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Studies on Physico-chemical evaluation of tamarind (*Tamarindus indica* L.) genotypes prevailing in bastar region of Chhattisgarh on chemical characters

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Abstract

The present investigation entitled “Studies on physico-chemical evaluation of tamarind (*Tamarindus indica* L.) genotypes prevailing in Bastar region of Chhattisgarh” was carried out in the laboratory, Department of Horticulture, College of Agriculture, IGAU, Raipur (C.G.) during the year 2004-05 and 2005-06. The study was carried out with 16 treatments (genotypes) consist of ripe fruits collected from selected trees of tamarind exist in Tokapal and Jagdalpur block of Bastar district (C.G.) under Randomized Block Design with three replications. The highest acidity (tartaric acid) was noticed in IGTAM-6, while the highest percentage of ascorbic acid content and the highest fruit thickness both were recorded in IGTAM-11. On the basis of findings of the present study, it is concluded that the tamarind genotypes *i.e.*, IGTAM-15, IGTAM-14, IGTAM-16, IGTAM-1 and IGTAM-6, which were found best for higher pulp, sugar, minerals and acidity content in the fruit as well as for individual fruit weight among all the genotypes studied in this investigation. Hence, these genotypes can be considered for further improvement of tamarind crop.

Keywords: Tamarind, genotype and physico-chemical.

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 $2n=24$. The name tamarind was derived from the Arabic word ‘Tamar-E-Hind’ meaning ‘Date of India’. It is cultivated throughout the tropics and sub-tropics of the world and has become naturalized at many places.

Tamarind is an economically important tree of India as well as Chhattisgarh. In India, it is abundantly grown in Madhya Pradesh, Bihar, Andhra Pradesh, Tamil Nadu and Karnataka.

In India, tamarind is one of the most important common fruit trees and it is under cultivation for several centuries. Almost every part of it finds some use, but the most important is the fruit pulp which is the richest source of tartaric acid. It is being used in the manufacture of several products such as tamarind juice concentrate, pulp powder, pectin, pickle, chutneys, sauces, soups, jam, syrups, candy, tartaric acid, alcohol, refreshing tamarind drinks and tamarind kernel powder.

In India, few improved varieties of tamarind are in existence, like PKM-1 of Periyakulam, Pratisthan of Maharashtra and Urigam of Tamil Nadu. Looking to the large area of tamarind either in forest or in homestead of tribal people.

Materials and method

The observations were recorded on the ripe fruits collected from the plus trees and replicated thrice. The methods used for the estimation of various physical components of the fruits of 16 tamarind genotypes are given in following sub-heads:

1. Total soluble solids (TSS)

The total soluble solids were determined by using portable hand refractometer. The 5 g pulp of fruit was mashed with 5 ml of distilled water to make into juice. A few drops of extracted juice was placed on refractometer and the reading recorded were expressed in degree Brix.

2. Titratable acidity

Acidity of tamarind pulp was calculated by titrating the diluted pulp against the standard N/10 NaOH solution using phenolphthalein as an indicator and expressed as anhydrous acetic acid w/w.

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3. pH of pulp

The of pH each sample of tamarind was recorded with the help of u-365 pH meter.

4. Ascorbic acid

A known weight of finely chopped flesh was properly blended with 15 ml 3 per cent metaphosphoric acid in pestle mortar. After macerating, the contents were transferred into 100 ml volumetric flask and volume was made upto the mark with 3 per cent metaphosphoric acid. A known volume of aliquot of the filtrate was titrated against 2, 6-Dichlorophenol-indophenol dye solution to a pink end point, which persisted for 15 seconds.

5. Total sugar

Total sugar was determined as per "Lane and Eynon" method.

$$\text{Total sugar} = \frac{\text{Factor for Fehling's solution} \times \text{Dilution} \times 100}{(\% \text{ invert sugar}) \text{ Titre value (ml)} \times \text{weight of sample taken} \times 1000}$$

6. Reducing sugar

The extract was taken and titrated against 10 ml of mixed Fehling's solution using methylene blue as an indicator according to the "Lane and Eynon" method. It was then boiled for two minutes, 2-3 drops of methylene blue indicator

The clear extract of tamarind pulp about 50 ml was taken in a 250 ml conical flask, 5 g of citric acid and 50 ml distilled water was added and boiled gently for 10 minutes to complete the inversion of sucrose, then cooled. This solution was transferred to another 250 ml conical flask and neutralized with 1N NaOH using phenolphthalein as an indicator. The volume was made upto 250 ml by adding distilled water. This aliquot was titrated against 10 ml of mixed Fehling's solution using "Methylene blue" as an indicator. It was then boiled for 2 minutes. Two drops of methylene blue were added and further titration was completed within a minute. The end point was indicated by decolourization of indicator. Percentage of total sugar was calculated by using the following formula:

were added and the titration was completed within a minute. The end point was identified when the decolourization of indicator occurred. Percentage of reducing sugar was calculated and expressed in terms of percentage, by using the following formula:

$$\text{Reducing sugar (\%)} = \frac{\text{Factor for Fehling's solution} \times \text{Dilution} \times 100}{\text{Titre value (ml)} \times \text{wt. or vol of sample taken} \times 1000}$$

7. Non-reducing sugar

Non-reducing sugar was calculated by deducting the quantity of reducing sugar from total sugar and multiplied by factor 0.95 and the results were expressed as per cent of non-reducing sugar.

$$\text{Non-reducing sugar (\%)} = (\text{Total sugar} - \text{reducing sugar}) \times 0.95$$

8. Protein per cent

Pulp protein was determined by Kjeldahl method by digesting 0.2 gm of fruit pulp sample in 10 ml diacid containing conc. H₂SO₄ and perchloric acid in 5:1 ratio and catalyst mixture of sodium sulphide and copper sulphate followed by distillation and titration. The obtained value of nitrogen was multiplied with the factor 6.25 to get pulp protein per cent.

9. Crude fibre per cent

Crude fibre refers to the residue of a food that is insoluble after successive boiling with dilute acid (1.25% H₂SO₄) and alkali (1.25% NaOH) by Weende's method with the help of fibre pulp and using muffle furnace at 550° C temperature for 4-6 hours. The crude fibre content of pulp was determined as.

Results and discussion

1. Acidity

The per cent of acidity among different genotypes was estimated during 2004-05 and 2005-06 and the results are presented in Table 1.

It is apparent from the data that acidity content ranged from 7.95 per cent (IGTAM-4) to 19.55 per cent (IGTAM-6) during 1st year (2004-05), 7.98 per cent (IGTAM-4) to 19.63 per cent (IGTAM-6) during 2nd year (2005-06) and 7.97 per cent (IGTAM-4) to 19.59 per cent (IGTAM-6) in case of pooled data (mean of both the years). Significant difference was observed among the genotypes in respect of acidity content during both the years as well as pooled mean basis.

During 1st year (2004-05), the highest acidity content was recorded in IGTAM-6 (19.55%) which was found significantly higher than all the genotypes studied in the investigation. This genotype (IGTAM-6) was followed by IGTAM-9 (13.60%), IGTAM-12 (13.50%) and IGTAM-10 (12.25%). The lowest acidity content was observed in IGTAM-4 (7.95%).

During 2nd year (2005-06), maximum acidity content was recorded in IGTAM-6 (19.63%) which was found significantly higher than all the genotypes studied in this investigation. This genotype (IGTAM-6) was followed by IGTAM-9 (13.56%) IGTAM-12 (12.92%) and IGTAM-10 (12.27%). The minimum acidity content was observed in IGTAM-4 (7.98%).

In case of pooled data, highest acidity content was observed in IGTAM-6 (19.59%) which was significantly higher than all the genotypes studied in this investigation. This genotype (IGTAM-6) was followed by IGTAM-9 (13.58%), IGTAM-12 (13.21%) and IGTAM-10 (12.26%). The lowest acidity content was recorded in IGTAM-4 (7.79%).

Thus, it is evident from the data that acidity content of tamarind was high and data clearly show that higher value (%) of acidity content was recorded in IGTAM-6 and minimum value (%) of acidity content was observed in IGTAM-4 in case of 1st year and 2nd year of the study as well as in pooled data.

The variation in titrable acidity in the different tamarind genotypes showed a significant deviation in this investigation. The titrable acidity (as per cent tartaric acid) ranged between minimum of 7.95 per cent (IGTAM-4) to maximum of 19.63 per cent (IGTAM-6).

2. Total soluble solids (TSS)

The results pertaining to total soluble solids of pulp are furnished in Table 2.

The range of variation in total soluble solids was from 12.06 (IGTAM-12) to 19.66 °Brix (IGTAM-15) during 1st year (2004-05), 12.17 (IGTAM-12) to 19.61 °Brix (IGTAM-15) during 2nd year (2005-06) and 12.13 (IGTAM-12) to 19.63 °Brix (IGTAM-15) in case of pooled data (mean of both the years). Significant difference was observed among the different tamarind genotypes with respect to total soluble solids of pulp during both the years as well as pooled basis. During 1st year (2004-05), the highest total soluble solids was recorded in IGTAM-15 (19.66 °B) which was found remarkably good than all the genotypes studied in the investigation. This genotype (IGTAM-15) was followed by IGTAM-16 (18.72 °B), IGTAM-14 (18.20°B) and IGTAM-9 (17.60°B). The lowest TSS was recorded in IGTAM-12 (12.06°B).

During 2nd year (2005-06), the maximum total soluble solids was recorded in IGTAM-15 (19.61°B) which was found significantly higher than all the genotypes studied in this investigation. This genotype (IGTAM-15) was followed by IGTAM-16 (18.83°B), IGTAM-14 (18.21°B) and IGTAM-9 (17.82°B). The least TSS was observed in IGTAM-12 (12.17°B).

In case of pooled data, highest total soluble solids was observed in IGTAM-15 (19.63°B) which was found remarkably better than all the genotypes studied in this investigation. This genotype (IGTAM-15) was followed by IGTAM-16 (18.77°B), IGTAM-14 (18.21°B) and IGTAM-9 (17.71°B). The lowest TSS was recorded in IGTAM-12 (12.13°B).

Table 1: Variation in chemical composition of different Tamarind genotypes (acidity, TSS and pH)

Treatments	Acidity per cent of pulp			Total soluble solids, °Brix			pH		
	2004-05	2005-06	Pooled	2004-05	2005-06	Pooled	2004-05	2005-06	Pooled
IGTAM-1	10.50	10.52	10.51	14.95	14.97	14.96	3.11	3.10	3.11
IGTAM-2	9.70	9.75	9.72	15.62	15.43	15.53	3.39	3.39	3.39
IGTAM-3	8.50	8.50	8.50	16.10	16.19	16.15	3.47	3.47	3.47
IGTAM-4	7.95	7.98	7.97	16.52	16.54	16.53	3.47	3.47	3.47
IGTAM-5	12.00	12.02	12.01	13.12	13.17	13.15	3.11	3.12	3.12
IGTAM-6	19.55	19.63	19.59	13.63	13.64	13.63	2.58	2.60	2.59
IGTAM-7	10.50	10.60	10.55	16.52	16.51	16.52	3.21	3.21	3.21
IGTAM-8	10.60	10.67	10.64	16.86	16.89	16.88	3.20	3.17	3.19
IGTAM-9	13.60	13.56	13.58	17.60	17.82	17.71	2.92	2.93	2.92
IGTAM-10	12.25	12.27	12.26	16.21	17.23	17.22	3.03	3.05	3.04
IGTAM-11	9.56	9.62	9.59	13.65	14.39	14.37	3.40	3.41	3.41
IGTAM-12	13.50	12.92	13.21	12.06	12.17	12.13	2.93	3.03	2.93
IGTAM-13	11.25	11.25	11.25	13.15	13.10	13.12	3.21	3.21	3.21
IGTAM-14	10.07	10.13	10.09	18.20	18.21	18.21	3.37	3.36	3.37
IGTAM-15	8.35	8.38	8.36	19.66	19.61	19.63	3.46	3.46	3.46
IGTAM-16	8.95	8.74	8.95	18.72	18.83	18.77	3.42	3.42	3.42
SE(m)±	0.048	0.0867	0.0436	0.3102	0.0567	0.0422	0.0103	0.0132	0.0073
CD (5%)	0.14	0.25	0.13	0.9	0.16	0.12	0.03	0.04	0.02

Thus, the data recorded on TSS of pulp clearly show that higher pulp was recorded in IGTAM-15 and least TSS of pulp observed in IGTAM-12 in case of both the year of study as well as in pooled data.

The total soluble solids (TSS) content of 16 different genotypes varied significantly. The maximum TSS was recorded in IGTAM-15 (19.66°B) and minimum TSS recorded in IGTAM-12 (12.06°B). This difference in TSS content of pulp may be due to difference in sugar content of fruits. Similar outcome with respect to TSS was reported by Shivanandam (1980) [12], Keskar *et al.* (1989) [7] and Prabhushankar *et al.* (2004) [10].

3. pH of fruit pulp

The data pertaining to pH of fruit pulp are presented in Table 3.

It was observed that pH of fruit in different genotypes of tamarind included in this study varied from 2.58 (IGTAM-6) to 3.47 (IGTAM-3) during 1st year (2004-05), 2.60 (IGTAM-6) to 3.47 (IGTAM-3) during 2nd year (2005-06) and 2.59 (IGTAM-6) to 3.47 (IGTAM-3) in case of pooled data. Significant difference was observed among the genotypes in respect of pH of fruit during both the years as well as pooled mean basis.

During 1st year (2004-05), the highest pH of fruit was recorded in IGTAM-3 (3.47) which was found significantly

higher than all the genotypes studied in this investigation except IGTAM-4 (3.46) and IGTAM-15 (3.46) which was followed by IGTAM-16 (3.42) and IGTAM-11 (3.40). The lowest pH of fruit was observed in IGTAM-6 (2.58).

During 2nd year (2005-06), the maximum pH of fruit was observed in IGTAM-3 (3.47) which was found significantly higher than all the genotypes studied in this investigation except IGTAM-4 (3.47) and IGTAM-15 (3.46), which was followed by IGTAM-16 (3.42) and IGTAM-11 (3.41). The minimum pH of fruit was recorded in IGTAM-6 (2.60).

In case of pooled data, the highest pH of fruit was observed in IGTAM-3 (3.47) which was found significantly higher than all the genotypes studied in this investigation except IGTAM-4 (3.47) and IGTAM-15 (3.46), which was followed by IGTAM-16 (3.42) and IGTAM-11 (3.41). The lowest pH of fruit was recorded in IGTAM-6 (2.59).

Thus the data revealed that maximum pH of fruit pulp was observed in IGTAM-3 and minimum pH in IGTAM-6 in case of both the years as well as in pooled data. The pH content of the pulp also varied significantly. The maximum pH was recorded in IGTAM-3 (3.47) and minimum pH in IGTAM-6 (2.58). The difference in pH content are attributed to the difference in genotypes and varies from season to season. Similar results were also reported by Azhakiyamanavalan and Vadivel (1997) [3] in tamarind.

4. Reducing sugar

The data pertaining to reducing sugar content of fruit is furnished in Table 4

The range of variation in reducing sugar of fruit was 25.08 per cent (IGTAM-13) to 38.07 per cent (IGTAM-15) during 1st year (2004-05), 25.22 per cent (IGTAM-13) to 37.72 per cent (IGTAM-15) during 2nd year (2005-06) and 25.19 per cent (IGTAM-13) to 37.89 per cent (IGTAM-15) in case of pooled data (mean of both the years). Significant difference was observed among the different genotypes with respect to reducing sugar of fruit during both the years as well as in pooled basis.

During 1st year (2004-05), the highest reducing sugar per cent of fruit was recorded in IGTAM-15 (38.07%) which was found excellent than all the genotypes studied in the investigation. This genotype (IGTAM-15) was followed by IGTAM-16 (37.13%), IGTAM-14 (36.58%) and IGTAM-9 (35.21%). The lowest reducing sugar content was recorded in IGTAM-13 (25.08%).

During 2nd year (2005-06), the maximum reducing sugar per cent of fruit was recorded in IGTAM-15 (37.72%) which was found significantly higher than all the genotypes studied in this investigation except IGTAM-16 (37.23%), which was followed by IGTAM-14 (36.50%), IGTAM-9 (35.72%) and IGTAM-7 (35.50%). The lowest reducing sugar content of fruit was recorded in IGTAM-13 (25.22) which was found statistically similar to IGTAM-2 (25.31%).

In case of pooled data, highest sugar per cent of fruit was observed in IGTAM-15 (37.89%) which was found exceptionally better than all the other genotypes studied in this investigation. This genotype (IGTAM-15) was followed by IGTAM-16 (37.18%), IGTAM-14 (36.54%) and IGTAM-9 (35.72%). The lowest reducing sugar content of fruit was observed in IGTAM-13 (25.19%) which was found significantly lower than all the genotypes except IGTAM-2 (25.20%).

Thus, the data recorded on reducing sugar per cent of fruit clearly show that higher reducing sugar per cent was observed in IGTAM-15 and lower reducing sugar per cent was recorded in IGTAM-13 in case of 1st year and 2nd year of the study as well as in pooled data. As regards to reducing sugar and total sugar content of tamarind fruit, the maximum reducing sugar and total sugar was recorded in IGTAM-15, 38.09 and 51.88 per cent, respectively, while the minimum reducing sugar and total sugar was recorded in IGTAM-13, 25.08 per cent and 33.34 per cent, respectively. In case of non-reducing sugar, maximum content was recorded in IGTAM-1 (15.00%) and minimum in IGTAM-6 (7.85%).

The level of sugar content in tamarind was possible due to ripening of fruits, which is associated with high metabolic changes in the fruits leading to conversion of complex polysaccharides into simple sugars. The difference in sugar content are attributed to the difference in genotypes.

Table 2: Reducing, non-reducing and total sugar content in fruit pulp of different Tamarind genotypes

Treatments	Reducing sugar (%)			Non-reducing sugar (%)			Total sugar (%)		
	2004-05	2005-06	Pooled	2004-05	2005-06	Pooled	2004-05	2005-06	Pooled
IGTAM-1	30.99	30.99	30.99	14.74	15.00	14.87	45.73	46.00	45.86
IGTAM-2	25.17	25.31	25.20	8.93	8.96	8.95	34.01	34.27	34.14
IGTAM-3	28.40	28.33	28.37	12.60	12.67	12.63	41.00	41.00	41.00
IGTAM-4	32.76	32.88	32.82	9.30	9.28	9.29	42.06	42.17	42.11
IGTAM-5	26.60	27.14	26.87	12.44	12.33	12.39	39.04	39.48	39.26
IGTAM-6	25.95	26.14	26.05	7.85	7.92	7.89	33.80	34.07	33.93
IGTAM-7	35.21	35.50	35.36	9.73	9.98	9.86	44.95	45.48	45.21
IGTAM-8	33.31	33.34	33.33	11.02	10.98	11.00	44.33	44.32	44.33
IGTAM-9	35.71	35.72	35.72	10.06	10.12	10.09	45.77	45.84	45.81
IGTAM-10	30.36	30.50	30.43	12.34	12.65	12.50	42.70	43.15	42.93
IGTAM-11	26.81	26.86	26.83	13.47	13.78	13.62	40.28	40.64	40.46
IGTAM-12	29.41	28.87	29.14	10.19	11.13	10.66	39.60	40.01	39.80
IGTAM-13	25.08	25.22	25.19	8.17	8.16	8.17	33.34	33.37	33.36
IGTAM-14	36.58	36.50	36.54	10.64	10.47	10.55	47.22	46.96	47.09
IGTAM-15	38.07	37.72	37.89	13.82	11.97	12.83	51.88	49.68	50.72
IGTAM-16	37.13	37.23	37.18	11.00	11.18	11.09	48.12	48.42	48.27
SE(m)±	0.2186	0.2284	0.1709	0.6449	0.2989	0.4282	0.6378	0.3829	0.7393
CD (5%)	0.63	0.66	0.49	1.86	0.86	1.24	1.84	1.11	2.13

5. Non-reducing sugar

Data obtained on non-reducing sugar per cent of fruit are presented in Table 5

It was observed that non-reducing sugar content of fruit in different genotypes included in this study varied from 7.85 per cent (IGTAM-6) to 14.74 per cent (IGTAM-1) during 1st year (2004-05), 7.92 per cent (IGTAM-6) to 15.00 per cent (IGTAM-1) during 2nd year (2005-06) and 7.89 per cent (IGTAM-6) to 14.87 per cent (IGTAM-1) in case of pooled data (mean of both the years). Significant difference was observed among the genotypes in respect of non-reducing sugar content of fruit during both the years as well as in pooled basis.

During 1st year (2004-05), the maximum non-reducing sugar per cent of fruit was observed in IGTAM-1 (14.74%) which was found at par with IGTAM-15 (13.82%) and IGTAM-11

(13.47%). This genotype (IGTAM-1) was found significantly higher than all the other genotypes included in this investigation which was followed by IGTAM-3 (12.60%) and IGTAM-5 (12.44%). The lowest non-reducing sugar content of fruit was found in IGTAM-6 (7.86%) which was found statistically similar to IGTAM-13 (8.17%), IGTAM-2 (8.93%) and IGTAM-4 (9.30%).

During 2nd year (2005-06) highest non-reducing sugar per cent of fruit was observed in IGTAM-1 (15.00%) which was found significantly higher than all the other genotypes studied in this investigation. This genotype (IGTAM-1) was followed by IGTAM-11 (13.78%), IGTAM-3 (12.67%) and IGTAM-10 (12.65%). The lowest non-reducing sugar per cent of fruit was recorded in IGTAM-6 (7.92%) which was significantly lower than all the other treatments except IGTAM-13 (8.16%).

In case of pooled data, maximum non-reducing sugar per cent of fruit was recorded in IGTAM-1 (14.87%) which was found remarkably better than all the genotypes studied in this investigation. This genotype (IGTAM-1) was followed by IGTAM-11 (13.62%), IGTAM-15 (12.83%) and IGTAM-3 (12.63%). The lowest non-reducing sugar content of fruit was recorded in IGTAM-6 (7.89%) which was significantly lower than all the treatments except IGTAM-13 (8.17%) and IGTAM-2 (8.95%).

Thus, it is obvious from the data that highest non-reducing sugar per cent of fruit was recorded in IGTAM-1 and least non-reducing sugar per cent of fruit was observed in IGTAM-6 in case of both the years as well as in pooled data.

6. Total sugar

The data pertaining to total sugar per cent of fruit are presented in Table 5

It was observed that total sugar per cent of fruit in different genotypes of tamarind included in this study ranged between 33.34 per cent (IGTAM-13) to 51.88 per cent (IGTAM-15) during 1st year (2004-05), 33.37 per cent (IGTAM-13) to 49.68 per cent (IGTAM-15) during 2nd year (2005-06) and 33.36 per cent (IGTAM-13) to 50.72 per cent (IGTAM-15) in case of pooled data (mean of both the years). Significant difference was observed among the genotypes in respect of total sugar per cent of fruit during both the years as well as pooled mean basis.

During 1st year (2004-05), the highest total sugar per cent of fruit was recorded in IGTAM-15 (51.88%) which was found exceptionally better than all the genotypes studied in this investigation. This genotype (IGTAM-15) was followed by IGTAM-16 (48.12%), IGTAM-14 (47.22%) and IGTAM-9 (45.77%). The lowest total sugar per cent of fruit was observed in IGTAM-13 (33.34%) which was found significantly lower than all the treatments except IGTAM-6 (33.80%).

During 2nd year (2005-06), the maximum total sugar per cent of fruit was recorded in IGTAM-15 (49.68%) which was found remarkably better than all the genotypes studied in this investigation. This genotype (IGTAM-15) was followed by IGTAM-16 (48.42%), IGTAM-14 (46.96%) and IGTAM-1 (46.00%). The least total sugar per cent of fruit was observed in IGTAM-13 (33.37%) which was found significantly lower than all the treatments except IGTAM-6 (34.07%).

In case of pooled data, the highest total sugar per cent of fruit was recorded in IGTAM-15 (50.72%) which was found exceptionally better than all the genotypes studied in this investigation. This genotype (IGTAM-15) was followed by IGTAM-16 (48.27%), IGTAM-14 (47.09%) and IGTAM-1 (45.86%). The least total sugar per cent of fruit was observed in IGTAM-13 (33.36%) which was found significantly lower than all the treatment except IGTAM-6 (33.80%).

Thus, the data recorded on total sugar per cent of fruit clearly show that maximum total sugar per cent was found in IGTAM-15 and minimum total sugar per cent was observed in IGTAM-13 in case of both the years as well as in pooled data.

7. Ascorbic acid

The data on ascorbic acid content of pulp is furnished in Table 6

It was observed that ascorbic acid content of pulp in different genotypes included in this study ranged from 1.81 per cent (IGTAM-8) to 4.03 per cent (IGTAM-11) during 1st year (2004-05), 1.81 per cent (IGTAM-8) to 4.05 per cent (IGTAM-11) during 2nd year (2005-06) and 1.81 per cent (IGTAM-8) to 4.04 per cent (IGTAM-11) in case of pooled data (mean of both the years). Significant difference was observed among the genotypes in respect of ascorbic acid content of pulp during both the years as well as in pooled data.

During 1st year (2004-05), the maximum ascorbic acid content of pulp was recorded in IGTAM-11 (4.03%) which was found excellent than all the other genotypes studied in this investigation. This genotype (IGTAM-11) was followed by IGTAM-4 (3.24%), IGTAM-9 (2.91%) and IGTAM-10 (2.81%). The minimum ascorbic acid content was observed in IGTAM-8 (1.81%).

During 2nd year (2005-06), the highest ascorbic content of pulp was recorded in IGTAM-11 (4.03%) which was found significantly higher than all the genotypes studied in this investigation. This genotype (IGTAM-11) was followed by IGTAM-4 (3.23%), IGTAM-10 (2.82%) and IGTAM-9 (2.79%). The lowest ascorbic acid content of pulp was noticed in IGTAM-8 (1.81%) which was found significantly lower than all the treatments except IGTAM-1 (1.93%).

In case of pooled data, the maximum ascorbic acid content of pulp was recorded in IGTAM-11 (4.04%) which was found significantly superior than all the genotypes studied in this investigation. This genotype (IGTAM-11) was followed by IGTAM-4 (3.24%), IGTAM-9 (2.85%) and IGTAM-10 (2.82%). The minimum ascorbic acid content of pulp was observed in IGTAM-8 (1.81%).

Thus, the data clearly reveal that highest ascorbic acid per cent of pulp was recorded in IGTAM-11 and lowest ascorbic acid content was observed in IGTAM-8 during 1st year and 2nd year of the study as well as in pooled data.

The ascorbic acid content in different tamarind genotypes included in this study ranged between minimum of 1.81 per cent (IGTAM-8) to maximum of 4.05 per cent (IGTAM-11). The difference in ascorbic acid content of fruit may be due to perpetual synthesis of glucose-6-phosphate throughout the growth and development of fruits which is thought to be the precursor of vitamin 'C' (ascorbic acid).

Table 3: Ascorbic acid, protein and crude fibre (%) of different Tamarind genotypes

Treatments	Ascorbic acid (%) pulp			Protein (%) pulp			Crude fibre (%) pulp		
	2004-05	2005-06	Pooled	2004-05	2005-06	Pooled	2004-05	2005-06	Pooled
IGTAM-1	1.92	1.93	1.93	4.58	4.55	4.57	10.39	10.36	10.37
IGTAM-2	2.01	2.03	2.02	3.28	3.29	3.29	9.30	9.30	9.30
IGTAM-3	2.09	2.12	2.11	2.52	2.50	2.51	3.38	3.41	3.40
IGTAM-4	3.24	3.23	3.24	2.11	2.14	2.13	7.33	7.38	7.36
IGTAM-5	2.21	2.28	2.25	3.14	3.11	3.12	3.58	3.54	3.56
IGTAM-6	1.96	1.94	1.95	5.22	5.27	5.25	5.64	5.65	5.64
IGTAM-7	2.45	2.45	2.45	2.73	2.75	2.74	4.24	4.30	4.27
IGTAM-8	1.81	1.81	1.81	2.03	2.04	2.03	8.28	8.38	8.33

IGTAM-9	2.91	2.79	2.85	3.07	3.12	3.14	6.44	6.47	6.46
IGTAM-10	2.81	2.82	2.82	5.12	5.11	5.12	5.79	5.75	5.77
IGTAM-11	4.03	4.05	4.04	3.25	3.31	3.28	5.61	5.76	5.69
IGTAM-12	2.23	2.22	2.22	4.28	4.30	4.29	4.38	4.39	4.39
IGTAM-13	2.33	2.34	2.34	3.22	3.19	3.21	3.29	3.23	3.26
IGTAM-14	2.13	2.13	2.13	5.44	5.39	5.42	7.10	7.01	7.05
IGTAM-15	2.04	2.07	2.05	6.71	6.67	6.69	7.27	7.18	7.22
IGTAM-16	2.20	2.19	2.20	4.87	5.72	4.79	8.16	8.18	8.17
SE(m)±	0.0138	0.0423	0.0226	0.0341	0.2471	0.0271	0.0905	0.0799	0.0683
CD(5%)	0.04	0.12	0.07	0.1	0.71	0.08	0.26	0.23	0.2

8. Protein

The data gathered on protein per cent of pulp are presented in Table 7

It is clear from the data that protein per cent of pulp in different genotypes included in this study varied from 2.03 per cent (IGTAM-8) to 6.71 per cent (IGTAM-15) during 1st year (2004-05), 2.04 per cent (IGTAM-8) to 6.67 per cent (IGTAM-15) during 2nd year (2005-06) and 2.03 per cent (IGTAM-8) to 6.69 per cent (IGTAM-15) in case of pooled data (mean of both the years). Significant difference was recorded among the genotypes in respect of protein per cent of pulp during both the years as well as in pooled data.

During 1st year (2004-05), the highest protein per cent of pulp was observed in IGTAM-15 (6.71%) which was found remarkably better than all the genotypes studied in this investigation. This genotype (IGTAM-15) was followed by IGTAM-14 (5.44%), IGTAM-6 (5.22%) and IGTAM-10 (5.12%). The lowest protein per cent of pulp was recorded in IGTAM-8 (2.03%) which was found at par with IGTAM-4 (2.11%).

During 2nd year (2005-06), the maximum protein per cent of pulp was recorded in IGTAM-15 (6.67%) which was found remarkably better than all the genotypes studied in this investigation. This genotype (IGTAM-15) was followed by IGTAM-16 (5.72%), IGTAM-14 (5.39%) and IGTAM-6 (5.27%). The lowest protein per cent of pulp was observed in IGTAM-8 (2.04%) which as found statistically similar with IGTAM-4 (2.14%), IGTAM-3 (2.50%) and IGTAM-7 (2.75%).

In case of pooled data, the maximum protein per cent of pulp was noticed in IGTAM-15 (6.69%) which was found exceptionally superior than all the genotypes studied in this investigation. This genotype (IGTAM-15) was followed by IGTAM-14 (5.42%), IGTAM-6 (5.25%) and IGTAM-10 (5.12%). The minimum protein per cent of pulp was noticed in IGTAM-8 (1.95%).

Thus, the data on protein per cent of pulp reveal that higher protein per cent of pulp was recorded in IGTAM-15 and lower protein per cent of pulp was observed in IGTAM-8 in case of both the years as well as in pooled data.

The protein content of fruit significantly varied from minimum 2.04 per cent (IGTAM-8) to maximum of 6.71 per cent (IGTAM-15). The variation among the genotypes may be due to concentration of nitrogen in the fruits of different genotypes. These results are in close conformity with the findings of Shankaracharya (1998)^[15] in tamarind.

9. Crude fibre

The data obtained on crude fibre are presented in Table 8

It is apparent from the data that crude fibre per cent of pulp ranged between 3.29 per cent (IGTAM-13) to 10.39 per cent (IGTAM-1) during 1st year (2004-05), 3.23 per cent (IGTAM-13) to 10.36 per cent (IGTAM-1) during 2nd year (2005-06) and 3.26 per cent (IGTAM-13) to 10.37 per cent (IGTAM-1) in case of pooled data (mean of both the years). Significant

difference was observed among the genotypes in respect of crude fibre per cent of pulp during both the years as well as pooled mean basis.

During 1st year (2004-05), the highest crude fibre per cent of pulp was recorded in IGTAM-1 (10.39%) which was found significantly higher than all the genotypes studied in the investigation. The genotype (IGTAM-1) was followed by IGTAM-2 (9.30%), IGTAM-8 (8.28%) and IGTAM-16 (8.16%). The lowest crude fibre per cent of pulp was recorded in IGTAM-13 (3.29%) which was found at par with IGTAM-3 (3.38%).

During 2nd year (2005-06), the maximum crude fibre per cent of pulp was recorded in IGTAM-1 (10.36%) which was found significantly higher than all the genotypes studied in this investigation. This genotype (IGTAM-1) was followed by IGTAM-2 (9.30%) IGTAM-8 (8.38%) and IGTAM-16 (8.18%). The minimum crude fibre per cent of pulp was noticed in IGTAM-13 (3.23%) which was found statistically similar to IGTAM-3 (3.41%).

In case of pooled data, the highest crude fibre per cent of pulp was recorded in IGTAM-1 (10.37%) which was found significantly higher than all the genotype studied in this investigation. This genotype (IGTAM-1) was followed by IGTAM-2 (9.30%) IGTAM-8 (8.33%) and IGTAM-16 (8.17%). The lowest crude fibre per cent of pulp was recorded in IGTAM-13 (3.26%) which was at par with IGTAM-3 (3.40%).

Thus, the data on crude fibre clearly show that highest crude fibre was observed in IGTAM-1 and lowest crude fibre per cent in IGTAM-13 in case of 1st year and 2nd year of the study as well as in pooled data.

Among the 16 different tamarind genotypes studied, the crude fibre ranged from 3.23 per cent to 10.39 per cent with a maximum of 10.39 per cent in IGTAM-1 and minimum of 3.23 per cent in IGTAM-13. The variation in crude fibre of fruit might be due to genetic difference among the genotypes included in this study. The supporting references have also been reported by Shankaracharya (1998)^[15].

Chemical characters

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