Singh, S., Singh, A. K., Meghwal, P. R., Singh, A and Swamy, G. S. K (2014). Karonda. Tropical and Sub tropical Fruit Crops: Crop Improvement and Varietal Wealth. 393-404.

Babu, P., Raghavendra, S. and Basavaraj L.T. (2019). Physico-chemical characterization of Jamun (*Syzygiumcumini*Skeels) seedling genotypes. Journal of Pharmacognosy and Phytochemistry, 8(4): 300-303.

Bal, J.S. 2003. Genetic resources of underutilized fruits in Punjab subtropics. *Acta Hort*., 623: 325-331.

Bhuyan, M. A. J and Guha, J (1995). Performance of some exotic mango germplasms under Bangladesh condi-tions. *Bangladesh Hort.* 23(1&2): 17-22.

Dalal, R. P. S., Navjot., Thakur, A and Singh A (2010). Nutritional value of Karonda (*Carissa carandas* L.)- A-non-conventional fruit under semi-arid condition of Punjab. *Indian Journal of Agroforestry*. 12(2): 102-104.

Hiregoudra, V. S (2012). Physico chemical characteristics, value addition and shelf life of evaluation Karonda (*Carissa carandas* L.). M.Sc. Thesis, *University of Agriculture Science*, Dharwad.

Kishor, S., Dwivedi, D. H., Maji, S., Singh, N and Gond, M (2019). Clonal Variability in Mango (*Mangifera indica* L.) Orchards cv. Dashehari. Indian Journal of Ecology, 46(2): 311-315.

Meghwal, P. R., Singh, S. K., Singh, A and Pathak, R (2014). Characterization of Karonda (*Carissa carandas* L.) accessions under arid region. *Journal of Applied Horticulture,* 16(2): 157-160.

Prakash, J., Maurya, A. N and Singh, S. P (2010). Studies on variability in fruit characters of Jamun. *Indian J Hort*. 2010; 63:63-69.

Sethi, V. K and Anand, J. C (1977). Drying of karonda for making their preserve. *Indian Food Pocker*. 33(8): 20-23.

Shahnawaz and Sheikh, A. S (2011). Physicochemcial characteristics of Jamun fruit. *J Hort. and For.,* 3:301-306.

Singh, B. D (2000). Plant breeding: Principles and methods. *Kalyani publishers*, Sixth revised and enlarged edition. p107.

Thomas, M. R., Cain, P and Scott, N. S (1994). DNA typing of grapevines: a universal methodology and database for describing cultivars and evaluating genetic relatedness. *Plant Mol. Biol.* 25: 939-949.

Vasugi, C., Dinesh M. R., Sekar K., Shivashankara K.S., Padmakar, B and Ravishankar, K. V (2012). Genetic diversity in unique indigenous mango accessions (Appemidi) of the Western Ghats for certain fruit characteristics. *Curr. Sci.* 103(2): 199-207.