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Variations in physico-chemical traits of tamarind genotypes

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ABSTRACT

Variability analysis was performed to investigate twenty tamarind genotypes' yield and fruit quality. As a result, the genotypes RHRTG 10, RHRTG 11, and RHRTG 14 were suitable for table purposes because of their less acidity and high TSS and pulp contents. Besides, RHRTG 20 (9.85%), RHRTG 4 (9.75%), and RHRHG 5 (9.30%) were found highly suitable for culinary purposes because of their high titratable acid content. Because of the very high acid content, RHRTH 16 (11.18%) was fit for confectionery uses. The genotypes RHRTG 4 (5.81 Kg/m^3), RHRTG 15 (5.09 Kg/m^3), and RHRTG 16 (4.75 Kg/m^3) proved the most productive. Genotypes having high yield efficiency can be utilized in high-density planting because of their lesser canopy volume and more yield per unit of canopy volume.

Keywords: *Tamarindus indica* L., pod quality, pulp percentage, yield efficiency

INTRODUCTION

Tamarind (*Tamarindus indica* L.), popularly known as 'Date of India' is a hardy evergreen tropical tree that belongs to the family 'Fabaceae', which is derived from an Arabic word "Tamar-ul-Hind". The fruit is commonly used as a spice because of its acidic nature but the sweet types from Thailand are now dominating the tamarind market as a table fruit. It is native to tropical Africa and Asia (Bailey, 4) although Watt (17) had suggested that it may have originated from the southern part of India. Almost every part (fruit pulp, seeds, fibre, and husk) of it is used in many industries. The fruit pulp is the richest source of tartaric acid and is being used in Ayurvedic medicine to treat gastric and digestive problems (Jayaweera, 8). Tamarind seed's kernels contain a polysaccharide with excellent sizing qualities, hence employed in paper sizing, colour printing, textile industries, leather tanning, and as a wood glue (Picout *et al*., 15).

It has a higher anthocyanin concentration (180 to 360 mg/g of unripe fruit) than any other anthocyanin-rich fruits like grapes (80-90 mg/g), cherry (70-75 mg/g), and jamun (120-130 mg/g) (Mayavel *et al*., 10). The anthocyanin in red tamarind has a lot of antioxidant qualities. As a result, it holds a lot of promise as a bio-colorant to replace carcinogenic inorganic colourants in the food processing, pharmaceutical, brewery, and confectionery industries (Kaur *et al*., 9; Mayavel *et al*., 10). In India, few improved varieties of tamarind are in existence. At present, varieties *viz*., PKM-1, Urigam, Cumban (in Tamil Nadu), Ajantha, Pratishthan, Yogeshwari, No. 263, Akola Smruti (in Maharashtra), Anantha Rudhira (in Andhra Pradesh) and Goma prateek (in Rajasthan) are grown on limited area.

The dried ripe fruit of sweet tamarind is typically eaten straight from the pod. Today's Indian's Sweet tamarind market is flooded with the Sweet type from Thailand. Hence, there is an urgent need to introduce or explore the sweet type tamarind so that dryland farming can be taken to its full potential under the current scenario of climate change. As a result of these considerations, the current experiment was carried out to look into the differences in physical and qualitative characteristics of tamarind genotypes in terms of yield and sweet type quality factors.

MATERIALS AND METHODS

The present investigation was conducted on 25-years old tamarind genotypes (grafted on local type) at the Instructional-cum-Research Farm, Department of Horticulture, Mahatma Phule Krishi Vidyapeeth, Rahuri, Dist. Ahmednagar (MS), India. The twenty genotypes from the university farm were evaluated for various physico-chemical characters and yield. The observations were taken during flowering month of May 2018 to harvesting date of March 2019. About twenty pods were randomly selected from all sides of the tree at the time of maturity from the selected tree. Fruit samples were wrapped in a polyethylene bag and transported to the lab for further analysis.

The observations were recorded on pod colour, pod shape, pulp colour, pod weight (g), pod length (cm), pod breadth (cm), shell weight (g), pulp weight (g), seed weight (g), vein weight (g), number of seeds

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per pod, weight of 100 seeds (g), shell percentage (%), pulp percentage (%), vein percentage (%), seed percentage (%), yield per tree (kg) and yield efficiency (kg/m^3). The data on physical parameters were recorded as per standard procedures with the help of electronic equipment. The qualitative physical attributes like mature pod colour, mature pod shape, mature pod pulp colour were grouped as per DUS guidelines (Anonymous, 1). Quality parameters like total soluble solids (°B), titratable acidity (%) and ascorbic acid (mg/100g) were assessed following standard procedures (AOAC, 2). The statistical analysis for mean, standard deviation, and coefficient of variation was done by adopting the procedure suggested by Panse and Sukhatme (14).

RESULTS AND DISCUSSION

Data presented in Table 1 indicate the variability among the genotypes for different qualitative physical attributes. With respect to mature pod colour, 11 genotypes were recorded for grey colour and 9 for the brown colour pod. The differences in pod colour might be due to the genotypic characteristics of the tree. Concerning mature pod shape, 16 genotypes were reported for moderately curved shape and 2 for straight, while remaining 2 had deeply curved shape (Plate 1). For pulp colour, 3 genotypes were observed with reddish-brown pulp, 12 for brown pulp, 2 for dark brown, 2 for pale brown, and only 1 for light brown colour pulp. The findings of Fandohan *et al*., (6) is likewise consistent with the findings of present study for these characters.

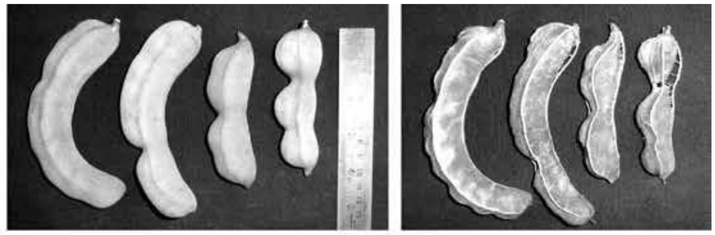
A considerable variation in pod weight (16.85 - 28.07 g) was observed in the studied population of tamarind (Table 2). The genotypes namely RHRTG 14, RHRTG 6, RHRTG 13 and RHRTG 18 were found to have higher fruit weight (25.89- 28.07g) than other genotypes. Individual genotypes may have different genetic constitutions, which could explain the diversity in pod weight. The pod length (ranged from 9.81 - 17.27 cm), and RHRTG 6 produced longest pods (17.27 cm) followed by RHRTG 13 and RHRTG 1, RHRTG 5. The pod breadth ranged from 2.05 cm (RHRTG 16) to 2.95 cm (RHRTG 14), and genotypes RHRTG 14, RHRTG 18 (2.75 cm) and RHRTG 11 (2.73 cm) were found superior in respect of this attribute (Table 2). Our results are in consonance with the study of Bilcke *et al*., (5).

The shell weight was highest in in the genotype RHRTG 6 (6.80 g) followed by RHRTG 4 (5.87 g), RHRTG 18 (5.72 g) and RHRTG 1 (5.62 g), while

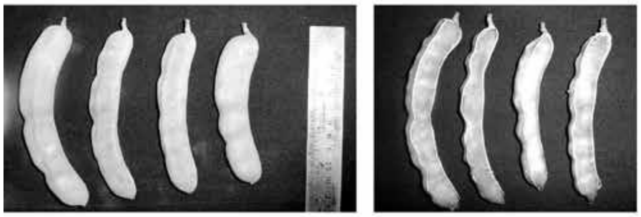
Table 1. Qualitative physical attributes of tamarind genotypes

Sr. No.	Genotype	Mature pod colour	Mature pod shape	Mature pod pulp colour
1.	RHRTG 1	Grey	Moderately curved	Reddish brown
2.	RHRTG 2	Grey	Moderately curved	Pale Brown
3.	RHRTG 3	Brown	Moderately curved	Reddish brown
4.	RHRTG 4	Grey	Deeply curved	Brown
5.	RHRTG 5	Grey	Moderately curved	Brown
6.	RHRTG 6	Grey	Straight	Brown
7.	RHRTG 7	Grey	Moderately curved	Brown
8.	RHRTG 8	Brown	Moderately curved	Dark brown
9.	RHRTG 9	Grey	Moderately curved	Dark brown
10.	RHRTG 10	Brown	Moderately curved	Light Brown
11.	RHRTG 11	Brown	Moderately curved	Brown
12.	RHRTG 12	Brown	Moderately curved	Brown
13.	RHRTG 13	Grey	Straight	Pale Brown
14.	RHRTG 14	Brown	Moderately curved	Brown
15.	RHRTG 15	Grey	Moderately curved	Brown
16.	RHRTG 16	Grey	Moderately curved	Reddish brown
17.	RHRTG 17	Brown	Moderately curved	Brown
18.	RHRTG 18	Brown	Moderately curved	Brown
19.	RHRTG 19	Grey	Moderately curved	Brown
20.	RHRTG 20	Brown	Deeply curved	Brown

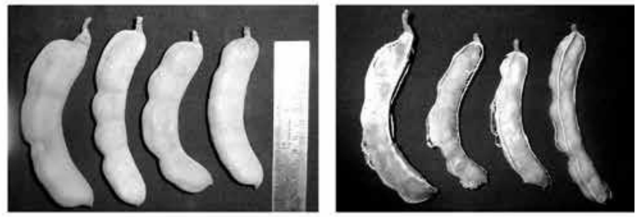
RHRTG 1



RHRTG 10

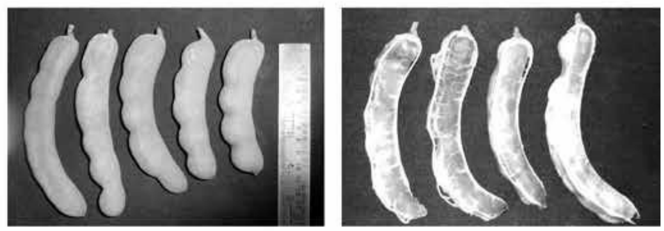


RHRTG 2



RHRTG 11

RHRTG 3



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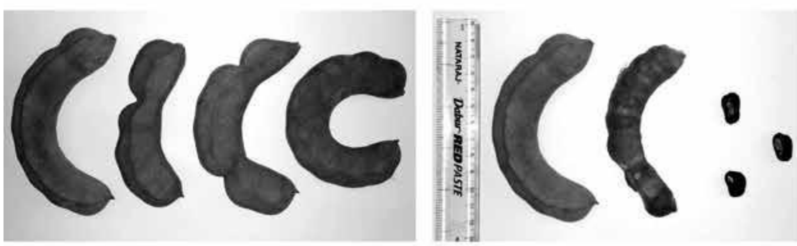
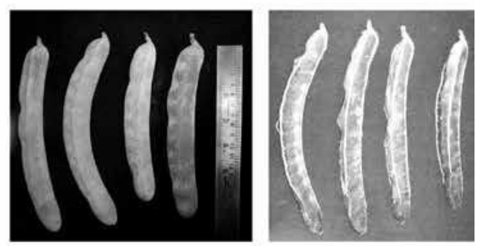
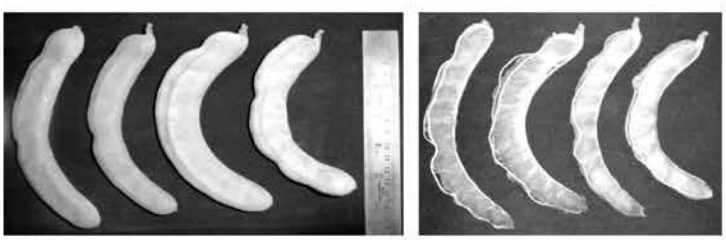


RHRTG 4



RHRTG 13



RHRTG 5

RHRTG 14

RHRTG 6

RHRTG 15

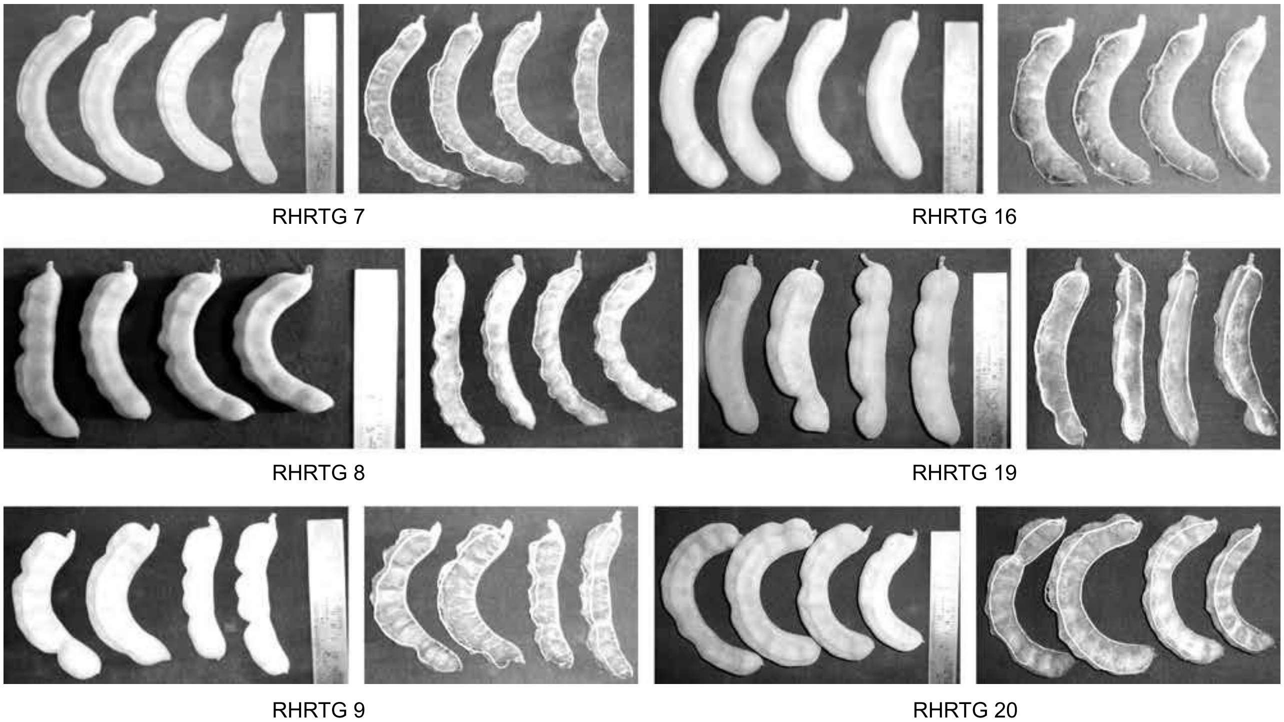


Plate 1. Variability for pod characteristics among different tamarind genotypes

it was lowest in RHRTG 9 (3.65 g). Of the various genotypes studied, RHRTG 14 tended to show the highest pulp content (17.45 g/ pod and 62.16%), while it was lowest in RHRTG 16 (7.29g/fruit). The pulp percentage was registered to be the lowest in RHRTG 4 (37.12%). Th lowest seed weight (2.37g/seed), seed percentage (12.32%) and vein percentage (6.65%) were recorded in RHRTG 10 with good pulp recovery (60.58%) too. RHRTG 6 proved most seedy (10 seeds/ pod), while the lowest number of seeds was noticed in RHRTG 11 (4.33 seeds/pod). RHRTG 13 was found to have the boldest seeds (98.60g/100 seeds), while it was lowest in RHRTG 7 (46.40g/100seeds).

RHRTG 4 proved to be the most productive (85.00 kg/tree) genotype with highest yield efficiency (5.81 kg/cm^3 CV). RHRTG 7 proved worse (9.0 kg/ tree and 0.53 kg/cm^3 CV) in respect of yield and yield efficiency. Various studies have reported more or less comparable results in terms of shell, pulp, seed and vein weight (Bilcke *et al*., 5; Okello *et al*., 12; Prabhushankar *et al*., 16). Yield, which is a principal objective for breeding, but at the same time very complex phenomenon influenced by various biotic and abiotic factors. A wide variation in yield pattern was also reported by Mayavel *et al*., (10).

In the case of sweet tamarind, primarily the TSS, acidity, and pulp percent are the major attributes that decide the palatability of this dryland crop as table fruit. From the data (Table 3) it is clear that TSS content varied from 28.68°B (RHRTG 15) to 34.80°B (RHRTG 6). The genotypes RHRTG 14 (33°B) and RHRTG 10 (32.76°B) were also found better to have the higher content of TSS than rest of the genotypes. There may be differences in the genetic constitutions of different genotypes, which could explain the variability in TSS. Fruit grown in arid regions with insufficient water tended to accumulate more dry matter, and decreased moisture could lead to greater accumulation of TSS in fruits (Meghwal and Azam, 11). Titratable acidity is also the governing factor, which determines the quality of tamarind pods for their table fruit consumption. The content of acid ranged between 8.08 to 11.18% (Table 3). The lowest content of titratable acids was recorded in RHRTG 2 (8.08 %), while it was highest in RHRTG 16 (11.18 %).

The genetic composition of each genotype may have played a role in the acidity differences observed between different genotypes. The ascorbic acid content of genotypes ranged from 1.35 to 3.54 mg per 100g (Table 3). Maximum ascorbic acid content was recorded in the genotype RHRTG 4 (3.54 mg/100g), while it was lowest in RHRTG 16 (2.70 mg/100g). Such variations have also been confirmed in the earlier studies of Osorio *et al*., (13).

Table 2. Quantitative physical characters of tamarind genotypes

Sr. No.	Genotype	Pod weight (g)	Pod length (cm)	Pod breadth (cm)	Shell weight (g)	Pulp weight (g)	Seed weight (g)	Vein weight (g)	No. of seeds/ pod	Weight of 100 seeds (g)	Shell content (%)	Pulp recover (%)	Seed (%)	Vein (%)	Yield per tree (kg)	Yield efficiency (kg/m^3 CV)
1.	RHRTG 1	22.53	15.12	2.38	5.62	10.29	5.85	0.58	7.33	81.80	24.94	45.67	25.96	2.57	51	1.86
2.	RHRTG 2	20.31	12.60	2.47	4.85	9.56	5.15	0.77	7.33	70.50	23.88	47.07	24.86	3.79	37	1.75
3.	RHRTG 3	18.44	12.58	2.30	4.19	9.24	4.15	0.80	5.00	68.50	22.72	50.10	22.50	4.33	42	2.54
4.	RHRTG 4	22.14	13.31	2.62	5.87	8.28	6.43	1.30	7.67	90.60	25.07	37.12	29.04	5.01	85	5.81
5.	RHRTG 5	18.82	15.12	2.44	4.62	9.73	3.74	0.61	6.00	96.00	24.54	51.70	19.87	3.24	15	1.15
6.	RHRTG 6	27.38	17.27	2.52	6.80	12.54	6.67	1.18	10.00	62.80	24.83	45.80	24.36	4.31	32	4.21
7.	RHRTG 7	16.85	12.61	2.33	4.53	8.18	3.09	0.90	5.33	46.40	26.88	48.54	18.33	5.34	09	0.53
8.	RHRTG 8	18.12	11.60	2.52	4.41	9.46	3.43	0.68	5.33	82.80	24.33	52.20	18.92	3.75	11	0.84
9.	RHRTG 9	16.96	10.52	2.09	3.65	8.02	4.12	0.90	6.33	50.20	21.52	47.29	24.29	5.31	10	1.96
10.	RHRTG 10	19.23	9.81	2.63	4.09	11.65	2.37	1.28	4.67	65.40	21.27	60.58	12.32	6.65	30	2.03
11.	RHRTG 11	22.83	11.75	2.73	4.60	13.60	3.16	1.22	4.33	90.80	20.15	59.57	13.84	5.34	70	2.93
12.	RHRTG 12	24.58	12.14	2.56	4.23	14.17	4.49	1.58	5.33	94.70	17.20	57.64	18.27	6.43	75	2.81
13.	RHRTG 13	26.80	17.11	2.57	5.36	14.12	5.73	1.19	8.33	98.60	20.00	52.68	21.38	4.51	25	1.36
14.	RHRTG 14	28.07	13.37	2.95	4.53	17.45	4.29	1.26	6.33	96.40	16.13	62.16	15.28	4.34	72	2.16
15.	RHRTG 15	22.30	10.72	2.34	4.89	12.51	3.67	1.20	5.33	84.70	21.92	56.10	16.45	5.38	68	5.09
16.	RHRTG 16	17.90	11.15	2.05	4.40	7.29	5.61	0.57	7.67	77.30	24.58	40.72	31.34	3.18	66	4.75
17.	RHRTG 17	23.86	12.85	2.52	4.76	12.56	5.19	1.00	6.33	82.80	19.95	52.64	21.75	4.36	60	2.23
18.	RHRTG 18	25.89	11.14	2.75	5.72	15.09	3.77	1.21	5.33	76.50	22.09	58.28	14.56	4.67	53	2.91
19.	RHRTG 19	20.10	11.16	2.27	3.73	11.53	3.60	1.18	4.67	75.50	18.55	57.36	17.91	5.87	40	1.92
20.	RHRTG 20	17.87	11.84	2.48	4.20	8.20	4.24	0.86	7.00	64.60	23.50	45.21	23.72	4.81	30	0.82
21.	Max.	28.07	17.27	2.95	6.80	17.45	6.67	1.58	10.00	98.60	26.88	62.16	31.34	6.65	85	5.81
22.	Min.	16.85	9.81	2.05	3.65	7.29	2.37	0.57	4.33	46.40	16.13	37.12	12.32	2.57	09	0.53
23.	GM	21.55	12.69	2.48	4.75	11.17	4.44	1.01	6.28	77.85	22.20	51.42	20.75	4.66	44.05	2.48
24.	SD	3.62	2.06	0.22	0.78	2.79	1.18	0.29	1.45	15.03	2.86	6.81	5.10	1.06	23.87	1.46
25.	CV (%)	16.79	16.20	8.71	16.37	24.94	26.50	28.19	23.05	19.30	12.89	13.24	24.56	22.66	54.19	58.93

Table 3. Bio-chemical characters of tamarind genotypes

Sr. No.	Genotype	TSS (°Brix)	Acidity (%)	Ascorbic acid (mg/100g)
1.	RHRTG 1	32	9.70	2.10
2.	RHRTG 2	31.73	8.08	1.98
3.	RHRTG 3	32.10	8.38	1.50
4.	RHRTG 4	30.03	9.75	3.54
5.	RHRTG 5	31.17	9.30	1.88
6.	RHRTG 6	34.80	8.68	2.14
7.	RHRTG 7	32.27	8.35	2.40
8.	RHRTG 8	30.30	8.33	1.95
9.	RHRTG 9	30.50	8.16	2.13
10.	RHRTG 10	32.76	8.10	1.80
11.	RHRTG 11	30.13	8.38	1.95
12.	RHRTG 12	30.60	8.95	1.58
13.	RHRTG 13	29.73	8.55	2.25
14.	RHRTG 14	33.00	8.49	1.35
15.	RHRTG 15	28.68	8.25	1.95
16.	RHRTG 16	30.48	11.18	2.70
17.	RHRTG 17	31.50	8.43	2.40
18.	RHRTG 18	29.37	8.13	1.80
19.	RHRTG 19	31.93	8.19	1.82
20.	RHRTG 20	30.84	9.85	1.95
21.	Max.	34.80	11.18	3.54
22.	Min.	28.68	8.08	1.35
23.	GM	31.20	8.76	2.06
24.	SD	1.43	0.81	0.47
25.	CV (%)	4.58	9.20	22.86

RHRTG 14 was reported superior for all prime characters like pulp weight, pulp percentage, yield, and TSS content. Some genotypes like RHRTG 10, RHRTG 11, and RHRTG 14 were reported suitable for table fruit purposes because of their lessor acidity percentage and more pulp percentage and TSS content. For culinary purposes genotypes like RHRTG 4, RHRHG 5 RHRTH 16, and RHRTG 20 were reported suitable because of their high titratable acidity percentage. Genotype RHRTG 16 having reddish-brown pulp can be utilized for storage purposes in confectionery. From the investigation, it is suggested that few genotypes which are showing superiority over others for some key attributes need to be exploited for their consumption as table fruit and also for a confectionary purpose.

AUTHORS' CONTRIBUTION

Conceptualization of research (VRJ), Designing of the experiments (VRJ, ALP, PDD); Execution of field/lab experiments and data collection (RK, PDD); Analysis of data and interpretation (RK, SSK, PDD); Preparation of the manuscript (RK, SMC).

DECLARATION

The authors are declaring no conflict of interest.

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