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Biochemical studies during fruit growth & development of Ber (*Zizyphus mauritiana* L.) genotypes

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Abstract
The present investigation was carried out during the year 2017-2018 at Department of Horticulture, College of Agriculture, Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur (M.P.). The experiment was laid out in Completely Randomized Design (CRD) with four replication comprising six treatment (different genotypes of ber - viz, Gola, Banarasi karaka, Umran, Jawahar ber-1, Jawahar ber-2, Jawahar ber-3.).
It was found that the various chemical parameters like TSS, total sugars, reducing sugars, non reducing sugars and ascorbic acid were found to be increased during the entire course (fruit setting to maturity) of growth and development period. Jawahar ber-3 had the highest T.S.S. content (22.28 Brix). The highest total sugar (9.21%) was noticed in jawahar ber-3. Umran had the highest reducing sugar content (4.64%). The highest ascorbic acid content was noticed in Jawahar ber-2 (96.60 mg/100 g of pulp).

Keywords: Ber genotype, chemical changes during growth and development

1. Introduction
Ber (*Ziziphus mauritiana* Lamk.) is one of the most ancient and common fruit indigenous to India and belongs to family Rhamnaceae. The genus Zizyphus includes about fifty species of which about 18 to 20 are native to India (Pareek, 1983) [8]. Being xerophytic, ber is an important fruit crop of arid and semi-arid regions. Ber is previously recognized as poor man's fruit, also designated as "King of Arid fruits" owing to fact that it can be grown in unproductive, waste, marginal or inferior soil with pH as high as 9.0 in arid and semi-arid regions. It can be grown on marginal lands generally unsuitable for cultivation of other horticultural and agronomic crops. Ber requires less water than other fruit crop. It is thus, much more suited to dryland farming. It is, thus, popularly called as a desert apple'. It can successfully be cultivated even in the most marginal ecosystems of the sub-tropics and tropics (Pareek, 2001) [9]. Ber is popular due to high economic returns, low cost of cultivation, wider adaptability and ability to withstand drought. The ber grows on variety of soils from gravelly, shallow to deep aridisols. Rajasthan, Haryana, Uttar Pradesh, Gujarat, Madhya Pradesh, Bihar, Maharashtra, Andhra Pradesh and Tamil Nadu are the major ber growing states of the India. The area and production of Ber in India is reported to be 49 Thousand ha and 526 Thousand MT, respectively (Anonymous, 2016-17) [1]. Ber is one of the most nutritious fruits and have medicinal and processing potential. Despite of all these attributes, the crop remained neglected for a long time and the area expansion is not at a desirable speed. Lack of the knowledge in respect of superior varieties and their adaptability in different agro-climatic zones appear to be the main hurdle in the expansion of area.
Reviewing the merits, there is considerable scope for improvement by thoroughly screening some genotypes for their growth behaviour to select or recommend superior varieties to the farmers. Variation in yield as well as physical and chemical properties of fruits of different ber varieties has been reported by several workers.
The information on pattern of chemical changes during growth and development of ber fruits are scanty and it is an essential factor to evaluate the different genotypes for chemical attributes and to study the variability among the different genotype of ber fruit crop. Therefore, the present investigation has been under taken with objective to study the chemical pattern of fruit during growth and development in different genotypes of ber.

2. Materials and Methods

The experiment was conducted at the Fruit research station Imalia, the biochemical analysis of fruits and organoleptic evaluation were carried out at the loboratries of Department of Horticulture and Food Science & Technology, College of Agriculture Jawaharlal Nehru Krishi Vishwa Vidyalaya Jabalpur during the year 2017-18. The experiment was laid out in Completely Randomized Design (CRD) with four replication comprising six different genotypes of ber (treatment) viz, Gola, Banarasi karaka, Umran, Jawahar ber-1, Jawahar ber-2, Jawahar ber-3. From each treatment, 5 fruits were selected and evaluated for chemical changes at an interval of 30 days from fruit setting to maturity. The total soluble solids was recorded with the help of Erma hand refract meter (0-32 0Brix). Total sugars were determined following the method described by Lane and Eyon. Reducing sugars were determined by the method of Lane and Eyon. The non-reducing sugar was calculated by subs tracking the reducing sugar from total sugar. The ascorbic acid content was estimated as per Assay method given by Ranganna (1986).

3. Results and Discussion

3.1 Total soluble solid

The data pertaining to the total soluble solid (^{0} Brix) of ber fruits as influenced by different genotypes during growth and development stages (table-1) showed that the total soluble solid of fruit of different ber genotypes have been found to be increased with advancement of growth and development period. The maximum (8.20^0) total soluble solid was recorded in Jawahar ber-1 and the minimum (4.10^0) in Umran at 30 days. At 60 days, the maximum (9.18^0) total soluble solid was found in Gola and the minimum (6.30^0) in Jawahar ber-3. The maximum (15.20^0) total soluble solid was observed in Gola and minimum (10.30^0) in Jawahar ber-3 at 90 days. At 120 days, the maximum (20.10^0) total soluble solid was recorded in Gola and the minimum (13.10^0) in Jawahar ber-3. The maximum (20.36^0) total soluble solid was found in Jawahar ber-2 and minimum (17.32^0) in Banarasi karaka at 150 days. At 180 days Jawahar ber-3 recorded TSS (22.28^0). Similar results are also supported by Teaotia *et al*. (1974) [12], Gupta (1977) [5], Singh *et al*. (1983) [10], Yamdagni *et al*. (1985) [13].

3.2 Total sugar

The data regarding total sugar (%) of ber fruits as influenced by different genotypes during growth and development stages (table -2) revealed that total sugar of fruit of different ber genotype have been found to be increased with advancement of growth and development period. The maximum (3.42%) total sugar was found in Gola and the minimum (2.54%) in Banarasi kadaka at 30 days. The maximum (4.12%) total saugar was found in Gola and the minimum (2.38%) in Jawahar ber-3 at 60 days. The maximum (5.16%) total sugar was observed in Gola and the minimum (2.24%) in Jawahar ber-3 at 90 days. At 120 days, the maximum (8.51%) total sugar was found in Gola and the minimum (4.64%) in Jawahar ber-3. The maximum (8.17%) total sugar was recorded in Banarasi karaka and minimum (6.23%) in Jawahar ber-3 at 150 days. At 180 days Jawahar ber-3 recorded (9.21%). Findings are in the line of Singh *et al*. (1983) [10] who studied chemical characteristics of ber cvs. Gola, Muria, Kaithli, Chhuhara and Umran and reported that total sugars were highest in Umran (8.1 per cent) and Gola (8.05 per cent). Pandey *et al*. (1990) [7].

3.3 Reducing sugar

The data pertaining to the reducing sugar (%) of ber fruits as influenced by different genotypes during growth and development stages (table -3) showed that the reducing sugar of fruit of different ber genotypes have been found to be increased with advancement of growth and development period. Regarding the maximum (1.81%) reducing sugar was found in Jawahar ber-1 and the minimum (1.38%) in Jawahar ber-2 at 30 dyas. At 60 days, the maximum (2.36%) reducing sugar was recorded in Umran and minimum (0.97%) in Jawahar ber-3. The maximum (2.97%) reducing sugar was observed in Umran and the minimum (1.21%) in Jawahar ber-3 at 90 days. At 120 days, the maximum (3.46%) reducing sugar was found in Umran and minimum (1.95%) in Jawahar ber-3. The maximum (4.64%) reducing sugar was observed in Umran and minimum (3.11%) in Banarasi karaka at 150. At 180 days Jawahar ber-3 recorded (4.06). Teaotia *et al*. (1974) [12] reported that highest reducing sugars were recorded in Jogia (9.776 per cent) followed by Badshah Pasand (7.726 per cent).

3.4 Nonreducing sugar

The data pertaining to the non-reducing sugar (%) of ber fruits as influenced by different genotypes during growth and development stages (table -4) showed that the non-reducing sugar of fruit of different ber genotype have been found to be increased with advancement of growth and development period. the maximum (2.01%) non reducing sugar was found in Gola and the minimum (1.05%) in Jawahar ber-1 at 30 days. at 60 days. The maximum (2.49%) non reducing sugar was recorded in Gola and minimum (1.451%) in Jawahar ber-3. The maximum (3.04%) non reducing sugar was found in Gola and minimum (1.03%) in Jawahar ber-3 at 90 days. At 120 days, the maximum (5.43%) non reducing sugar was recorded in Gola and the minimum (2.69%) in Jawahar ber-3. The maximum (4.92%) non reducing dugar was observed in Jawahar ber-2 and minimum (3.11%) in Jawahar ber-3 at 150 days. At 180 days Jawahar ber-3 recorded (5.15%) non reducing sugar. Teaotia *et al*. (1974) [12] reported that highest reducing sugars were recorded in Jogia (9.776 per cent) followed by Badshah Pasand (7.726 per cent). Dhingra *et al*. (1973) [4].

3.5 Ascorbic acid/100g of pulp

The data pertaining to the ascorbic acid (mg/100g pulp) of ber fruits as influenced by different genotypes during growth and development stages (table -5) revealed that ascorbic acid of fruit of different ber genotype have been found to be increased with advancement of growth and development period. The maximum (52.00 mg/100g pulp) ascorbic acid was found in Jawahar ber-2 and the minimum (17.00 mg /100 g pulp) in Jawahar ber-1 at 30 days. At 60 days, the maximum (61.20 mg/100 g pulp) ascorbic acid was observed in Umran and minimum (20.80 mg/100 g pulp) in Jawahar ber-3. The maximum (78.20 mg/100 g pulp) ascoprbic acid was found in Umran and minimum (50.80 mg/100 g pulp) in Jawahar ber-3 at 90 days. At 120 days, the maximum (85.40 mg/100 g pulp) ascorbic acid was observed in Umran and minimum (63.60 mg/100 g pulp) in Jawahar ber-3. The maximum (96.60 mg/100 g pulp) ascorbic acid was found in Jawahar ber-2 and the minimum (80.80 mg/100 g pulp) in Jawahar ber-3 at 150 days. At 180 days, Jawahar ber-3 recorded 90.58 mg/100 g pulp. Yamdagni *et al*. (l985) [13] reported that Illaichi was rich in ascorbic acid content (138.45 mg/100 g). Gupta (1977) [5]. Bisla *et al*. (1980) [2]. Chovatia *et al*. (1992) [3].

Table 1: Periodical total soluble solid (^{0} Brix) of ber fruit as influenced by different genotypes during their growth and development stages

Genotypes	Days After Fruit Setting (DAFS)					
	30	60	90	120	150	180
Gola	5.40	9.18	15.20	20.10	-	-
Banarasi karaka	5.40	8.08	12.10	16.30	17.32	-
Umran	4.10	7.40	11.20	15.80	18.10	-
Jawahar ber -1	8.20	7.50	12.08	17.30	-	-
Jawahar ber -2	6.10	7.85	11.20	18.18	20.36	-
Jawahar ber- 3	-	6.30	10.30	13.10	19.10	22.28
SEm±	0.12	0.14	0.97	1.06	0.87	0.30
C.D.5% level	0.36	0.42	2.92	3.18	2.62	0.90

Table 2: Periodical total sugar (%) of ber fruit as influenced by different genotypes during their growth and development stages

Genotypes	Days After Fruit Setting (DAFS)					
	30	60	90	120	150	180
Gola	3.42	4.12	5.16	8.51	-	-
Banarasi karaka	2.54	3.08	4.23	6.40	8.71	-
Umran	2.65	3.25	3.38	5.48	7.16	-
Jawahar ber -1	2.86	3.52	4.51	6.16	-	-
Jawahar ber -2	2.95	3.96	4.56	6.17	8.64	-
Jawahar ber- 3	-	2.38	2.24	4.64	6.23	9.21
SEm±	0.09	0.18	0.11	0.45	0.70	0.44
C.D.5% level	0.29	0.53	0.33	1.35	2.11	1.31

Table 3: Periodical reducing sugar (%) of ber fruit as influenced by different genotypes during their growth and development stages

Genotypes	Days After Fruit Setting (DAFS)					
	30	60	90	120	150	180
Gola	1.41	1.63	2.12	3.08	-	-
Banarasi karaka	1.53	1.73	1.41	2.98	3.11	-
Umran	1.69	2.36	2.97	3.46	4.64	-
Jawahar ber -1	1.81	1.95	2.04	2.96	-	-
Jawahar ber -2	1.38	1.62	1.62	2.72	3.72	-
Jawahar ber- 3	-	0.97	1.21	1.95	3.12	4.06
SEm±	0.09	0.10	0.11	0.10	0.09	0.25
C.D.5% level	0.27	0.30	0.33	0.30	0.27	0.75

Table 4: Periodical non reducing sugar (%) of ber fruit as influenced by different genotypes during their growth and development stages

Genotypes	Non reducing sugars (%) at					
	30	60	90	120	150	180
Gola	2.01	2.49	3.04	5.43	-	-
Banarasi karaka	1.53	1.73	1.41	2.98	3.11	-
Umran	1.69	2.36	2.97	3.46	4.64	-
Jawahar ber -1	1.05	1.57	2.47	3.20	-	-
Jawahar ber -2	1.57	2.34	2.94	3.45	4.92	-
Jawahar ber- 3	-	1.41	1.03	2.69	3.11	5.15
SEm±	0.12	0.11	0.11	0.11	0.09	0.44
C.D.5% level	0.36	0.33	0.34	0.33	0.27	1.32

Table 5: Periodical ascorbic acid (mg/100g pulp) of ber fruit as influenced by different Genotypes during their growth and development stages

Genotypes	Days After Fruit Setting (DAFS)					
	30	60	90	120	150	180
Gola	37.00	51.00	71.60	82.40	-	-
Banarasi karaka	31.00	47.00	54.80	71.60	85.23	-
Umran	47.00	61.20	78.20	85.40	94.20	-
Jawahar ber -1	17.00	52.20	67.80	80.60	-	-
Jawahar ber -2	52.00	61.00	74.60	84.40	96.60	-
Jawahar ber- 3	-	20.80	50.80	63.60	80.80	90.58
SEm±	0.83	0.70	0.41	0.41	0.89	0.11
C.D.5% level	2.49	2.11	1.22	1.23	2.67	0.34

4. Conclusion

The various biochemical fruit characters like total soluble solids (T.S.S), total sugars, reducing sugars, non-reducing sugar, ascorbic acid content at an interval of 30 days during growth and development period was significantly influenced by different genotypes and found to be increased with advancement of period from fruit setting to maturity. The wide range of variation was found for these parameters under investigation. The maximum Total sugar (9.21%) was noted in Jawahar ber-1 followed by Umran (8.71%).The maximum reducing sugar (4.07%) was found in Umran followed by Jawahar ber-3 (4.06). The maximum Non-reducing sugar (5.43%) was observed in Gola followed by Jawahar ber-3 (5.15%).The minimum Total sugar (6.16%) and reducing sugar (2.96) was noted in Jawaharber-1, whereas, Non-reducing sugar (3.11%) in Banarasi karaka. The various Jawahar ber-3 had the highest T.S.S. content (22.28 Brix), whereas, the highest ascorbic acid content was noticed in Jawahar ber-2 (96.60 mg/100 g of pulp).

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