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Anil Kumar
Department of Biochemistry
ND University of Agriculture and Technology, Kumarganj, Faizabad, Uttar Pradesh, India

Pratibha Singh
Department of Biochemistry
ND University of Agriculture and Technology, Kumarganj, Faizabad, Uttar Pradesh, India

Correspondence
Anil Kumar
Department of Biochemistry
ND University of Agriculture and Technology, Kumarganj, Faizabad, Uttar Pradesh, India

Biochemical and antioxidative characters of underutilized fruits (Aonla, Bael, Ber, Jackfruit and Kaitha)

Anil Kumar and Pratibha Singh

Abstract
Biochemical and antioxidative evaluation of five underutilized fruit germplasms/varieties i.e Aonla (NA_6 and NA_7), Bael (NB_5 and NB_9), Ber (Karaka and Umran), Jackfruit (NJ_2 and NJ_3) and Kaitha (K_1 and K_2) resulted a slight variation within two varieties of each fruit containing to total soluble solid (TSS), malic acid, total phenols and ascorbic acid. Antioxidative characters were found higher in fresh fruit as compared to storage. On whole germplasms/varieties i.e Aonla (NA_6 and NA_7), Bael (NB_5 and NB_9), Ber (Karaka and Umran), Jackfruit (NJ_2 and NJ_3) and Kaitha (K_1 and K_2) were found best in terms of qualitative as well as biochemical and antioxidative evaluation.

Keywords: Underutilized fruits, TSS, malic acid, total phenols, and ascorbic acid

Introduction
Southeast Asia is represented by more than 500 species of fruits, while the Indian region of diversity represents 344 species of fruits having vast potential for new crops (Arora, 1995). Despite the vast biochemical and genetic diversity of these fruits, only important fruits like mango, banana, citrus and guava have gained in the productivity and acceptability by the people. Many of the indigenous tropical and temperate fruits have still remained underexploited due to the lack of awareness of their potential, market demand and low and erratic bearing in many cases. In view of the great importance of these underutilized fruit species and urgent need to strengthen the biochemical, genetic resources and improvement work.

India is the second largest producer of fruits in the world nearly covers 6.36 million hectares of area with a total production of over 88.82 million metric tonnes with productivity of 13.97 tonnes/ha. In Uttar Pradesh it is grown on 0.46 million hectares with production of 8.54 million metric tonnes, under fruit crops ranks first in terms of area, but production-wise it ranks third (Horticultural Statistics at a Glance, 2015-16) [13].

There are several fruits taken by human as its nutritional importance but several fruits are present in nature which are also nutritionally important and superior in quality but are rarely used by human because people are not aware of its nutritional importance, these fruits are known as minor fruits *viz*., Ber, Bael, Aonla, Kaitha, Jackfruit, Karonda, Imli etc.

Gorh is a ber variety was superior in terms of ascorbic acid (176.45 mg/100g), protein (3.13%) and TSS (24.01%) (Abbas *et al.* 2012) [2]. Fresh aonla fruits of cv. Chakaiya had moisture, TSS, total sugars, reducing sugars, acidity, ascorbic acid, pectin, tannin, crude fibre, pH and browning were recorded as 86.50 per cent, 10.10 per cent, 8.53 per cent, 5.14 per cent, 1.85 per cent, 662 mg/100 g, 1.93 per cent, 2.93 per cent, 3.07 per cent, 2.90 and 0.063, respectively (Daisy and Singh 2007). Biochemical analysis of wood apple (Kaitha) revealed that the total soluble solids ranged from 12.45 to 14.67^0 Brix, ascorbic acid from 4.87 to 6.26 mg (per 100 g), reducing from 2.70 to 3.11%, non-reducing sugar from 4.90 to 6.79% and total sugar from 7.60 to 9.74% (Pandey *et al*.2013) [18]. Biochemical constituents of bael fruits such as total soluble solids, total sugars, reducing sugars and acidity percentage were analyzed to be 28.20, 16.72, 4.53 and 0.39, whereas ascorbic acid, total carotenoids, pectin and total phenols were found to be 17.21 mg/100 g, 45.33 mg/100 g, 2.40, 23.66 mg/100 g, respectively (Punam *et al.* 2009) [21]. Jagadeesh *et al.* (2010) [14] reported the biochemical parameters starch content (67.30%), TSS: Acid ratio (34.69%) and titratable acidity (31.76%) exhibited a wide variation of jackfruit clones for crop improvement.

Materials and methods

The experiment was carried out in Student's Instructional Farm and Research Laboratory of the Department of Biochemistry, N.D. University of Agriculture and Technology, Narendra Nagar (Kumarganj), Faizabad (U.P) India. Five minor fruits germplasms/varieties namely Aonla (NA_6 and NA_7), Bael (NB_5 and NB_9), Ber (Karaka and Umran), Jackfruit (NJ_2 and NJ_3) and Kaitha (K_1 and K_2) were collected from Horticulture Nursery, N.D.U.A. & T, Kumarganj, Faizabad. The samples were used for the biochemical and antioxidative observations.

Five Fruits were randomly selected and were crushed using pestle and mortar. Juice was squeezed of using muslin cloth and was used for determination of T.S.S. value using hand refractometer. The value of T.S.S. (^{0}Brix) from the refractometer scale were recorded for each cultivar at each date of observation. (Rangana, 1986).

Malic acid content was determined by the method described in A.O.A.C. (1970) [1]. Took 10 gm sample, boiled it with distilled water (500 ml) to reduce the effect of colour of sample. Collect the supernatant and added 2 drop of 1 per cent phenolphthalein solution as indicator. Fill the burette with 0.1N NaOH and titrate the whole content of beaker until the end point (pink colour obtained). Per cent malic acid was determined by multiplying titer value with hundred.

Total phenol content in fruits was analysed by method as described by Swain and Tills (1959) [27]. Phenol/reduces Phosphotungusto molybedic acid under alkaline condition to produce blue colour complex which is measured colorimetrically at 750 nm 1 gm biological material was taken and blended it with 20 ml 80 per cent alcohol. The whole content was centrifuged at 1000 rpm for 15 minutes and supernatant was collected in 3 test tubes for blank, standard and biological sample. 1 ml supernatant was taken in a test tube and mixed with phenol reagent (1ml. finally), 2 ml sodium carbonate solution was added and made up the volume with 50 ml water. Similarly, blank and standard solution was also prepared by above method taking 1ml gallic acid solution. The intensity of colour was recorded at 750 nm and total phenol content was calculated in mg/100 gm sample on the basis of standard curve prepared from gallic acid.

Ascorbic acid content was determined by A.O.A.C (1970) [1] method.100 gm fresh fruit sample were taken and crushed the whole material into pestle and mortar by adding 100 ml 2% oxalic acid solution. The whole content was finally transferred into a pre weighed beaker and the weight of crushed slurry was recorded on chino-metric balance. 20gm crushed slurry was transferred in 100ml capacity of conical flask and its volume was made by adding 1% oxalic acid solution (100ml). Filtered the whole content of the conical flask with the help of filter paper and filtrate was collected into another flask. 5 ml filtrate of each flask was taken and titrated whole content of conical flask against dye solution (2, 6 dichloro phenol endophenol) until the end point (pink colour) was achieved and filter value was noted. 5 ml standard ascorbic acid solution was taken in another conical flask and titrated the whole content against dye solution until the end point was obtained. The result was expressed as mg of ascorbic acid per 100 gm of fresh sample.

Results and Discussion

The data pertaining to the total soluble solid (^{0}Brix) of fruits were given in Table 1. The range of variability in selected two varieties of five fruits viz. Aonla (NA_6 and NA_7), Bael (NB_5 and NB_9), Ber (Karaka and Umran), Jackfruit (NJ_2 and NJ_3) and Kaitha (K_1 and K_2) were found significant variations in terms of total soluble solid (^{0}Brix). The variations were recorded having 9.50 to 11.82 ^{0}Brix in Aonla fruit, 29.39 to 32.50 ^{0}Brix for Bael fruit, 7.92 to 8.13 ^{0}Brix for Ber fruit, 20.12 to 22.13 ^{0}Brix for jackfruit and 13.36 to 14.33 ^{0}Brix for Kaitha fruit, respectively. Similar results were witnessed by Singh (2012) [26] in four cultivers of Aonla, NA-7 (11.80^{0}B), Banarasi (12.2^{0}B), Chakaiya (8.10^{0}B) and Desi (13.70^{0}B). Raju *et al.* (2014) [22] have reported 27.40 to 32.60^{0}B TSS in three cultivars of bael fruit. Similar result was reported by Uddin and Hussain (2012) [29] found 7.90 to 9.50^{0}B TSS in two cultivars of ber fruits. Chowdhury *et al.* (2008) [4] supported in Kaitha fruit regarding 18.52^{0}B TSS in Kaitha pulp. Goswami *et al.* (2011) [11] observed that 19.30 to 20.10^{0}B TSS in pulp of jackfruit collected from different growing areas.

Table 1: Total soluble solid in underutilized fruit germplasms/varieties

Germplasms	TSS (^{0}Brix)	TSS (^{0}Brix)
	2013-14	2014-15
NA-6	9.50	9.50
NA-7	11.82	11.82
NB-5	26.39	26.41
NB-9	26.52	26.55
BER-K	7.92	7.66
BER-U	8.13	8.13
K-1	13.36	13.35
K-2	14.33	14.34
NJ-2	20.12	20.13
NJ-3	22.13	22.14
C D at 5%	0.03	0.24

The data containing to malic acid of underutilized fruits viz. Aonla, Bael, Ber, Jackfruit and Kaitha were given in Table 2 and resulted a slight variation within two varieties of each fruit. The range of variability in selected two varieties of five fruit viz. Aonla (NA_6 and NA_7), Bael (NB_5 and NB_9), Ber (Karaka and Umran), Jackfruit (NJ_2 and NJ_3) and Kaitha (K_1 and K_2) were found significant variations in respect of malic acid. The variations in terms of malic acid in five different fruits were recorded i.e. 1.92 to 1.95 mg/100g (Aonla), 0.14 to 0.16 mg/100g (Bael), 0.32 to 0.33 mg/100g (Ber), 0.12 to 0.13 mg/100g (Jackfruit) and 1.52 to 1.56 mg/100g for (Kaitha). Singh and Singh (2015) [25] observed 1.02 to 1.03 per cent specific gravity in aonla fruit. Malic acid from 1.04 to 2.64 was reported by (Singh *et al.* 2012) [26] in respect of four cultivars of aonla fruits. The average concentration of malic acid in (Bael) *A. marmelos* fruit was detected as 0.155%. It is evident from the results that the concentration of tartaric acid is more as compared to oxalic and malic acid in (Bael) *A.marmelos* fruit (Yadav *et al.* 2011) [31]. Malic acid was the most abundant of all the organic acids analyzed in cultivars of ber P3 and P5, cultivar P5 exhibited a higher level of malic acid than cultivar P3 (25% for stage 1 and 60% for stage 5). Transient accumulation of malic acid was observed during the ripening of both P3 and P5 fruits, with a maximum observed at stage 2 (Zozioa *et al.* 2014) [32]. Ong *et al.* (2014) [17] studied that dominant acids in jackfruit were malic acid and citric acid.

Table 2: Malic acid content of underutilized fruit germplasms/varieties

Germplasms	2013-14	2014-15
	Malic acid (mg/100g)	Malic acid (mg/100g)
NA-6	2.64	2.63
NA-7	2.71	2.71
NB-5	0.15	0.15
NB-9	0.15	0.17
BER-K	0.32	0.32
BER-U	0.33	0.35
K-1	1.93	1.93
K-2	1.98	1.97
NJ-2	0.12	0.13
NJ-3	0.13	0.14
C D at 5%	0.03	0.03

The data regarding to total phenol of minor fruits viz. Aonla, Bael, Ber, Jackfruit and Kaitha were given in Table 3 and resulted a slight variation within two varieties of each fruit. The range of variability in selected two varieties of five fruit viz. Aonla (NA_6 and NA_7), Bael (NB_5 and NB_9), Ber (Karaka and Umran), Jackfruit (NJ_2 and NJ_3) and Kaitha (K_1 and K_2) were found significant variations in respect of total phenol. The variations were recorded from 271.54 to 263.84 mgGAE/g (Aonla), 80.30 to 81.54 mgGAE/g (Bael), 50.26 to 51.63 mgGAE/g (Ber), 11.67 to 12.48 mgGAE/g (Jackfruit), and 72.44 to 73.81 mgGAE/g for (Kaitha). Prajapati *et al.* (2011) [20] also reported that total phenol (270 mgGAE/g) in fresh aonla fruit. Ghosh, and Gangopadhyay (2002) [10] studied that total phenol in Bael fruit. Koley *et al.* (2011) [16] also reported that Indian jujube is a good source of ascorbic acid and total phenolics ranging from 19.54 to 99.49 mg/100 g and 172 to 328.6 mg GAE/100 g, respectively. Phapale and Thakur (2010) [19] studied that The phenolic glycoside extract presented higher (229.0 mg/g, GAE) total phenolic contents followed by phenolic ester (37.5 mg/g) and free phenolics (11.0mg/g). Whereas the antioxidant activity was 88.7%, 11.8% and 3.8% respectively and good correlation between total phenol content, antioxidant activity and antimutagenic effect. Total phenolic content in jackfruit is 0.36 mg GAE/100 g DW (milligrams of Gallic acid equivalent per gram of dry weight) (Wongsa and Zamaluddien 2005) [30]. The LF methanol extract showed total phenol contents of 33.38 µg/mg and the flavonoids was found to be 33.80 µg/mg extract. FT-IR analysis indicated the presence of phenols, alkanes, amino acids, α, β-unsaturated esters, alkenes, nitro compounds, aromatics, aliphatic amines, carboxylic acid, alkenes, and alkyl halides functional groups (Deivamarudachalam *et al.* 2015) [7].

Table 3: Total phenol (mgGAE/g) in underutilized fruit germplasms/varieties

Germplasms	2013-14	2014-15
	Total phenol	Total phenol
NA-6	263.83	270.51
NA-7	271.54	272.53
NB-5	80.30	81.33
NB-9	81.54	82.73
BER-K	50.26	51.26
BER-U	51.63	51.79
K-1	72.44	73.44
K-2	73.81	73.81
NJ-2	36.30	37.17
NJ-3	37.80	38.80
C D at 5%	6.27	0.03

The data pertaining to ascorbic acid content of minor fruits viz. Aonla, Bael, Ber, Jackfruit and Kaitha were showed in Table 4 and resulted a slight variation within two varieties of each fruit. The range of variability in selected two varieties of five fruit viz. Aonla (NA_6 and NA_7), Bael (NB_5 and NB_9), Ber (Karaka and Umran), Jackfruit (NJ_2 and NJ_3) and Kaitha (K_1 and K_2) were found significant variations in respect of ascorbic acid content. The variations were recorded from 524.32 to 525.72 mg/100g (Aonla), 14.23 to 16.33 g/100g (Bael), 95.30 to 98.77 g/100g (Ber), 11.67 to 12.48 g/100g (Jackfruit) and 15.39 to 15.43 g/100g for (Kaitha). Prajapati *et al.* (2011) [20] also noticed that ascorbic acid content 503 mg/100g in fresh aonla fruit and similar result was investigated by Ghosh *et al.* (2013) [9] in seven variety of aonla fruit. Yadav *et al.* (2011) [31] have studied that ascorbic acid and antioxidant activity in Bael fruit. Das (2012) [6] reported that the antimicrobial and antioxidant activities of tropical fruits *Averrhoa carambola* L. (starfruit) and *Zizyphus mauritiana* L. (jujube) fruits. The edible parts of the fruits were analyzed for different phytochemicals and phenolics, flavonoids, alkaloids and glycosides were found in all ripe and green starfruits or jujubes. Gupta *et al.* (2011) [12] have investigated that nutritional, phytochemical content and antioxidant activity of seeds of the jackfruit (*Artocarpus heterophyllus* L.) the antioxidant properties were evaluated using free radical scavenging, metal chelating, ferric reducing antioxidant power and reducing power assays. Vitamin C (ascorbic acid) is a water-soluble free radical scavenger. The daily recommended dietary allowance is 60 mg. In jackfruit 12 to 14 mg vitamin C is present per 100 g and jackfruit also contains useful antioxidant compounds. Antioxidants' are substances that neutralize free radicals or their actions (Swami *et al.* 2012) [28], (Devasagayam *et al.* 2004) [8], (Sies 1996) [17]. The GC-MS analysis revealed the presence of linoleic acid, octadecanoic acid, hexadecanoic acid, maltol, vinly guaiacol, furanone, and ascorbic acid (Deivamarudachalam *et al.* 2015) [7].

Table 4: Ascorbic acid content in underutilized fruit germplasms/varieties

Germplasms	2013-14	2014-15
	Ascorbic acid (mg/100g)	Ascorbic acid (mg/100g)
NA-6	425.00	424.67
NA-7	604.33	604.67
NB-5	14.23	14.25
NB-9	16.37	16.35
BER-K	95.30	95.31
BER-U	98.77	98.78
K-1	15.39	15.39
K-2	15.43	15.44
NJ-2	12.48	12.48
NJ-3	11.67	11.68
C D at 5%	1.37	2.15

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