The Bioscan 10(3): 1427-1430, 2015 (Supplement on Agronomy)
AN INTERNATIONAL QUARTERLY JOURNAL OF LIFE SCIENCES
www.thebioscan.in

PHYSICO-CHEMICAL STUDIES OF DIFFERENT BER (*ZIZYPHUS MAURITIANA* LAMK.) GERMPLASM UNDER RAINFED CONDITIONS OF JAMMU

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KEYWORDS
Zizyphus mauritiana
Physical
Chemical characteristics

Received on :
13.09.2015

Accepted on :
26.11.2015

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ABSTRACT
An experiment was conducted during 2013-14 to study the physico-chemical characteristics of eight ber cultivars under rainfed conditions of Jammu. Among the physical characters, maximum fruit weight (19.07 g), fruit length (49.68 mm), fruit breadth (29.81 mm), fruit volume (17.50 cm^3) was recorded in Sanaur-4 while, maximum specific gravity was recorded in Gola (1.38).The biochemical characters of different ber cultivars showed that Sanaur-4 recorded maximum TSS (15.75^{0}B) and TSS/acid ratio (40.38).Titratable acidity and Vitamin-C was found to be maximum (0.72 %) in Ranjari Selection-1 and Gola (106.80 mg/100g), respectively. Total sugars (12.30 %) and non-reducing sugars (8.41 %) were highest in Sanaur-4, whereas reducing sugars (4.35 %) was highest in Z.G-2. From the present investigation, it may be concluded that on the basis of quality attributes, Sanaur-4 was superior among all the cultivars and is the most promising ber cultivar for commercialization in rainfed conditions of Jammu.

INTRODUCTION

Ber (*Zizyphus mauritiana* Lamk.) is one of the most ancient and common fruit indigenous to India and belongs to family Rhamnaceae. 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 which are characterized by extreme variations of diurnal annual temperatures and high evaporations coupled with sparse and highly variable precipitations. It is found growing wild as well as in cultivated forms throughout the warmer regions upto an altitude of 1500 metres above mean sea level. It can successfully be cultivated even in the most marginal ecosystems of the sub-tropics and tropics (Pareek, 2001). Ber is popular due to high economic returns, low cost of cultivation, wider adaptability and ability to withstand drought (Chadha and Pareek, 1993). The ber grows on variety of soils from gravelly, shallow to deep aridisols.

According to De Candolle (1886), the centre of origin of ber is Central Asia, where it is found growing under varying climatic conditions. Ber is grown in India traditionally from ancient times where it has been in use for almost 4000 years (Prakash, 1961). The ber is distributed worldwide including the Indian sub-continent, South-east Asia, Australia, China, Africa, Mediterranean region and American centre but its cultivation is confined over drier part of the globe and the main cultivation occurs in India. Rajasthan, Haryana, Uttar Pradesh, Gujarat, Madhya Pradesh, Bihar, Maharashtra, Andhra Pradesh and Tamil Nadu are the major ber growing states of the country. The area and production of ber in Jammu is 7.90 thousand ha and 13.20 thousand MT, respectively (Anonymous, 2013). This fruit crop has vast scope of growing in wasteland like salt affected marginal forest soil (Shukla, 2007). The choice of suitable cultivar is of paramount importance for successful cultivation under particular region (Aulakh*et al.,* 2000). The gene and environment interaction also plays a significant role in the expression of qualitative and quantitative traits of an individual (Singh, 1990) Therefore, environmental requirements may also differ depending on the cultivar. The quality of fruit produced in Jammu region is poor with variable yield as its main reason is due to poor quality of germplasm and poor selection of varieties by farmers. Proper selection of varieties specifically suited to different agro-climatic zones of Jammu region is very essential for obtaining good yield and quality of ber. Thus, evaluation of different bercultivars underrainfed regions of Jammu is of utmost importance. The present investigations were therefore, aimed to generate basic informations on thephysico-chemical characteristics and yield attributes of ber varieties.

MATERIALS AND METHODS

The experiment was carried out at the Rainfed Research Sub Station for Subtropical Fruits, Raya, Jammu and Division of Fruit Science, Sher-e-Kashmir University of Agricultural Sciences and Technology of Jammu, during 2013-2014.The experimental field is situated at an elevation of 332 m above mean sea level and lies at 32º39"North latitude and 74º53" East longitude.The cultivars of ber selected for the present investigation were Raya Selection, Gola, Ranjari Selection-1, Small Apple, Sanaur-4, RanjariSelection-2, Z.G-2 and Walliati.

The trial was laid out in a randomized block design having eight treatments with four replications. All the trees were given uniform cultural operations as per package of practices of SKUAST-J.The length and diameter of fruits were taken with the help of Vernier Calliper. The fruit weight was taken on electronic balance. The volume of ber fruits were determined by water displacement method. Specific gravity of fruits was determined by weighing the fruits in air and then determining its volume in water. The total soluble solids (TSS) of the fruit juice was recorded with the help of Erma hand refractometer (0-32^{0}B) according to standard procedure as given in AOAC (1994) in terms of degree Brix (^{0}B) at room temperature. The titratable acidity of ber was determined as per the method of Ranganna (2003) by titrating sample against 0.1 N NaOH using phenolphthalein as an indicator. Sugars were determined by the method of Lane and Eynon as described by (Ranganna, 2003). The ascorbic acid was estimated by the method of AOAC (1994). The data was statistically analyzed by using Panse and Sukhatme (1998) method.

RESULTS AND DISCUSSION

Physico-chemical characteristics

The data on fruit weight, fruit length, fruit breadth, fruit volume and specific gravity per fruit are presented in Table 1. The maximum fruit weight was registered in Sanaur-4 (19.07 g). Minimum fruit weight was observed in Small apple (10.00 g).The results obtained in the present investigation are in consonance with those findings of Gupta *et al.* (2012) who also reported highest fruit weight in Sanaur-4. The variation among cultivars as regard to average fruit weight might be due to genotypic variation of the cultivar, inherent characters and climatic adaptability in a particular region (Mahajan and Dhillon, 2000 and Kumar *et al.*, 2014) which might prove an important diagnostic character for selection of germplasm for local conditions. The cultivar Sanaur-4 produced longest fruits (49.68 mm). The minimum fruit length was recorded in Ranjari Selection-2 (29.06 mm).The fruit breadth was maximum in Sanaur-4 (29.81 mm) followed by Z.G-2 (29.00 mm). The minimum fruit breadth was recorded in Walliati (20.41 mm). Variation in some of the genotypes is due to the difference in agro climatic conditions and the genotypes under study. Variations in fruit length and breadth have also been reported by Aulakh *et al.* (2005); Navjot *et al.* (2007) and Dhanumjaya and Subramanayam (2010). The maximum fruit volume was observed in Sanaur-4 (17.50 cm^3) which was at par with

Table 1: Fruit weight, fruit length, fruit breadth, fruit volume and specific gravity of different ber cultivars under rainfed conditions

Cultivars	Fruit weight(g)	Fruit length(mm)	Fruit breadth(mm)	Fruit volume (cm^3)	Specific gravity
Gola	16.05	39.48	27.15	13.25	1.38
Sanaur -4	19.07	49.68	29.81	17.50	1.12
Z.G-2	18.00	40.57	29.00	17.00	1.25
Small Apple	10.00	29.87	23.17	9.75	1.02
Walliati	17.00	39.57	20.41	16.75	0.97
Ranjari Selection-1	15.23	38.17	26.27	15.50	0.99
Ranjari Selection -2	15.00	29.06	25.20	11.78	1.29
Raya Selection	10.27	33.10	27.00	9.00	1.15
C.D (p=0.05)	0.23	7.83	0.08	0.79	0.24

Table 2: Total soluble solids, Titratable acidity and TSS/acid ratio of different ber cultivars under rainfed conditions

Cultivars	Total soluble solids (°Brix)	Titratable acidity (%)	TSS/acid ratio
Gola	14.60	0.46	31.74
Sanaur -4	15.75	0.39	40.38
Z.G-2	14.50	0.40	36.25
Small Apple	13.75	0.48	28.64
Walliati	14.40	0.40	36.00
Ranjari Selection-1	13.70	0.72	19.03
Ranjari Selection -2	13.50	0.65	20.77
Raya Selection	12.50	0.56	22.41
C.D (p=0.05)	1.23	0.28	2.59

Table 3: Total, reducing and non-reducing sugars and vitamin C of different ber cultivars under rainfed conditions

Cultivars	Total sugars(%)	Reducing sugars (%)	Non-reducing sugars(%)	Vitamin C(mg/100g)
Gola	9.50	2.94	6.23	106.80
Sanaur -4	12.30	3.45	8.41	93.20
Z.G-2	10.20	4.35	5.56	101.8
Small Apple	8.05	3.87	3.97	88.80
Walliati	9.68	3.90	5.49	92.5
Ranjari Selection-1	7.60	3.20	4.18	77.4
Ranjari Selection -2	8.00	3.80	3.99	89.70
Raya Selection	6.90	3.60	3.13	82.80
C.D (p=0.05)	0.02	0.16	0.93	0.13

Z.G-2 (17.00 cm^3) and Walliati (16.75 cm^3), however minimum fruit volume was recorded in Raya Selection (9.00 cm^3).It is evident from the data in Table 2 that the maximum specific gravity was recorded in Gola (1.38) which was at par with Ranjari Selection-2 (1.29), Z.G-2 (1.25) and Raya selection (1.15), while minimum specific gravity was recorded in Walliati (0.97).

Bio-chemical characteristics

Data pertaining to total soluble solids (T.S.S), acidity, total sugar, reducing sugars, non-reducing sugars, and ascorbic acid are presented in Table 2 and 3.It is evident from the Table 2that cultivar Sanaur-4 showed highest TSS (15.75^{0}B) which is at par with cultivar Gola (14.60 ^{0}B). However, Raya Selection cultivar of ber had fruits with lowest TSS of (12.50 ^{0}B).Similar variations in TSS were also reported by Lal *et al*. (2004); Aulakh *et al*. (2005); Shukla *et al*. (2007); Sharma*et al*. (2008) and Gupta *et al*. (2012) in different ber cultivars. Increased total soluble solids were attributed to the conversion of starch into soluble solid and with the advancement of ripening, starch contents decreased progressively, while TSS increased (Sharma *et al*., 2008 and Singh *et al*., 2015). Under hot arid ecosystem most of the cultivars shown good level of TSS and the differences in the value of TSS could be attributed to seasonal/climatic variation in the area and generally dry weather favours enhanced TSS in most of the cultivars (Shukla *et al*., 2007).

Among all the ber cultivars, Sanaur-4 showed the lowest acidity (0.39 %) closely followed by Z.G-2 (0.40 %) and Walliati (0.40 %), whereas, highest acidity was recorded in Ranjari selection-1 (0.72 %).Acids might have either been converted to sugars and derivatives by the reactions involving the reversal of glycolytic pathway, might be used in the respiration or both. The results are in agreement with those of Gujarathi *et al*. (1992).These results are in line with the finding of Gupta *et al*. (2012) who also reported maximum acidity in RanjariSelection-1. The data presented in Table 2 revealed that highest TSS/ acid ratio was recorded in cultivar Sanaur-4 (40.38) whereas, lowest TSS/acid ratio of 19.03 was observed in cultivar Ranjari Selection-1. Data presented in Table 4 revealed that among all the cultivars, highest total sugar content was recorded in Sanaur-4 (12.30 %) whereas, Raya Selection showed lowest total sugars content of 6.90 per cent. Among all the cultivars Z.G-2 registered highest reducing sugar content of 4.35 per cent whereas lowest reducing sugar content of 2.94 % was observed in cultivar Gola.The cultivar Sanaur-4 had the highest non-reducing sugar content of 8.41 per cent, whereas cultivar Raya selection showed lowest non-reducing sugar content of 3.13 per cent.Similar findings were reported by Sharma *et al*. (2008) and Abbas *et al*. (2012) in different ber cultivars. The increase in total sugar during fruit ripening could be due to hydrolysis of starch by starch hydrolyzing enzymes. Starch which is the main storage polysaccharide in many unripe fruits and is degraded with ripening resulting in sweetness and textural changes. Degradation of certain cell wall components such as pectin and hemicelluloses may also contribute to increase in reducing sugar content (Stahl and Camp, 1971). Such observation of increase in sugar have also been reported in ber (Jawanda and Bal, 1980; Bhatia and Gupta, 1985).The cultivar Gola had highest ascorbic acid content of 106.80 mg/100 g of fruit pulp whereas, cv. RanjariSelection-1 had lowest ascorbic acid content of 77.4 mg/100 g.Similar variations with regards to ascorbic acid in different ber cultivars were reported by Aulakh*et al*. (2005); Sharma *et al*. (2008) and Abbas *et al*. (2012).The accumulation of ascorbic acid was slow during the initial stages of fruit growth and was rapid during subsequent period. The rapid increase in ascorbic acid content might be the result of greater synthesis of glucose-6 phosphate, a precursor of L-ascorbic acid. It was advocated by Singh *et al*. (1981) that in maturing fruits, there is perpetual synthesis of vitamin-C from its precursor till the development to chocolate tint colour on the ground surface of ber fruits.

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