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Short communication

Standardization of recipes for tamarind paste and squash

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ABSTRACT

An attempt was made to use tamarind pulp for preparation of paste and squash. Changes in the chemical constituents during storage at ambient temperature were studied. Results showed that in the stored products, TSS, titratable acidity and sugar content increased, whereas, the amount of ascorbic acid decreased. Better quality of paste was prepared from 100g paste + 20g salt with 10ml oil + 20mg BHA, followed by 100g paste + 15g salt with 10ml oil + 20mg BHA. Squash with 30% juice, 50% TSS, 1% acidity and 0.5% salt was superior to the other recipes. Both tamarind paste and squash retained their characteristic colour, aroma, taste and were microbiologically safe up to 3 months of storage at room temperature.

Key words: Tamarind, pulp, paste, salt, spiced squash, storage, and nutritional quality

Tamarind (*Tamarindus indica* L.) is an arboreal fruit of the family Fabaceae. The name 'tamarind' is derived from the Arabic term 'tamar-ul-Hind' which means 'date of India'. The most outstanding characteristic of tamarind is its acidity, with total acidity ranging from 12.2% to 23.8% as tartaric acid. Tamarind is a good source of Vitamin B (Siddig *et al*, 2006). The fruit is used for making different products such as powder, juice, concentrate, paste, kernel powder, tartaric acid, pectin, tartarates and alcohol. Tamarind products have been extensively used in traditional Indian and African medicine. Although several medicinal values are claimed for various preparations from the fruit, leaf, flower, bark, etc. of the tamarind tree, only antiscorbutic properties of the pulp, laxative action of the juice and diuretic properties of the leaf sap are well-established (Siddig *et al*, 2006).

Looking into the fast increasing area under tamarind cultivation, methods of preservation of tamarind products need to be developed to regulate prices of the fresh tamarind fruit and to safeguard interest of the tamarind grower during a period of glut (Joshi *et al*, 2012). Nowadays, people prefer 'instant' preparations and, hence, tamarind could be more easily used in the form of paste. Value-added products such as tamarind paste, with proper packaging, can be easily transported to areas where it is difficult to transport the pulp. Tamarind products posses good export potential (Champakam and Peter, 2000). Due to the perishable nature of fruits, these require immediate processing, to avoid post-harvest losses (Ramakumar *et al*, 1997) and changes in colour from brown to black due to phenolics, and non-enzymatic browning during storage. Therefore, the present investigation was carried out to develop a technology for preparation of value-added products (paste and squash) in tamarind.

Fully ripe tamarind fruits of cv. DTS-1 were procured from Department of Plantation and Spices Crops, Kittur Rani Channamma College of Horticulture, Arabhavi. The pulp was manually separated from the shell and seed. Ginger *(Zingiber officinalis)* and mango ginger (*Curcuma amada*) were procured from the market.

The experiment, with seven treatments, was conducted using Completely Randomized Block design. Tamarind paste was prepared by adding different concentration of salt, and the squash was prepared by varying tamarind juice concentration and the TSS.

Treatment details

Recipe for tamarind paste

T_1- 100g paste + 5g salt
T_2- 100g paste + 10g salt
T_3-100g paste + 15g salt
T_4-100g paste + 20g salt
T_5- 100g paste + 25g salt
T_6- 100g paste + 30g salt
T_7- 100g paste (Control) without salt

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Sunflower oil (10ml) and BHA (Butylated hydroxy anisole) were added (20mg) in all the treatments

Recipe for tamarind squash blended with ginger: all the treatments had identical acidity (1%), salt (0.5%) and KMS (0.25g/l)

Treatment	Juice (%)	TSS (%)
T_1	25 (9:1) Tamarind: Ginger	40
T_2	30 (9:1) Tamarind: Ginger	40
T_3	25 (9:1) Tamarind: Ginger	45
T_4	30 (9:1) Tamarind: Ginger	45
T_5	25 (9:1) Tamarind: Ginger	50
T_6	30 (9:1) Tamarind: Ginger	50
T_7	30 (9:1) Tamarind : Mango ginger	40

Preparation of tamarind paste: One kg of de-seeded pods were taken and soaked in water in the ratio 1:2 for four hours. The juice was extracted by repeated squeezing of the soaked pulp and by passing it through one mm sieve. Juice so extracted was boiled until it attained the required consistency. The end-point was judged by recording the TSS (32-34º Brix). At the end of boiling, table salt, edible oil and BHA were added as per treatments shown above, and mixed thoroughly. Sunflower oil is a preservative and BHA is an antioxidant. Then, the product was filled while hot into a pre-sterilized PET jar to hold 200g, and sealed. The jars were stored at room temperature (28-38ºC) three months.

Preparation of tamarind squash: Tamarind juice was mixed with sugar and water as per recepies mentioned in treatment details. The squash was preserved by adding potassium metabisulphate @ 0.25 gram per litre and salt at 0.5%. Prepared squash was filled in clean, sterile bottles of 200ml capacity and sealed. This was stored at room temperature (28-38ºC) for three months.

Chemical analysis: TSS was measured using a digital refractometer (Make:Erma, Japan). pH meter was used to measure the pH (Model: Analog Research, USA). Titratable acidity was estimated as per the modified procedure of AOAC (Anon., 1984). Ascorbic acid content was determined titrimetrically using 2, 6-dichlorophenol indophenol dye as per the modified procedure of AOAC (Anon., 1984). Sugars were estimated by dinitro salicylic acid (DNSA) method (Miller, 1972).

Organoleptic evaluation of tamarind squash was done at 30 day intervals, i.e., 30, 60 and 90 days after storage (DAS). The squash was diluted with water in the ratio 1:3 before serving. Organoleptic characters like colour and appearance, aroma and flavour, taste and overall acceptability were evaluated by a panel of semi-trained judges, on a five-point Hedonic scale (Ranganna, 1997).

Microbial analysis: Microbial count of the tamarind beverages after storage was taken as per Harrigan and Mccance (1996).

Preparation of sample: Samples were prepared by taking 10ml of the representative sample from each treatment. Each sample was mixed with 90ml sterilized distilled water in a conical flask.

Dilution: Serial dilution technique was applied to estimate bacterial, fungal and yeast load in the tamarind products. Dilutions 10^{-5} and 10^{-6} were used for counting bacteria and 10^{-3} and 10^{-4} were used for counting fungi and yeast. Nutrient Agar media, Rose Bengal agar media and Wichraham media were used to enumerate bacterial, fungal and yeast colonies, respectively, in the processed products of tamarind.

Enumeration: The medium was sterilized in a pressure cooker at 121ºC for 20 minutes. Into each sterilized petri dish, 1ml of the respective aliquot was transferred; 10ml of the medium was poured into duplicate plates. After solidification, the plates were incubated upside down at 37ºC for six days.

Colony count: The colonies were counted and the total count was expressed by multiplying the number of colonies with the dilution factor, and expressed as CFU per gram or ml of the sample.

Changes in chemical composition of tamarind paste during storage: Significantly high TSS was found in T_6 consisting of 100g paste + 30g salt + 10ml oil + 20mg BHA at 30, 60 and 90 days after storage. These differences between treatments may be attributed to different levels of the salt used. Difference in the TSS has been seen to be mainly due to the addition of different concentration of salt by Kotecha and Kadam (2003). Highest pH was recorded in T_7 at 30, 60 and 90 days after storage. Corresponding decrease in acidity might be responsible for high pH. Similar observations for change in pH were made by Nath *et al* (2005) in kinnow mandarin-ginger squash (Table 1). Significantly high titrable acidity was recorded in the Control (Fig. 1). Decrease in acidity during storage could be attributed to chemical interaction induced by temperature between chemical constituents of the juice and the action of enzymes (Mapson, 1970).

With increase in storage period, ascorbic acid content decreased (Fig 2). Significantly high ascorbic acid content remained in T_6 consisting of 100g paste + 30g salt + 10ml oil + 20mg BHA Gradual decrease seen in ascorbic acid content may be due to oxidative destruction of this acid by ascorbic acid enzymes in the presence of molecular oxygen and, may also be due to the effect of storage temperature and catalytic activity of fructose during storage (Mapson, 1970). Higher amount of reducing and non-reducing sugars were recorded in T_6 and T_5 at 30, 60 and 90 DAS. At 30 days after storage significantly high total sugars were recorded in T_6 (29.55 %). However, total sugars at 60 or 90 days after storage were found non-significant. Increase seen in sugar content could be due to the slow hydrolysis of polysaccharides, acids and pectic substances into simpler substances like sugars (Table 2). These findings are in accordance with Sarita *et al* (2006) in Rangpur lime RTS and squash, and Kichu (2008) in sapota beverages.

Table 1. Changes in TSS and pH of tamarind paste during storage

Treatment	TSS (%)*			pH**		
	30 DAS	60 DAS	90 DAS	30 DAS	60 DAS	90 DAS
T_1- 100g paste + 5g salt	34.10	29.56	30.40	2.87	2.96	3.12
T_2- 100g paste + 10g salt	32.83	33.60	35.23	2.85	2.94	3.01
T_3- 100g paste + 15g salt	33.60	35.82	37.16	2.74	2.83	2.97
T_4- 100g paste + 20g salt	35.10	39.82	40.23	2.48	2.57	2.73
T_5- 100g paste + 25g salt	34.80	35.71	37.86	2.71	2.80	2.95
T_6- 100g paste + 30g salt	38.50	41.85	42.60	2.51	2.60	2.77
T_7- 100g paste (control)	32.10	25.08	23.03	3.10	3.19	3.35
CD *(P=0.01)*	0.553	4.433	1.917	0.041	0.024	0.041

*Initial TSS content was 34% DAS - Days after storage
** Initial pH was 3.0

Changes in chemical composition of tamarind squash during storage: An increasing trend was observed in the content of total soluble solids in tamarind-ginger blended squash during storage period (Table 3). Treatment T_6 recorded highest TSS compared to other treatments during storage which could be due to hydrolysis of polysaccharides

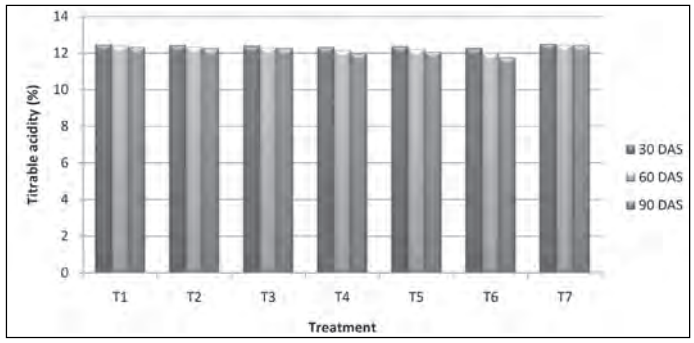

Fig 1. Changes in titratable acidity (%) of tamarind paste during storage.

T_1- 100g paste + 5g salt T_5- 100g paste + 25g salt
T_2- 100g paste + 10g salt T_6- 100g paste + 30g salt
T_3-100g paste + 15g salt T_7- 100g paste (Control)
T_4-100g paste + 20g salt
*Initial titratable acidity was 12.5%

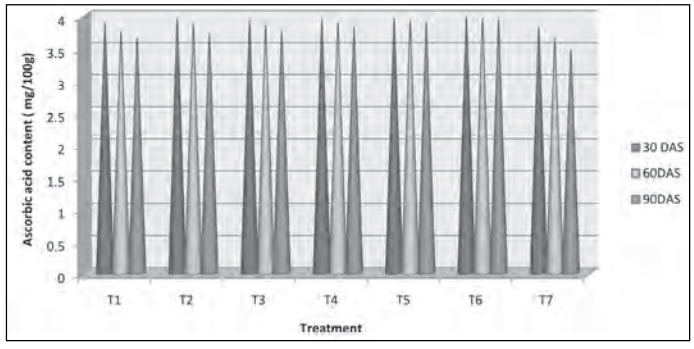

Fig 2. Changes in ascorbic acid content (mg/100g) of tamarind paste during storage.

T_1- 100g paste + 5g salt T_5- 100g paste + 25g salt
T_2- 100g paste + 10g salt T_6- 100g paste + 30g salt
T_3-100g paste + 15g salt T_7- 100g paste *(Control)
T_4-100g paste + 20g salt
*Initial ascorbic acid content was 4.00mg/100g

Table 2. Changes in various sugars in tamarind paste during storage

Treatment	Reducing sugars (%)*			Non-reducing sugars (%)**			Total sugars (%)***		
	30 DAS	60 DAS	90 DAS	30 DAS	60 DAS	90 DAS	30 DAS	60 DAS	90 DAS
T_1- 100g paste + 5g salt	22.46	22.77	23.09	2.88	3.07	3.25	25.34	25.84	26.34
T_2- 100g paste + 10g salt	23.63	23.94	24.24	2.10	2.29	2.49	25.73	26.23	26.73
T_3- 100g paste +15g salt	24.23	24.54	24.84	2.47	2.66	2.86	26.70	27.20	27.70
T_4- 100g paste +20g salt	25.03	25.35	25.65	3.07	3.25	3.45	28.10	28.60	29.10
T_5- 100g paste +25g salt	22.63	22.95	23.25	3.77	3.95	4.15	26.40	26.90	27.40
T_6- 100g paste +30g salt	26.93	27.25	27.55	2.62	2.80	3.00	29.55	30.05	30.55
T_7- 100g paste (Control)	21.05	21.36	21.67	3.18	3.47	3.66	24.23	24.83	25.33
CD *(P=0.01)*	0.037	0.048	0.024	1.027	0.240	0.249	1.057	NS	NS

*Initial reducing sugars 20.02% DAS - Days after storage
**Initial non-reducing sugars 2.20% NS- Non Significant
***Initial total sugars 22.22%

like starch and pectic substances into simpler substances. Similar observations were recorded by Kotecha and Kadam (2003) in tamarind syrup and Nath *et al* (2005) in ginger-blended kinnow mandarin squash. Among the treatments, T_1 recorded the highest pH, which was on par with T_2 (2.70) and T_7 (2.62, 2.64 and 2.75 corresponding to 30, 60 and 90 days, respectively). This was mainly due to a corresponding decrease in acidity. Similar observation for change in pH was reported by Nath *et al* (2005) in kinnow mandarin-ginger squash (Table 3).

Table 3. Changes during storage in TSS and pH of tamarind squash blended with ginger

#Treatment	TSS (%)*			pH **		
	30 DAS	60 DAS	90 DAS	30 DAS	60 DAS	90 DAS
T_1- 25% juice + 40% TSS	40.16	40.33	40.96	2.74	2.75	2.79
T_2- 30% juice + 40% TSS	40.33	40.70	41.70	2.70	2.70	2.76
T_3- 25% juice + 45% TSS	45.16	45.76	46.40	2.32	2.45	2.47
T_4- 30% juice + 45% TSS	47.10	47.53	48.20	2.24	2.26	2.32
T_5- 25% juice + 50% TSS	53.23	53.40	54.40	2.16	2.21	2.41
T_6- 30% juice + 50% TSS	53.70	54.03	54.66	2.13	2.16	2.16
T_7- 30% juice + 40% TSS	41.20	41.33	41.70	2.62	2.64	2.75
CD *(P=0.01)*	0.265	0.175	1.178	0.263	0.280	0.360

Acidity (1%) and salt (0.5%)
DAS - Days after storage
* Initial TSS in T_1 T_2 and T_7 = 40%, in T_3 and T_4 = 45%, in T_5 and T_6 = 50%
** Initial pH = 2.0

Acidity of the products prepared gradually declined during storage (Table 4). Among the various treatments, maximum acidity was noticed in T_1 which was on par with T_2. This decrease in acidity may have been due to acid hydrolysis of polysaccharides and non-reducing sugars into their simpler components, where, the acid is utilized for converting the former into hexose sugars or complexes in the presence of metal ions. Analogous result was reported by Gajanana (2002) in amla juice. Reduction in acidity during storage period in beverages was observed by Lakshmi *et al* (2005) in flavoured tamarind RTS beverages and Nidhi *et al* (2008) in RTS bael-guava beverage. Gradual decrease during storage in ascorbic acid content in tamarind squash blended with ginger was observed (Table 4). Among the treatments, T_2 (3.68mg/100g), which was on par with T_1 (3.64mg/100g) and T_6 (3.60mg/100g), recorded maximum ascorbic acid retention during storage compared to other treatments. Decrease in ascorbic acid content could be due to the effect of storage temperature (Mapson, 1970). As ascorbic acid content of a squash is directly dependent on blended-juice used for its preparation, comparatively higher ascorbic acid content was observed at the end of storage period in the case of samples with higher percentage of juice, in all the treatments. Analogous observations for decline in ascorbic acid content were reported in aonla juice by Gajanana (2002), in rose apple-aonla squash by Basavaraja (2005), and in bael-guava RTS by Nidhi *et al* (2008).

Table 4. Changes during storage in titratable acidity and ascorbic acid content of tamarind squash blended with ginger

#Treatment	Titratable acidity (%)*			Ascorbic acid (mg/100 g)**		
	30 DAS	60 DAS	90 DAS	30 DAS	60 DAS	90 DAS
T_1- 25% juice + 40% TSS	0.97	0.95	0.93	3.73	3.64	3.60
T_2- 30% juice + 40% TSS	0.96	0.94	0.92	3.75	3.70	3.62
T_3- 25% juice + 45% TSS	0.93	0.92	0.89	3.71	3.61	3.56
T_4- 30% juice + 45% TSS	0.92	0.91	0.88	3.58	3.56	3.54
T_5- 25% juice + 50% TSS	0.91	0.89	0.86	3.40	3.28	3.20
T_6- 30% juice + 50% TSS	0.90	0.87	0.84	3.67	3.64	3.51
T_7- 30% juice + 40% TSS	0.95	0.94	0.91	3.71	3.62	3.58
CD *(P=0.01)*	0.024	0.022	0.028	0.102	0.067	0.264

Acidity (1%) and salt (0.5%)
DAS - Days after storage
**Initial ascorbic acid content = 3.75mg/100
*Initial titrable acidity = 1.0%

Among the treatments, the maximum amount of reducing sugars, non-reducing sugars and total sugars were noticed in T_6 consisting of 30% juice + 50% TSS (Table 5). Total sugar content of tamarind-blended ginger squash increased only slightly during storage. This could be attributed to acid hydrolysis of polysaccharides that result in an increase in soluble sugars. Increase in reducing and total sugars, and decrease in non-reducing sugars, is a general phenomenon as has been noticed by several workers. Kotecha and Kadam (2003) in tamarind syrup and Sahu *et al* (2006) in mango-lemongrass beverage observed an increase in total and a reducing sugars and decrease in non-reducing sugars during storage.

Organoleptic evaluation of tamarind squash (scores out of 5.00): For 30, 60 and 90 days after storage of

Table 5. Changes during storage in sugars in tamarind squash blended with ginger

Treatment#	Reducing sugars (%)			Non-reducing sugars (%)			Total sugars (%)		
	30 DAS	60 DAS	90 DAS	30 DAS	60 DAS	90 DAS	30 DAS	60 DAS	90 DAS
T_1- 25% juice + 40% TSS	8.53	8.82	9.12	13.74	13.95	14.15	22.27	22.77	23.27
T_2- 30% juice + 40% TSS	8.63	8.96	9.25	17.67	17.84	18.05	26.30	26.80	27.30
T_3- 25% juice + 45% TSS	8.80	9.10	9.40	19.50	19.70	19.97	28.30	28.80	29.30
T_4- 30% juice + 45% TSS	8.94	9.23	9.53	18.39	18.60	18.80	27.33	27.83	28.33
T_5- 25% juice + 50% TSS	9.08	9.37	9.67	14.32	14.53	14.73	23.40	23.90	24.40
T_6- 30% juice + 50% TSS	9.22	9.51	9.81	20.53	20.74	20.94	29.75	30.25	30.75
T_7- 30% juice + 40% TSS	8.62	8.93	9.22	16.61	16.80	17.01	25.23	25.73	26.23
CD *(P=0.01)*	0.037	0.024	0.312	0.191	NS	NS	NS	NS	NS

#Acidity (1%) and salt (0.5%)
DAS - Days after storage
NS- Non significant

*Initial reducing sugars = 8.25%
**Initial non-reducing sugars = 13.40%
***Initial total sugars = 21.65%

Table 6. Organoleptic scores (out of 5.00) for colour, aroma and taste of tamarind squash as influenced by various treatments

Treatment	Colour score (out of 5.00)			Aroma score (out of 5.00)			Taste score (out of 5.00)		
	30 DAS	60 DAS	90 DAS	30DAS	60 DAS	90 DAS	30DAS	60 DAS	90 DAS
T_1- 25 % juice + 40% TSS	3.30	3.20	3.18	3.00	2.41	2.21	3.25	3.35	3.46
T_2- 30 % juice + 40% TSS	3.50	3.40	3.38	3.51	2.83	2.68	3.54	3.61	3.75
T_3- 25 % juice + 45% TSS	3.40	3.30	3.28	3.16	3.08	2.86	3.38	3.41	3.55
T_4- 30 % juice + 45% TSS	3.80	3.78	3.76	3.78	3.58	3.25	3.85	3.91	4.05
T_5- 25 % juice + 50% TSS	3.70	3.68	3.66	3.68	2.98	2.51	3.93	4.18	4.48
T_6- 30 % juice + 50% TSS	3.90	3.80	3.78	3.83	3.75	3.48	3.90	4.13	4.26
T_7- 30 % juice + 40% TSS	3.60	3.50	3.45	3.26	3.08	2.66	3.18	3.21	3.35
CD *(P=0.01)*	0.24	0.184	0.210	0.551	0.879	0.644	0.426	0.487	0.483

DAS - Days after storage

tamarind squash significantly maximum score for colour, aroma & overall acceptability was observed in treatment $T_{6,}$ whereas for taste maximum score was found in treatment T_5 (Table T_6 & Fig 3). This might be due to better consistency, acceptable color and sugar acid blend. Similar result has been reported (Kotecha and Kadam, 2003) in tamarind RTS.

Microbial load: Safety of a product with respect to its microbial load is as important as its chemical composition. In tamarind paste, bacterial, fungal and yeast populations were fewer in treatment T_4 (2.60×10^5, 0.90×10^3 and 2.4×10^3 CFU/ml, respectively). Reasons for the low microbial load could be on inhibitory effect of salt and acid on these microorganisms; whereas, in squash, bacterial, fungal and yeast populations were found to be the minimum in treatment T_3 (4.3×10^5, 2.41×10^3 and 1.61×10^3 CFU/ml, respectively), followed by treatment T_6 (4.41×10^5, 2.52×10^3 and 1.72×10^3 CFU/ml, respectively) (Tables 7 and 8). A low microbial load could be due to an inhibitory effect of high sugar concentration (55-70°Brix) and inhibitory effect of acid and KMS on microorganisms. Similar results were also reported by Li *et al* (1989) in orange juice, Shobana (2003) in guava beverages and Kotecha and Kadam (2003) in tamarind concentrate.

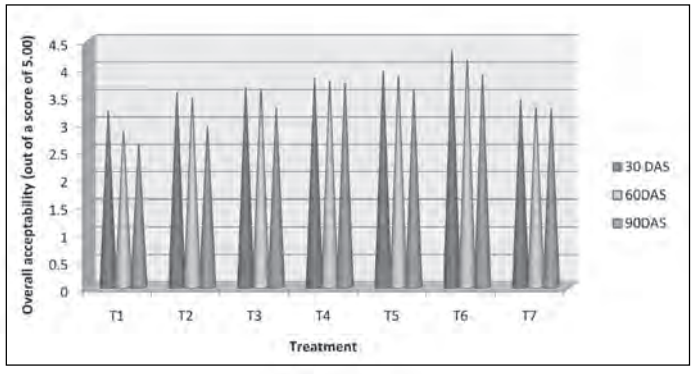

Fig 4. Changes in overall acceptability of stored tamarind squash blended with ginger.

T_1- 25% juice + 40% TSS
T_2- 30% juice + 40% TSS
T_3- 25% juice + 45% TSS
T_4- 30% juice + 45% TSS
T_5- 25% juice + 50% TSS
T_6- 30% juice + 50% TSS
T_7- 30% juice + 40% TSS

Table 7. Effect of various treatments on microbial load in tamarind squash

Treatment	Microbial load (No. x 10^3 CFU/ml) three months after storage		
	Bacteria	Fungi	Yeast
T_1- 25% juice + 40% TSS	5.06	3.2	2.4
T_2- 30% juice + 40% TSS	5.22	3.3	2.5
T_3- 25% juice + 45% TSS	4.64	2.78	1.98
T_4- 30% juice + 45% TSS	4.88	2.99	2.19
T_5- 25% juice + 50% TSS	4.3	2.41	1.61
T_6- 30% juice + 50% TSS	4.41	2.52	1.72
T_7- 30% juice + 40% TSS	5.08	3.19	2.39

Table 8. Effect of various treatments on microbial load in tamarind paste

Treatment	Microbial load (No. x 10^3 CFU/ml) three months after storage		
	Bacteria	Fungi	Yeast
T_1- 100g paste + 5g salt	20.75	1.6	67.55
T_2-100g paste + 10g salt	10.25	2.20	3.05
T_3-100g paste + 15g salt	3.25	1.35	2.90
T_4-100g paste + 20g salt	2.60	0.90	2.4
T_5-100g paste + 25g salt	4.35	1.0	18.7
T_6- 100g paste + 30g salt	3.05	1.70	4.2
T_7- 100g paste (control)	37.15	2.40	115.5

CFU- Colony forming unit

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