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GENETIC BIODIVERSITY OF WOOD-APPLE (*FERONIA LIMONIA* L.) IN BUNDELKHAND REGION OF UTTAR PRADESH, INDIA

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ABSTRACT

Bundelkhand region of Uttar Pradesh, India has a significant biodiversity of wood apples. The agro-climatic conditions of Bundelkhand have great potential for its commercial cultivation. Keeping these things in mind, 25 genotypes of wood apple fruit samples with shoots were gathered from various parts of Uttar Pradesh's Bundelkhand region and examined for a variety of physico-chemical characteristics. The study's findings showed a wide range of variability in biochemical etc. TSS (10.98 ^{0}Brix to 18.27^0 Brix), acidity (2.32% to 6.31%), total sugar (1.57% to 2.41%), reducing sugar (0.87% to 1.3%), non-reducing sugar (0.70% to 1.28%), ascorbic acid (12.76 mg/100g to 35.92 mg/100g), protein (1.1% to 5.56%), pectin (0.64% to 2.12%), TSS & Acidity ratio (2.19 to 6.19). Thus, the genotypes FS/WA-3, FS/WA-4, FS/WA-5, FS/WA-6, FS/WA-8, FS/WA-10 and FS/WA-25 were tested as promising genotypes based on morphological quantitative and biochemical quality parameters. These genotypes show promise and can be suggested for commercial multiplication, field cultivation, and gene bank conservation for future analysis and agricultural development.

Key words : Wood apple (*Feronia limonia* L.), Variability, Total sugar, TSS, Protein and Pectin.

Introduction

The wood apple (*Feronia limonia* L.) is a native fruit of India and it is commonly known as elephant-apple, monkey fruit, and curd fruit, locally known as Kaithbel or Kaitha. Fruits have a high level of antioxidants and are rich in nutrients. This resilient fruit tree is primarily found in arid and semi-arid climates, particularly in the central and southern dry woods of Uttar Pradesh's Bundelkhand region. The Bundelkhand region is home to a diverse range of wood apples. Bundelkhand's agroclimatic conditions are highly conducive to commercial fruit cultivation because of the fruit's extended shelf life, high nutritional content, and hardiness. The number of native species, including *Feronia limonia*, which can be found in both wild and cultivated forms in India. Wood apples are widely distributed throughout the nation and exhibit modest levels of germplasm heterogeneity. This fruit tree has a very high status of germplasm erosion due to urbanization and deforestation. Hence the tree needs high collection priority (Gupta *et al*., 1996).

According to Rao *et al*. (1989), the fruit is high in iron, protein, and minerals, particularly calcium and phosphorus. Numerous phytochemicals, including vitamins, amino acids, coumarins, polyphenols, phytosterols, saponins, tannins and triterpenoids are present in the fruits (Dar *et al*., 2013). Additionally, it can treat a variety of disorders affecting the bones and joints, bilious illnesses, piles, diarrhea, colds, influenza, chronic constipation, and scurvy (Diengngan and Hasan, 2015). Keeping these points in view, the present investigation on the diversity of wood apple (*Feronia limonia* L.) fruits under Bundelkhand region of Uttar Pradesh to find out

the morphological physico-chemical attribute promising genotypes for further utilization, conservation multiplication, crop improvement and commercial growing under Bundelkhand regions of Uttar Pradesh.

Materials and Methods

The present investigation was carried out at the Department of Fruit Science, College of Horticulture, Banda University of Agriculture & Technology, Banda (UP) during 2018-2019 and 2019-2020. Twenty-five genotypes were collected from Bundelkhand region Banda, Mahoba, Hamirpur, Jalon and Jhansi districts of Uttar Pradesh. A total of twenty-five wood apple fruits were chosen at random from every direction of the trees. Every site was gathered, placed in bags, labeled with a number, and then examined physico-chemically at a lab. The 2, 6-Dichlorophenol-indophenols visual titration method was used to detect ascorbic acid (Johnson, 1948). Protein was calculated using Lowry's procedure, sugar content was estimated using Fehling's solutions (Lane and Eynon, 1923) and the procedure as given by Rangana (2010), reducing sugars (Nelson, 1944) and pectin by Rangana (1977). By deducting the values of reducing sugar from the total sugars and multiplying by 0.95, one can determine the percentage of non-reducing sugars (Somogyi, 1952). The two years' data obtained during experimentation was statistically analysed as per the method given by Panse and Sukhatme (1985) and results were evaluated at a 5% level of significance.

Fig. 1 : Geographical map Bundelkhand region of Uttar Pradesh, India.

Results and Discussion

Variability in chemical attributes was found among different elite-selected wood apple genotypes. Total soluble solid (TSS) in different genotypes of wood apple ranged from 10.98^0 Brix to 18.27^{0}Brix. However, among the genotypes of wood apple, maximum (18.27^{0}Brix) total soluble solid was noticed in genotype FS/WA-6 followed by genotype FS/WA-8(18.27^0 Brix). In contrast, the minimum total soluble solid (10.98^{0}Brix) was noticed by the genotype FS/WA-21, which is on par with the genotype FS/WA-19 (11.51^{0}Brix). However, maximum ascorbic acid was found in genotype FS/WA-16(35.94 mg/100g) followed by FS/WA-19 (28.68mg/100g), whereas, minimum ascorbic acid was found in FS/WA-12(12.76 mg/100g).Similar trend of total soluble solid was reported by Yadav *et al.* (2018), Singh *et al.* (2016), Sharma *et al.*

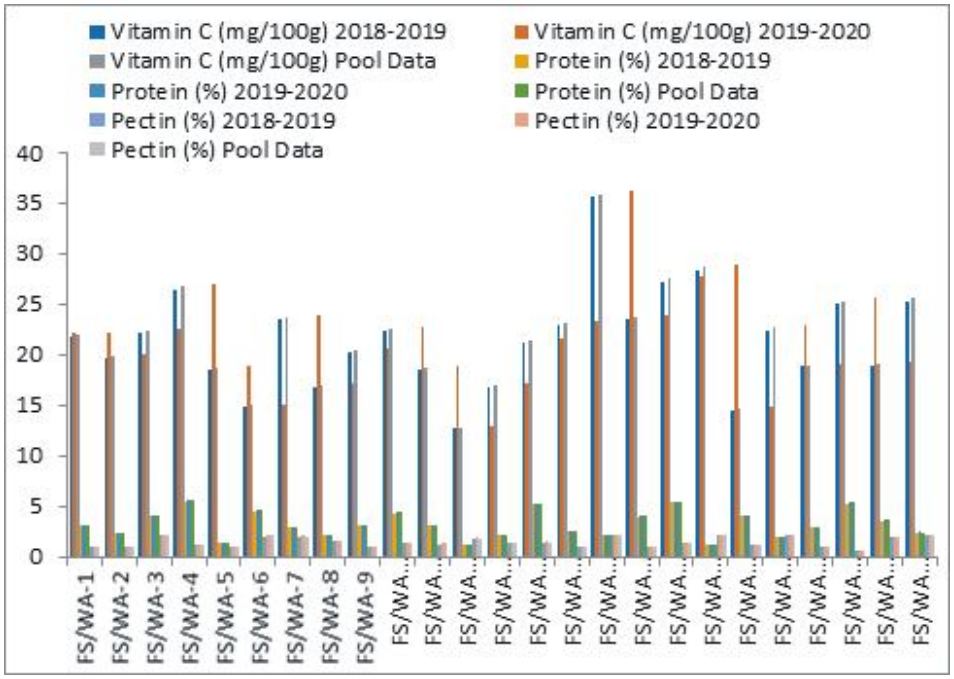

Fig. 2 : Chemical parameter in different genotypes of wood apple.

Table 1 : Variation of different chemical character of wood apple (*Feronia limonia* L.).

Treatment	TSS(Brix)			Acidity (%)			Reducing sugar (%)			Non-reducing sugar (%)			Total sugar (%)		
	2018-2019	2019-2020	Pool Data	2018-2019	2019-2020	Pool Data	2018-2019	2019-2020	Pool Data	2018-2019	2019-2020	Pool Data	2018-2019	2019-2020	Pool Data
FS/WA-1	13.49	13.76	13.62	4.23	4.32	4.28	1.09	13.49	13.76	13.62	0.98	0.97	2.05	2.09	2.07
FS/WA-2	14.04	14.32	14.18	4.68	4.78	4.73	0.95	14.04	14.32	14.18	1.16	1.15	2.09	2.13	2.11
FS/WA-3	16.03	16.35	16.19	3.09	3.15	3.12	0.89	16.03	16.35	16.19	0.90	0.89	1.78	1.81	1.80
FS/WA-4	15.62	15.93	15.77	4.61	4.70	4.66	1.07	15.62	15.93	15.77	0.76	0.75	1.82	1.86	1.84
FS/WA-5	14.39	14.68	14.54	6.25	6.37	6.31	1.05	14.39	14.68	14.54	0.98	0.97	2.02	2.06	2.04
FS/WA-6	18.09	18.45	18.27	4.73	4.83	4.78	1.18	18.09	18.45	18.27	1.05	1.04	2.21	2.25	2.23
FS/WA-7	14.26	14.54	14.40	3.84	3.92	3.88	1.17	14.26	14.54	14.40	1.21	1.20	2.36	2.41	2.39
FS/WA-8	17.31	17.65	17.48	3.54	3.61	3.58	1.03	17.31	17.65	17.48	1.29	1.28	2.28	2.33	2.30
FS/WA-9	15.21	15.52	15.37	5.73	5.84	5.79	1.12	15.21	15.52	15.37	0.95	0.94	2.06	2.10	2.08
FS/WA-10	13.68	13.95	13.81	2.92	2.98	2.95	1.19	13.68	13.95	13.81	1.15	1.14	2.32	2.36	2.34
FS/WA-11	15.32	15.63	15.48	4.46	4.55	4.51	1.15	15.32	15.63	15.48	1.04	1.03	2.16	2.21	2.19
FS/WA-12	17.27	17.62	17.45	3.95	4.03	3.99	0.99	17.27	17.62	17.45	1.02	1.01	1.99	2.03	2.01
FS/WA-13	14.24	14.53	14.38	2.30	2.35	2.32	1.28	14.24	14.53	14.38	1.05	1.04	2.31	2.36	2.34
FS/WA-14	15.22	15.52	15.37	4.64	4.74	4.69	1.17	15.22	15.52	15.37	1.24	1.23	2.39	2.44	2.41
FS/WA-15	16.39	16.71	16.55	2.96	3.02	2.99	1.19	16.39	16.71	16.55	1.05	1.04	2.22	2.26	2.24
FS/WA-16	13.48	13.75	13.61	6.15	6.27	6.21	1.21	13.48	13.75	13.61	1.13	1.12	2.32	2.36	2.34
FS/WA-17	16.42	16.75	16.59	5.17	5.27	5.22	1.27	16.42	16.75	16.59	0.91	0.90	2.17	2.21	2.19
FS/WA-18	12.63	12.89	12.76	4.93	5.03	4.98	0.86	12.63	12.89	12.76	0.71	0.70	1.55	1.58	1.57
FS/WA-19	11.40	11.63	11.51	4.17	4.25	4.21	1.05	11.40	11.63	11.51	1.14	1.13	2.18	2.22	2.20
FS/WA-20	16.24	16.56	16.40	3.55	3.62	3.58	1.21	16.24	16.56	16.40	1.19	1.18	2.38	2.43	2.41
FS/WA-21	10.87	11.08	10.98	2.66	2.71	2.69	1.18	10.87	11.08	10.98	0.97	0.96	2.13	2.17	2.15
FS/WA-22	13.80	14.07	13.94	3.53	3.60	3.57	1.20	13.80	14.07	13.94	1.15	1.14	2.32	2.37	2.35
FS/WA-23	11.76	12.00	11.88	4.51	4.60	4.55	1.26	11.76	12.00	11.88	1.10	1.09	2.34	2.38	2.36
FS/WA-24	16.24	16.56	16.40	4.37	4.46	4.41	1.16	16.24	16.56	16.40	1.05	1.04	2.19	2.23	2.21
FS/WA-25	14.27	14.55	14.41	3.42	3.49	3.45	1.29	14.27	14.55	14.41	1.00	0.99	2.27	2.31	2.29

Table 1 continued...

Table 1 continued...

C.D.	0.50	0.84	0.43	0.22	0.26	0.13	0.05	0.50	0.84	0.43	0.06	0.03	0.06	0.12	0.06
SE(m)	0.17	0.30	0.15	0.08	0.09	0.04	0.02	0.17	0.30	0.15	0.02	0.01	0.02	0.04	0.02
Average	14.71	15.00	14.85	4.18	4.26	4.22	1.13	14.71	15.00	14.85	1.05	1.04	2.16	2.20	2.18
Range	10.87-18.09	11.08-18.45	10.98-18.27	2.30-6.25	2.35-6.37	2.32-6.31	0.86-1.29	10.87-18.09	11.08-18.45	10.98-18.27	0.71-1.29	0.70-1.28	1.55-2.39	1.58-2.44	1.57-2.41

Treatment	**Vitamin C (mg/100g)**			**Protein (%)**			**Pectin (%)**			**TSS Acidity Ratio**		
	2018-2019	**2019-2020**	**Pool Data**	**2018-2019**	**2019-2020**	**Pool Data**	**2018-2019**	**2019-2020**	**Pool Data**	**2018-2019**	**2019-2020**	**Pool Data**
FS/WA-1	21.73	22.13	21.95	3.12	3.18	3.15	1.05	1.07	1.06	3.19	3.19	3.19
FS/WA-2	19.70	22.16	19.90	2.34	2.39	2.36	1.04	1.06	1.05	3.00	3.00	3.00
FS/WA-3	22.14	20.09	22.37	4.07	4.15	4.11	2.09	2.14	2.12	5.19	5.19	5.19
FS/WA-4	26.48	22.59	26.74	5.50	5.61	5.56	1.11	1.13	1.12	3.39	3.39	3.39
FS/WA-5	18.52	27.01	18.71	1.37	1.39	1.38	1.03	1.05	1.04	2.30	2.30	2.30
FS/WA-6	14.80	18.89	14.95	4.52	4.61	4.56	2.05	2.09	2.07	3.82	3.82	3.82
FS/WA-7	23.48	15.09	23.72	2.83	2.89	2.86	2.03	2.07	2.05	3.71	3.71	3.71
FS/WA-8	16.87	23.95	17.04	2.16	2.20	2.18	1.51	1.54	1.53	4.89	4.89	4.89
FS/WA-9	20.24	17.21	20.45	3.08	3.14	3.11	1.05	1.07	1.06	2.66	2.66	2.66
FS/WA-10	22.39	20.65	22.61	4.34	4.43	4.38	1.31	1.34	1.32	4.68	4.68	4.68
FS/WA-11	18.53	22.84	18.72	3.11	3.17	3.14	1.27	1.30	1.29	3.44	3.44	3.44
FS/WA-12	12.64	18.90	12.76	1.12	1.14	1.13	1.83	1.86	1.85	4.37	4.37	4.37
FS/WA-13	16.87	12.89	17.04	2.14	2.18	2.16	1.44	1.47	1.45	6.19	6.19	6.19
FS/WA-14	21.13	17.21	21.34	5.21	5.31	5.26	1.46	1.49	1.47	3.28	3.28	3.28
FS/WA-15	22.90	21.55	23.13	2.44	2.49	2.46	0.95	0.97	0.96	5.54	5.54	5.54
FS/WA-16	35.57	23.36	35.92	2.17	2.21	2.19	2.08	2.12	2.10	2.19	2.19	2.19
FS/WA-17	23.42	36.28	23.66	3.95	4.03	3.99	1.03	1.05	1.04	3.18	3.18	3.18
FS/WA-18	27.26	23.89	27.54	5.39	5.50	5.44	1.31	1.33	1.32	2.56	2.56	2.56
FS/WA-19	28.40	27.81	28.68	1.09	1.11	1.10	2.07	2.11	2.09	2.74	2.74	2.74
FS/WA-20	14.47	28.97	14.62	4.08	4.16	4.12	1.13	1.15	1.14	4.58	4.58	4.58
FS/WA-21	22.43	14.76	22.66	2.01	2.05	2.03	2.06	2.10	2.08	4.09	4.09	4.09

Table 1 continued...

Table 1 continued...

FS/WA-22	18.80	22.88	18.99	2.95	3.01	2.98	1.06	1.08	1.07	3.91	3.91	3.91
FS/WA-23	25.09	19.18	25.34	5.31	5.41	5.36	0.63	0.64	0.64	2.61	2.61	2.61
FS/WA-24	18.81	25.59	19.00	3.56	3.64	3.60	1.92	1.96	1.94	3.72	3.72	3.72
FS/WA-25	25.32	19.19	25.57	2.39	2.44	2.42	2.07	2.11	2.09	4.17	4.17	4.17
C.D.	0.63	1.19	0.65	0.28	0.20	0.10	0.12	0.08	0.05	0.01	0.01	0.01
SE(m)	0.22	0.42	0.22	0.10	0.07	0.04	0.04	0.03	0.02	0.00	0.00	0.00
Average	21.52	21.80	21.74	3.21	3.27	3.24	1.46	1.49	1.48	3.74	3.74	3.74
Range	12.64-35.57	12.80-36.28	12.76-35.92	1.09-5.50	1.11-5.61	1.10-5.56	0.63-2.09	0.64-2.14	0.64-2.12	2.19-6.19	2.19-6.19	2.19-6.19

(2014) and Ghosh *et al.* (2016) in wood apple Pandey *et al.* (2006) in Bael fruits Rajangam *et al.* (2022), Siddique *et al.* (2022), Khan *et al.* (2023) Kumar *et al*. (2023) and Kamble *et al.* (2023) in ber fruits.

It is evident from the observation that the highest reducing sugars were found in genotype FS/WA-13 (1.3%) followed by FS/WA-17 (1.29%), whereas minimum reducing sugars were recorded in the genotype FS/WA-16 (0.87%). The non-reducing sugar ranged 1.28% to 0.70%. The maximum non-reducing sugar was recorded in genotype FS/WA-8 (1.28%) closely followed by FS/WA-14 (1.23%). While, minimum non-reducing sugar was observed in genotype FS/WA-18 (0.70%). The maximum total sugar content (2.41%) was recorded in genotype FS/WA-20 followed by FS/WA-14(2.4%), whereas minimum (1.57%) total sugars were found in FS/WA-14. Similar variations of sugars of wood apple were reported by Singh *et al*. (2016), Pandey *et al*. (2013), Yadav *et al*. (2018), Ram and Singh (2003) and Pandey *et al*. (2006) in Bael Rajangam *et al.* (2022), Siddique *et al.* (2022), Khan *et al.* (2023), Kumar *et al*. (2023) and Kamble *et al.* (2023) in ber fruits.

The highest protein was noted in FS/WA-4 (5.56%) followed by genotype FS/WA-18 (5.44%), while the minimum was in genotype FS/WA-19 (1.1%). Similar variations in protein content in wood apple were reported by Singh *et al*. (2016), Sharma *et al*. (2014), Ghosh *et al.* (2016), Anitha *et al*. (2016). The average pectin content ranged from 0.64% to 2.12%, maximum in genotype FS/WA-3 (2.12%) and minimum in genotype FS/WA-23 (0.64%). Similar variations of pectin content in wood apple were reported by Singh *et al*. (2016), Sharma *et al*. (2014), Ghosh *et al.* (2016), Anitha *et al*. (2016). Khan *et al.* (2019) Pandey *et al*. (2013), Shyamala Devi *et al.* (2018), Rajangam *et al.* (2022) Siddique *et al.* (2022), Khan *et al.* (2023), Kumar *et al*. (2023) and Kamble *et al*. (2023) in ber fruits.

Conclusion

The findings indicate that there is considerable genetic diversity among the wood apple genotypes in the population that currently exists in the rain-fed regions Bundelkhand region of Uttar Pradesh. This diversity is evident in the quantitative, qualitative, morphological, and biochemical traits of the various wood apple genotypes. The following genotypes were screened as promising: FS/WA-3, FS/WA-4, FS/WA-5, FS/WA-6, FS/WA-8, FS/WA-10 and FS/WA-25. These genotypes show promise and can be suggested for commercial multiplication, field cultivation, and gene bank conservation for future release as cultivars and additional assessment.

Photo Plates

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