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Evaluation of chemical properties of tamarind (*Tamarindus indica* L.) genotypes prevailing in Bastar district of Chhattisgarh

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Abstract
The present experiment entitled "Evaluation of chemical properties of tamarind (*Tamarindus indica* L.) genotypes prevailing in Bastar district of Chhattisgarh" was conducted during *Rabi* season in year 2023-24 at Mahatma Gandhi University of Horticulture and Forestry, Sankra-Patan, Durg (C.G.). The experiment was laid out in RBD (Randomized Block Design) with 20 treatments and three replications. The treatment consists of T_1 (BTM-1), T_2 (BTM-2), T_3 (BTM-3), T_4 (BTM-4), T_5 (BTM-5), T_6 (BTM-6), T_7 (BTM-7), T_8 (BTM-8), T_9 (BTM-9), T_{10} (BTM-10), T_{11} (BTM-11), T_{12} (BTM-12), T_{13} (BTM-13), T_{14} (BTM-14), T_{15} (BTM-15), T_{16} (BTM-16), T_{17} (BTM-17), T_{18} (BTM-18), T_{19} (BTM-19) and T_{20} (BTM-20). The results of the present investigation reveal that T_{18} (BTM-18**)** attained significantly higher at TSS (°Brix) total soluble solids, T_{15} (BTM-15**)** at total sugars (%), reducing sugars (%), T_4 (BTM-4**)** at non-reducing sugars (%), T_{12} (BTM-12**)** at acidity (%) and T_6 (BTM-6**)** at ascorbic acid (mg/100 g). Thus these can be at par with the treatment T_{17} (BTM-17) and T_{16} (BTM-16) for TSS (°Brix) total soluble solids, T_{17} (BTM-17) and T_{19} (BTM-19) for total sugars (%), T_{19} (BTM-19) and T_{17} (BTM-17) for reducing sugars (%), T_3 (BTM-3) and T_5 (BTM-5) for non-reducing sugars (%),T_{10} (BTM-10) and T_{16} (BTM-16) for acidity (%) and T_{10} (BTM-10) for ascorbic acid (mg/100 g). Genotypes T_{18}, T_{15}, T_4, T_{12}, and T_6 exhibited superior traits in TSS, sugars, acidity, and ascorbic acid. These genotypes show promise for future selection and improvement in tamarind breeding and value-added utilization.

Keywords: *Tamarindus indica* L., genotypes, total soluble solids, total sugars, reducing sugars, non-reducing sugars, acidity, ascorbic acid, Bastar

1. Introduction
Tamarind (*Tamarindus indica* L.) is a hardy evergreen monotypic tree which belongs to the family "Leguminosae" and sub-family Caesalpinaceae and has the chromosome number 2n=24 (Anon, 1972; Purseglove, 1981) [2, 12]. According to Merrill (1912) [10], this family contains about 520 genera and 12,000 species in the Philippines. The name tamarind was derived from the Arabic word "Tamar-E-Hind" meaning "Date of India". In India, tamarind is known by a wide variety of vernacular names: tetuli (Assamese); amli, nuli, tentul (Bengali); amali, ambali (Gujarati); ambli, amli, imli, (Hindi); puli (Malayalam); amli, chinch, chitz (Marathi); koya, tentuli, tetal (Odiya); imli (Punjabi); chinta (Telugu); amli, imli (Chhattisgarhi) and tetar (Halbi and Bhatari of Bastar platau).

It is cultivated throughout the tropics and sub-tropics of the world and has become naturalized at many places. The tree is indigenous to tropical Africa and Southern India. The tamarind is native to tropical Africa and Asia (Bailey, 1947) [5], although the species name indica gives an illusion of it being of Indian origin.

In India, tamarind is particularly valued for its tangy, acidic fruit pulp, which constitutes 30-50% of the ripe pod and is used in culinary preparations, traditional medicine, and industrial applications (Shukla & Singh, 2020) [16]. The tree's adaptability to diverse agro-climatic conditions, including semi-arid and dryland environments, makes it a resilient species for cultivation in regions with challenging climatic conditions, such as the Bastar district of Chhattisgarh.

It is an economically important tree of India. It is also called as "Indian Date" from the date like appearance of dried pulp.

The tree grows wild, though cultivated to a limited extent. In India, it is abundantly grown in Madhya Pradesh, Bihar, Andhra Pradesh, Tamilnadu and Karnataka (Anon, 1993) [3]. In-situ characterization of tamarind genotypes is a vital step in assessing their performance under natural conditions, providing insights into their adaptability, yield potential, and suitability for cultivation. In-situ studies allow researchers to evaluate traits such as pod yield, fruit morphology, and resistance to environmental stresses, which are critical for selecting elite genotypes for breeding programs (Kanupriya *et al.*, 2020) [7]. For example, a study in Karnataka identified top-performing tamarind genotypes based on fruit yield and morphological traits, demonstrating the efficacy of in-situ evaluation in genetic resource conservation (Mamathashree *et al.*, 2020) [9]. Such approaches are particularly relevant in Bastar, where tamarind trees are often grown in mixed agroforestry systems and face varying degrees of biotic and abiotic stress.

The chemical evaluation of tamarind genotypes involves analyzing parameters such as total soluble solids (TSS), titratable acidity properties. These attributes determine the fruit's nutritional value, sensory appeal, and industrial applicability. For instance, tamarind pulp is rich in tartaric acid, sugars, and minerals like calcium, phosphorus, and iron, which contribute to its health-promoting properties (Adeola & Aworh, 2012) [1]. Studies in Nigeria and Sudan have reported variations in ascorbic acid, mineral composition, and sugar profiles among tamarind populations, emphasizing the importance of localized assessments to capture genotypic diversity (Adeola & Aworh, 2012; Sulieman *et al.*, 2016) [1, 19]. In the context of Bastar, where tamarind is a dietary staple and economic resource, understanding these properties can guide the selection of genotypes with superior nutritional and commercial potential.

2. Materials and Methods

The field experiment was conducted during *Rabi* 2023-24 at Mahatma Gandhi University of Horticulture and Forestry, Sankra-Patan, Durg (C.G.). The experiment was laid out in a RBD (Randomized Block Design) with 20 treatments and three replications. The proposed study includes evaluation of physico-chemical properties of tamarind (*Tamarindus indica* L.) genotypes prevailing in Bastar district of Chhattisgarh. For conduct of proposed study, the materials to be used and methods to be followed have been detailed in this chapter.

2.1 TSS (°Brix) total soluble solids

The total soluble solids were recorded with the help of Erma Hand refractometer (0-32º Brix). A drop of juice was placed on the prism facing the light source and value was recorded. Care was also taken to clean the prism with distilled water and dry it before taking next reading.

2.2 Total sugars (%)

Total sugar was estimated by the same method as that of reducing sugar. For this, 50 ml clean filtrate was taken in 50 ml volumetric flask and 5 ml of 35 percent hydrochloric acid (HCL) was added to it. This was hydrolysed for half an hour in hot water bath. After hydrolyzing, the excess acid was neutralized by sodium carbonate (40%) and the volume was made to 250 ml. It was then titrated against 5 ml each of Fehling A and Fehling B solutions using methyl blue as an indicator.

$$\text{Total sugar} = \frac{250\text{ml}}{\text{Burette reading}} \text{ X } 100$$

2.3 Reducing sugar (%)

The reducing sugar from juice was estimated as per the method described by Ranganna (1979) [14] and expressed in percentage. 50 ml composite juice sample of the same kind of juice was taken and precipitated by using 2 ml neutral lead acetate (45%). After 10 minutes, 1.8 ml of potassium oxalate (22%) was added to delead the sample solution and then the final volume was made up to 250 ml. After filtration, the filtrate was used for estimating reducing sugar by titrating it against Fehling solution (Fehling A and B in 1: 1 proportion) at boiling temperature with an end point as brick red by using methyl blue as an indicator.

$$\text{Reducing sugar} = \frac{50\text{ml}}{\text{Burette reading}} \text{ X } 100$$

2.4 Non-reducing sugars (%)

Non-reducing sugars content was calculated using the formula:

Non-reducing sugars (%) = Total sugars (%)-Reducing sugars (%)

2.5 Acidity (%)

An estimation of acidity was done by the method of Rangana (2000) [15], small amount of fruit were crushed well is homogenized and 5g was taken out in a 20 ml beaker. The volume was made up to 50 ml with distilled water. Shake well and filter. Take 2 ml from filter in a conical flask and add few drop of phenolphthalein indicator. The solution was titrated against 0.1N NaOH and the titer value was recorded. The NaOH was standardized by titration against 10 ml of 0.1N oxalic acid.

$$\text{Acidity (\%)} = \frac{\text{Titer value x Normality x Volume made up x Eq. Wt. of acid x 100 of NaOH}}{\text{Volume of sample taken for estimation x Wt. of sample takenx1000}}$$

2.6 Ascorbic acid (mg/100 g)

Assay method was followed given by Ranganna (2000) [15].

3. Results and Discussion

The data regarding as evaluation of physico-chemical properties of tamarind genotypes prevailing in Bastar district of Chhattisgarh has been presented in Table 1 and Table 2.

3.1 Total soluble solids (°Brix)

Based on data presented in table no. 1, the significantly maximum TSS (°Brix) total soluble solids was seen in the treatment T_{18} (BTM-18**)** at (21.33), which was at par with the treatment T_{17} (BTM-17) and T_{16} (BTM-16) at (20.70) and (21.26). Significantly minimum TSS (°Brix) total soluble solids was seen in the treatment T_{13} (BTM-13) with value of (12.16). The observed variation in TSS (°Brix) across treatments suggests that different treatments may

influence the accumulation of soluble solids in the organism. This could be due to factors like nutrient availability, water quality, or the presence of stressors, highlighting the need for further investigation to understand the environmental factors influencing TSS levels. Similar study were also observed by Prabhushankar *et al.* (2004) [11].

3.2 Total sugars (%)

Based on data presented in table no. 1 the significantly highest total sugars (%) was seen in the treatment T_{15} (BTM-15**)** at (42.27%), which was at par with the treatment T_{17} (BTM-17) and T_{19} (BTM-19) at (41.43%) and (41.78%). Significantly lowest total sugars (%) was seen in the treatment T_8 (BTM-8) with value of (24.72%). The observed differences in total sugar percentages across treatments suggest that specific treatments might influence the production or accumulation of sugars. This could be due to factors like nutrient availability, stress levels, or metabolic pathways specific to each treatment. Further analysis is needed to determine the exact environmental and biological factors contributing to these differences. Similar result was also found by Azhakiamanavalan and Vadivel (1997) [4].

3.3 Reducing sugars (%)

Based on data presented in table no. 1 the significantly maximum reducing sugars (%) was seen in the treatment T_{15} (BTM-15**)** at (35.26%), which was at par with the treatment T_{19} (BTM-19) and T_{17} (BTM-17) at (33.42%) and (33.98%). Significantly minimum reducing sugars (%) was seen in the treatment T_6 (BTM-6) with value of (19.23%). The differences in reducing sugar percentages across treatments suggest that specific treatments may influence the production or accumulation of reducing sugars in the organism. This could be due to factors like nutrient availability, stress levels, or metabolic pathways specific to each treatment. Further analysis is needed to determine the exact environmental and biological factors contributing to these differences. Similar result was also found by Singh and Nandini (2011) [17].

3.4 Non-reducing sugars (%)

Based on data presented in table no. 2 the significantly maximum non-reducing sugars (%) was seen in the treatment T_4 (BTM-4**)** at (13.43%), which was at par with the treatment T_3 (BTM-3) and T_5 (BTM-5) at (12.92%) and (13.28%). Significantly minimum non-reducing sugars (%) was seen in the treatment T_8 (BTM-8) with value of (5.15%). The variation in non-reducing sugar percentages across treatments suggests that specific treatments might influence the production or accumulation of these sugars. This could be due to factors like nutrient availability, stress levels, or metabolic pathways specific to each treatment. Further analysis is needed to pinpoint the exact environmental and biological factors contributing to these differences. Similar results were also observed by Sinha (2015) [18].

3.5 Acidity (%)

Based on data presented in table no. 2, the significantly highest acidity (%) was seen in the treatment T_{12} (BTM-12**)** *at* (19.54%), which was at par with the treatment T_{10} (BTM-10) and T_{16} (BTM-16) at (19.42%) and (19.46%). Significantly lowest acidity (%) was seen in the treatment T_7 (BTM-7) with value of (8.25%). The significant differences in acidity percentages may be attributed to environmental factors affecting fruit ripening and chemical composition. T_{12} (1.54%) likely experienced conditions favoring acid accumulation, while T_7 (8.25%) may have been influenced by unfavorable factors that reduced acidity levels. Similar study were also observed by Joshi *et al.* (2012) [6] and Rajamanickam (2019) [13].

3.6 Ascorbic acid (mg/100 g)

Based on data presented in table no. 2, the significantly maximum ascorbic acid (mg/100 g) noted in the treatment T_6 (BTM-6**)** at (12.33 mg/100 g), which was at par with the treatment T_{10} (BTM-10) at (11.88 mg/100 g). Significantly minimum ascorbic acid (mg/100 g) was seen in the treatment T_1 (BTM-1) with value of (5.13 mg/100 g). The observations indicate significant variations in ascorbic acid content among treatments. T_6 (12.33 mg/100 g) showed the highest levels, likely due to optimal environmental conditions that enhanced nutrient synthesis. In contrast, T_1 (5.13 mg/100 g) had the lowest ascorbic acid content, possibly due to suboptimal growth factors affecting nutrient accumulation. Similar results were reported by Kotecha and Kadam (2002) [8].

Table 1: Evaluation of chemical properties of tamarind genotypes on TSS (°Brix) total soluble solids, total sugars (%) and reducing sugars (%).

Tr. No.	Genotype	TSS (°Brix) total soluble solids.	Total sugars (%)	Reducing sugars (%)
T_1	BTM-1	15.36	34.63	23.10
T_2	BTM-2	14.85	34.01	21.47
T_3	BTM-3	14.77	33.76	20.84
T_4	BTM-4	13.59	39.97	26.54
T_5	BTM-5	16.74	33.49	20.21
T_6	BTM-6	15.45	27.06	19.23
T_7	BTM-7	12.61	33.30	21.38
T_8	BTM-8	17.25	24.72	19.57
T_9	BTM-9	16.92	36.54	25.77
T_{10}	BTM-10	19.74	34.69	28.92
T_{11}	BTM-11	18.67	35.67	25.38
T_{12}	BTM-12	17.67	38.09	31.58
T_{13}	BTM-13	12.16	35.33	24.78
T_{14}	BTM-14	18.58	39.06	29.56
T_{15}	BTM-15	20.51	42.27	35.26
T_{16}	BTM-16	21.26	31.69	22.72
T_{17}	BTM-17	20.70	41.43	33.98
T_{18}	BTM-18	21.33	34.36	24.66
T_{19}	BTM-19	19.31	41.78	33.42
T_{20}	BTM-20	19.00	40.17	32.56
	S.Em (±)	0.62	1.05	0.94
	C.D. (5%) =	1.75	2.96	2.65
	C.V. (%) =	7.12	5.88	7.18

Table 2: Evaluation of chemical properties of tamarind genotypes on non-reducing sugars (%), acidity (%) and ascorbic acid (mg/100 g).

Tr. No.	Genotype	Non-reducing sugars (%)	Acidity (%)	Ascorbic acid (mg/100 g)
T_1	BTM-1	11.53	10.87	5.13
T_2	BTM-2	12.54	10.48	8.65
T_3	BTM-3	12.92	11.66	5.50
T_4	BTM-4	13.43	8.58	6.29
T_5	BTM-5	13.28	9.44	5.85
T_6	BTM-6	7.83	8.92	12.33
T_7	BTM-7	11.92	8.25	6.58
T_8	BTM-8	5.15	12.66	11.13
T_9	BTM-9	10.77	11.86	7.57
T_{10}	BTM-10	5.77	19.42	11.88
T_{11}	BTM-11	10.29	13.65	7.50
T_{12}	BTM-12	6.51	19.54	11.43
T_{13}	BTM-13	10.55	18.66	8.37
T_{14}	BTM-14	9.50	12.89	10.87
T_{15}	BTM-15	7.01	14.43	9.28
T_{16}	BTM-16	8.97	19.46	7.90
T_{17}	BTM-17	7.45	15.65	10.59
T_{18}	BTM-18	9.70	16.30	9.58
T_{19}	BTM-19	8.36	17.62	10.50
T_{20}	BTM-20	7.61	18.19	9.72
	S.Em (±)	0.34	0.51	0.30
	C.D. (5%) =	0.97	1.45	0.86
	C.V. (%) =	7.16	7.34	6.89

4. Conclusion

The evaluation of 20 tamarind genotypes from Bastar, Chhattisgarh revealed significant variability in physico-chemical properties. Genotype T_{18} showed the highest TSS (21.33 °Brix), while T_{15} excelled in total sugars (42.27%) and reducing sugars (35.26%). T4 recorded the highest non-reducing sugars (13.43%), T_{12} had the highest acidity (19.54%), and T_6 showed maximum ascorbic acid content (12.33 mg/100 g). These differences suggest strong genotypic influence on nutritional traits, likely shaped by environmental and metabolic factors. The superior-performing genotypes identified—T_{18}, T_{15}, T_4, T_{12}, and T_6—hold potential for future breeding, conservation, and commercial utilization in tamarind improvement programs.

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6. Future Scope

1. Superior genotypes like T_{18}, T_{15}, T_4, T_{12}, and T_6 can be used for future tamarind improvement programs.
2. These genotypes may serve as parent material in breeding for quality traits.
3. Multi-location trials can help assess the adaptability and stability of identified genotypes.
4. Genotype performance under varying Agro-climatic conditions needs to be evaluated.
5. Value-added product development from high TSS and sugar-rich genotypes is recommended.
6. Processing industries can explore commercial utilization of superior genotypes.
7. Molecular characterization of genotypes can support genetic diversity and trait mapping.

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