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Original Research Article

Changes in Chemical Composition of Cashew Apple Juice during Storage

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A B S T R A C T

An experiment entitled "Changes in chemical composition of cashew apple juice during storage" was conducted in the Fruit and Vegetable Processing Unit Laboratory, Department of Horticulture, College of Agriculture, Dapoli, Dist-Ratnagiri (M.S.) during the year 2015-2016. The experiment was carried out in Factorial Completely Randomized Design (FCRD) with five treatments of different varieties of cashew apple juice i.e. T_1 –Vengurla-1, T_2 –Vengurla-4, T_3 –Vengurla-6, T_4 –Vengurla-7 and T_5 –Vengurla-8 and two storage conditions i.e. S_1 - Ambient storage (27-29°C) and S_2 - Cold storage (12 ± 1ºC). From the study, it was observed that, T.S.S., reducing sugars, total sugars, ascorbic acid, pH and tannins were found to be decreased during storage whereas, titratable acidity and alcohol were found to be increase throughout the storage period. In case of treatments and storage conditions, interaction T_3S_2 showed best results with respect to T.S.S., reducing sugars, total sugars, pH and alcohol and it was at par with T_2S_2 and T_4S_2 who have best result with respect to ascorbic acid and titratable acidity. Interaction T_2S_2 showed best result with ascorbic acid and it was at par with five parameters (T.S.S., reducing sugars, titratable acidity, pH and alcohol). Even interaction T_4S_2 showed best result with titratable acidity and it was at par with three parameters (T.S.S., reducing sugars and pH). Hence, looking to the above findings interaction T_3S_2 showed best results with respect to changes in chemical composition of cashew apple juice during storage, followed by T_2S_2 and T_4S_2.

Keywords

Cashew apple juice, Chemical parameters and storage

Introduction

Botanically, cashew apple is the peduncle of the fruit. The juice is astringent due to presence of tannins which has got innumerable medicinal properties as an anti-dote for cholera. The high tannin content in juice makes it suitable remedy for sore throat and chronic dysentery in Cuba and Brazil (Morton, 1987). Cashew apple is a valuable source of minerals and vitamins and more fructose, the honey sugar. Indeed, cashew apple juice is reported to contain 5 times as much vitamin C as in citrus juice (Akinwale,

2000). Also it has anti-mutagenic (Cavalcante *et al.,* 2005), anti-bacterial and anti-oxidant properties (Melo-Cavalcante *et al.,* 2003). Cashew apple contains 0.2 per cent protein, 0.2 per cent mineral matter, 0.1 per cent fats, 11.6 per cent carbohydrates, 0.01 per cent phosphorus and 0.2 mg/100 g iron. It also contains 261.5 mg/100 g ascorbic acid (Chempakam, 1983). Cashew apple juice is a good source of water soluble vitamins viz., ascorbic acid, riboflavin and thiamine.

The processors generally use fallen cashew apples under the tree for preparation of processed products. Some processors take freshly harvested cashew apples. However, as the cashew apples are highly perishable in nature, it is necessary to find out the shelf life of cashew apples, so that processors can use harvested cashew apples within that period to prepare quality products. Unlike other fruit juices, the juice extracted from cashew apple cannot be consumed due to its characteristic astringent taste due to tannins, which causes biting sensation of the tongue and throat. Hence in order to prepare quality products with less astringency it is necessary to find out varieties suitable for preparing value added products. However, very scanty research work has been done on these aspects. Dr. B.S.K.K.V., Dapoli has released nine varieties of cashew. However, till research is not done on shelf life of cashew apple juice and screening of these varieties for preparation of processed product. Keeping this in to view, five released varieties viz. Vengurla-1, Vengurla-4, Vengurla-6, Vengurla-7 and Vengurla-8 were selected and investigation entitled "Changes in chemical composition of Cashew apple juice during storage".

Materials and Methods

The experiment entitled "Changes in chemical composition of Cashew apple juice during storage" was conducted in the Fruit and Vegetable Processing Unit Laboratory, Department of Horticulture, College of Agriculture, Dapoli, Dist-Ratnagiri (M.S.) during 2015-2016. In this experiment, the cashew apple juice of five different varieties was stored at ambient storage (27-29°C) and cold storage (12±1ºC) condition for 6 months. Treatment are T_1Vengurla-1, T_2-Vengurla-4, T_3- Vengurla-6, T_4- Vengurla-7, T_5- Vengurla-8 and two storage conditions viz., S_1-ambient temperature (24-30°C) and S_2- cold storage (12 ± 2°C) replicated four in factorial completely randomized design (FCRD). The ripe cashew apples of different varieties selected for study were washed with chlorinated water (100 ppm) and squeezed in basket press for extraction of juice. The extracted juice was further strained through four fold muslin cloth to obtain clear cashew apple juice and it was then pasteurized at 85ºC for 10 minutes. Then preservative potassium metabisulphite was added @ 1000 ppm. Before filling juice in bottle, glass bottles were washed with hot plain water, after that they were sterilized by keeping in boiling water for 30 minutes**.** Then they were dried in air and used for filling hot juice (82°C temperature). For each treatment combination 48 bottles were filled. Juice was filled in 200 ml glass bottle after leaving head space. After filling and sealing, bottles were pasteurized at 85°C and stored at ambient (27-29°C) temperature and cold storage (12±1ºC) and observations were recorded at every 2 months interval to study the quality of stored cashew apple juice.

The chemical parameters like T.S.S., titratable acidity (%), pH, reducing sugars (%), total sugars (%), ascorbic acid (mg/100gm), Tannin (%) and alcohol (%) were analyzed at 0, 2, 4 and 6 months of storage. The results were analyzed statistically as per the methods suggested by Panse and Sukhatme (1995).

Results and Discussion

The data presented in Table 1 indicated that T.S.S content of cashew apple juice was decreased from 0 month to 6 months of storage, irrespective of treatments and storage conditions. The T.S.S of cashew apple juice differs significantly with respect to different treatments during entire storage period and non-significant data was registered at initial day of storage (0 month) while significant results were observed at 2, 4 and 6 months of storage period. At 6 months storage, interaction T_3S_2 (6.31 %) recorded minimum decrease in T.S.S. which was at par with T_3S_1 (7.04 %), T_1S_2 (6.82 %), T_2S_2 (8.31 %) and T_4S_2 (6.69 %), whereas T_1S_1 (14.12 %) showed maximum decrease in T.S.S., irrespective of storage conditions and treatments. From the study it was observed that juice stored in cold storage showed minimum decrease as compared to ambient temperature. The low temperature and high humidity prevalent in cold storage might have restricted the growth and activity of microbes and hence less fermentation and slow reduction in sugar. Similar findings were also reported by Patil (2001) in jamun juice at ambient storage and cold storage conditions.

The reducing sugar content of cashew apple juice was found decreased from 0 month to 6 months of storage, irrespective of treatments and storage conditions. The reducing sugars of cashew apple juice differ significantly with respect to different treatments during entire storage period (Table 2).

At storage conditions it was non-significant at initial day of storage (0 month) while significant results were observed at 2, 4 and 6 months of storage period. At 6 month storage, interaction T_3S_2 (5.24 %) recorded minimum decrease in reducing sugars and it was at par with T_2S_1 (9.98 %), T_5S_1 (12.78%),T_2S_2 (6.68%), T_4S_2 (11.36%) and T_5S_2 (7.63%), whereas T_1S_1 (30.01%) showed maximum decrease in reducing sugars, irrespective of storage conditions and treatments.

Juice stored in cold storage showed minimum decrease in reducing sugars as compared to ambient temperature. Reducing sugars in ambient storage showed maximum decrease and it may be due to higher rate of microbial fermentation as high temperature favourable for microbial growth was available at ambient temperature. This might have converted sugars into alcohol. Similar findings were also reported by Prabhu Desai (1991) in ber juice at ambient temperature.

The total sugars of cashew apple juice differs significantly with respect to different treatments during entire storage period. At 6 month storage, interactions T_3S_2 (14.45 %) recorded minimum decrease in total sugars and it was significantly superior over all the interactions, whereas T_5S_1 (31.36%) showed maximum decrease in total sugars, irrespective of storage conditions and treatments. From table 3 it was observed that, in case of treatments, treatment T_1 recorded minimum decrease in total sugars may be due to slow fermentation. Among interactions, interaction T_3S_2 recorded minimum decrease in reducing sugars followed by T_4S_2.

The data presented in Table 4 showed that titratable acidity content of cashew apple juice was increased from 0 month to 6 months of storage, irrespective of treatments and storage conditions. The titratable acidity of cashew apple juice differs significantly with respect to different treatments during entire storage period. During storage conditions titratable acidity content of cashew apple juice was non-significant at initial day of storage (0 month) while significant results were observed at 2, 4 and 6 months of storage period.

Table.1 Changes in T.S.S. (°Brix) of cashew apple juice during storage at ambient temperature (27-29°C) and cold storage (12 ± 1°C)

Treatments	0 month			2 months			4 months			6 months		
	S_1	S_2	**Mean**	S_1	S_2	**Mean**	S_1	S_2	**Mean**	S_1	S_2	**Mean**
T_1	13.10	13.04	**13.07**	12.60 (3.82)	12.81 (1.74)	12.71 **(2.78)**	12.10 (7.63)	12.33 (5.48)	12.21 **(6.56)**	11.25 (14.12)	12.15 (6.82)	11.70 **(10.47)**
T_2	13.48	13.42	**13.45**	12.85 (4.64)	13.29 (0.95)	13.07 **(2.79)**	12.23 (9.28)	13.15 (1.98)	12.69 **(5.63)**	11.70 (13.17)	12.30 (8.31)	12.00 **(10.74)**
T_3	12.08	12.34	**12.21**	11.94 (1.14)	12.23 (0.91)	12.08 **(1.02)**	11.80 (2.28)	12.08 (2.13)	11.94 **(2.20)**	11.23 (7.04)	11.55 (6.31)	11.39 **(6.68)**
T_4	13.08	13.00	**13.04**	12.73 (2.67)	12.90 (0.73)	12.81 **(1.70)**	12.38 (5.35)	12.75 (1.88)	12.56 **(3.62)**	11.58 (11.48)	12.13 (6.69)	11.85 **(9.09)**
T_5	13.33	13.27	**13.30**	12.83 (3.75)	13.10 (1.24)	12.96 **(2.49)**	12.48 (6.38)	12.80 (3.51)	12.64 **(4.95)**	11.50 (13.69)	11.78 (11.23)	11.64 **(12.46)**
Mean	**13.01**	**13.01**	**13.01**	**12.59 (3.20)**	**12.87 (1.11)**	**12.73 (2.16)**	**12.20 (6.18)**	**12.62 (3.00)**	**12.41 (4.59)**	**11.45 (11.90)**	**11.98 (7.87)**	**11.72 (9.89)**
	S.Em.±	C.D. at 1%		S.Em.±	C.D. at 1%		S.Em.±	C.D. at 1%		S.Em.±	C.D. at 1%	
Treatment (T)	0.043	0.168		0.199	0.773		0.368	1.431		0.603	2.346	
Storage (S)	0.027	NS		0.126	0.489		0.233	0.905		0.381	1.484	
Interaction (TxS)	0.061	NS		0.281	1.093		0.520	2.024		0.853	3.318	

T_1 – Vengurla-1 T_2 – Vengurla-4 T_3 – Vengurla-6 T_4 – Vengurla-7 T_5 – Vengurla-8

S_1 – Ambient temperature S_2 – Cold storage NS – Non-significant

Figures in parenthesis indicates per cent decrease of T.S.S. to its original value

Table.2 Changes in reducing sugars (%) of cashew apple juice during storage at ambient temperature (27-29°C) and cold storage (12 ± 1°C)

Treatments	0 month			2 months			4 months			6 months		
	S_1	S_2	**Mean**	S_1	S_2	**Mean**	S_1	S_2	**Mean**	S_1	S_2	**Mean**
T_1	8.37	8.57	**8.47**	7.54 (9.97)	7.98 (6.91)	7.76 **(8.44)**	6.70 (19.97)	7.46 (12.98)	7.08 **(16.48)**	5.86 (30.01)	6.94 (19.01)	6.40 **(24.51)**
T_2	7.20	7.39	**7.29**	7.14 (3.43)	7.03 (2.26)	7.09 **(2.85)**	6.93 (6.31)	6.87 (4.50)	6.90 **(5.40)**	6.65 (9.98)	6.71 (6.68)	6.68 **(8.33)**
T_3	8.69	8.88	**8.78**	7.90 (9.10)	8.75 (1.47)	8.32 **(5.29)**	7.10 (18.22)	8.59 (3.36)	7.84 **(10.79)**	6.31 (27.29)	8.42 (5.24)	7.36 **(16.27)**
T_4	8.62	8.81	**8.71**	8.04 (6.63)	8.50 (3.55)	8.27 **(5.09)**	7.47 (13.29)	8.43 (4.34)	7.95 **(8.81)**	6.90 (19.85)	7.81 (11.36)	7.35 **(15.61)**
T_5	7.44	7.64	**7.54**	6.98 (6.12)	7.45 (2.43)	7.22 **(4.27)**	6.73 (9.50)	7.30 (4.38)	7.02 **(6.94)**	6.48 (12.78)	7.05 (7.63)	6.77 **(10.20)**
Mean	**8.06**	**8.26**	**8.16**	**7.52 (7.05)**	**7.94 (3.32)**	**7.73 (5.19)**	**6.99 (13.46)**	**7.73 (5.91)**	**7.36 (9.68)**	**6.44 (19.98)**	**7.39 (9.98)**	**6.91 (14.98)**
	S.Em.±	C.D. at 1%		S.Em.±	C.D. at 1%		S.Em.±	C.D. at 1%		S.Em.±	C.D. at 1%	
Treatment (T)	0.091	0.355		0.713	2.772		0.931	3.619		1.610	6.262	
Storage (S)	0.058	NS		0.451	1.753		0.589	2.289		1.018	3.961	
Interaction (TxS)	0.129	NS		1.008	3.921		1.316	5.118		2.277	8.856	

T_1 – Vengurla-1 T_2 – Vengurla-4 T_3 – Vengurla-6 T_4 – Vengurla-7 T_5 – Vengurla-8

S_1 – Ambient temperature S_2 – Cold storage NS – Non-significant

Figures in parenthesis indicates per cent decrease of reducing sugars to its original value

Table.3 Changes in total sugars (%) of cashew apple juice during storage at ambient temperature (27-29°C) and cold storage (12 ± 1°C)

Treatments	0 month			2 months			4 months			6 months		
	S_1	S_2	**Mean**	S_1	S_2	**Mean**	S_1	S_2	**Mean**	S_1	S_2	**Mean**
T_1	12.04	12.13	**12.08**	10.54 (12.42)	11.29 (6.87)	10.91 **(9.65)**	9.71 (19.29)	10.51 (13.24)	10.11 **(16.27)**	9.14 (24.03)	10.01 (17.45)	9.57 **(20.74)**
T_2	10.86	10.94	**10.90**	9.36 (13.82)	10.52 (3.82)	9.94 **(8.82)**	8.30 (23.52)	9.67 (11.61)	8.99 **(17.56)**	7.54 (30.55)	8.93 (18.44)	8.23 **(24.50)**
T_3	11.15	11.24	**11.19**	9.65 (13.41)	10.77 (4.22)	10.21 **(8.82)**	8.65 (22.44)	10.16 (9.66)	9.40 **(16.05)**	7.82 (29.85)	9.61 (14.45)	8.71 **(22.15)**
T_4	10.95	11.04	**10.99**	9.45 (13.70)	10.75 (2.61)	10.10 **(8.16)**	8.52 (22.17)	9.88 (10.51)	9.20 **(16.34)**	7.82 (28.57)	9.11 (17.46)	8.47 **(23.02)**
T_5	10.84	10.93	**10.89**	9.34 (13.84)	10.54 (3.59)	9.94 **(8.71)**	8.42 (22.37)	9.59 (12.31)	9.00 **(17.34)**	7.44 (31.36)	8.42 (22.99)	7.93 **(27.18)**
Mean	**11.17**	**11.26**	**11.21**	**9.67 (13.44)**	**10.77 (4.22)**	**10.22 (8.83)**	**8.72 (21.96)**	**9.96 (11.46)**	**9.34 (16.71)**	**7.95 (28.87)**	**9.21 (18.16)**	**8.58 (23.52)**

	S.Em.±	C.D. at 1%	S.Em.±	C.D. at 1%	S.Em.±	C.D. at 1%	S.Em.±	C.D. at 1%
Treatment (T)	0.069	0.268	0.263	1.021	0.326	1.267	0.544	2.115
Storage (S)	0.044	NS	0.166	0.646	0.206	0.801	0.344	1.338
Interaction (TxS)	0.097	NS	0.371	1.444	0.461	1.791	0.769	2.991

T_1 – Vengurla-1 T_2 – Vengurla-4 T_3 – Vengurla-6 T_4 – Vengurla-7 T_5 – Vengurla-8

S_1 – Ambient temperature S_2 – Cold storage NS – Non-significant

Figures in parenthesis indicates per cent decrease of total sugars to its original value

Table.4 Changes in titratable acidity (%) of cashew apple juice during storage at ambient temperature (27-29°C) and cold storage (12 ± 1°C)

Treatments	0 month			2 months			4 months			6 months		
	S_1	S_2	**Mean**	S_1	S_2	**Mean**	S_1	S_2	**Mean**	S_1	S_2	**Mean**
T_1	0.21	0.20	**0.20**	0.39 (9.15)	0.37 (7.22)	0.38 **(8.18)**	0.40 (10.53)	0.38 (9.40)	0.39 **(9.96)**	0.42 (16.39)	0.39 (13.64)	0.41 **(15.01)**
T_2	0.38	0.38	**0.38**	0.41 (5.82)	0.39 (2.75)	0.40 **(4.28)**	0.43 (11.64)	0.39 (3.02)	0.41 **(7.33)**	0.48 (24.14)	0.41 (8.91)	0.44 **(16.52)**
T_3	0.21	0.20	**0.21**	0.38 (2.76)	0.37 (2.84)	0.37 **(2.80)**	0.39 (5.50)	0.39 (10.60)	0.39 **(8.05)**	0.40 (9.35)	0.40 (13.43)	0.40 **(11.39)**
T_4	0.41	0.40	**0.40**	0.42 (3.99)	0.41 (1.89)	0.41 **(2.94)**	0.44 (7.98)	0.42 (4.63)	0.43 **(6.31)**	0.48 (17.35)	0.43 (7.38)	0.45 **(12.36)**
T_5	0.39	0.38	**0.38**	0.41 (4.88)	0.38 (0.91)	0.39 **(2.89)**	0.44 (12.49)	0.40 (5.97)	0.42 **(9.23)**	0.47 (22.30)	0.44 (15.48)	0.45 **(18.89)**
Mean	**0.32**	**0.31**	**0.32**	**0.40 (5.32)**	**0.38 (3.12)**	**0.39 (4.22)**	**0.42 (9.63)**	**0.40 (6.72)**	**0.41 (8.18)**	**0.45 (17.91)**	**0.41 (11.77)**	**0.43 (14.84)**

	S.Em.±	C.D. at 1%	S.Em.±	C.D. at 1%	S.Em.±	C.D. at 1%	S.Em.±	C.D. at 1%
Treatment (T)	0.004	0.014	0.354	1.377	0.628	2.442	1.502	5.841
Storage (S)	0.002	NS	0.224	0.871	0.397	1.544	0.950	3.694
Interaction (TxS)	0.005	NS	0.501	1.947	0.888	3.453	2.124	8.260

T_1 – Vengurla-1 T_2 – Vengurla-4 T_3 – Vengurla-6 T_4 – Vengurla-7 T_5 – Vengurla-8

S_1 – Ambient temperature S_2 – Cold storage NS – Non-significant

Figures in parenthesis indicates per cent increase of titratable acidity to its original value

Table.5 Changes in pH of cashew apple juice during storage at ambient temperature (27-29°C) and cold storage (12 ± 1°C)

Treatments	0 month			2 months			4 months			6 months		
	S_1	S_2	**Mean**	S_1	S_2	**Mean**	S_1	S_2	**Mean**	S_1	S_2	**Mean**
T_1	4.48	4.50	**4.49**	4.42 (1.39)	4.47 (0.55)	4.45 **(0.97)**	4.36 (2.79)	4.42 (1.78)	4.39 **(2.28)**	4.28 (4.57)	4.36 (3.17)	4.32 **(3.87)**
T_2	4.23	4.24	**4.24**	4.17 (1.42)	4.22 (0.47)	4.20 **(0.94)**	4.11 (2.84)	4.22 (0.61)	4.16 **(1.73)**	3.85 (8.93)	4.09 (3.59)	3.97 **(6.26)**
T_3	4.45	4.47	**4.46**	4.40 (1.07)	4.46 (0.22)	4.43 **(0.64)**	4.36 (2.13)	4.45 (0.34)	4.40 **(1.24)**	4.29 (3.59)	4.37 (2.13)	4.33 **(2.86)**
T_4	4.26	4.28	**4.27**	4.19 (1.76)	4.27 (0.23)	4.23 **(0.99)**	4.11 (3.52)	4.23 (1.11)	4.17 **(2.31)**	3.90 (8.45)	4.12 (3.62)	4.01 **(6.04)**
T_5	4.24	4.25	**4.25**	4.16 (1.82)	4.25 (0.06)	4.21 **(0.94)**	4.11 (3.01)	4.21 (1.00)	4.16 **(2.00)**	3.90 (7.96)	4.13 (3.00)	4.01 **(5.48)**
Mean	**4.33**	**4.35**	**4.34**	**4.27 (1.49)**	**4.33 (0.31)**	**4.30 (0.90)**	**4.21 (2.86)**	**4.30 (0.97)**	**4.26 (1.91)**	**4.04 (6.70)**	**4.21 (3.10)**	**4.13 (4.90)**
	S.Em.± C.D.		at 1%	S.Em.± C.D.		at 1%	S.Em.± C.D.		at 1%	S.Em.± C.D.		at 1%
Treatment (T)	0.008		0.029	0.063		0.247	0.129		0.503	0.459		1.786
Storage (S)	0.005		NS	0.040		0.156	0.082		0.318	0.290		1.130
Interaction (TxS)	0.011		NS	0.090		0.349	0.183		0.712	0.650		2.526

T_1 – Vengurla-1 T_2 – Vengurla-4 T_3 – Vengurla-6 T_4 – Vengurla-7 T_5 – Vengurla-8

S_1 – Ambient temperature S_2 – Cold storage NS – Non-significant

Figures in parenthesis indicates per cent decrease of pH to its original value

Table.6 Changes in ascorbic acid (mg/100 ml) of cashew apple juice during storage at ambient temperature (27-29°C) and cold storage (12 ± 1°C)

Treatments	0 month			2 months			4 months			6 months		
	S_1	S_2	**Mean**	S_1	S_2	**Mean**	S_1	S_2	**Mean**	S_1	S_2	**Mean**
T_1	241.17	244.12	**242.64**	214.98 (10.84)	224.90 (7.82)	219.94 **(9.33)**	193.80 (19.61)	205.67 (15.63)	199.73 **(17.62)**	84.36 (65.04)	129.76 (46.78)	107.06 **(55.91)**
T_2	217.53	219.27	**218.40**	156.75 (27.93)	188.98 (13.77)	172.87 **(20.85)**	100.72 (53.69)	146.69 (33.04)	123.71 **(43.36)**	91.75 (57.81)	132.27 (39.65)	112.01 **(48.73)**
T_3	187.82	194.56	**191.19**	146.63 (21.93)	156.12 (19.76)	151.37 **(20.84)**	107.94 (42.52)	117.68 (39.51)	112.81 **(41.02)**	93.36 (50.29)	105.49 (45.76)	99.42 **(48.02)**
T_4	185.42	190.02	**187.72**	144.40 (22.10)	151.43 (20.28)	147.91 **(21.19)**	107.89 (41.80)	112.84 (40.56)	110.36 **(41.18)**	96.62 (47.86)	101.59 (46.50)	99.10 **(47.18)**
T_5	225.18	230.35	**227.76**	158.59 (29.54)	187.97 (18.37)	173.28 **(23.96)**	106.33 (52.77)	150.50 (34.65)	128.41 **(43.71)**	94.16 (58.19)	103.93 (54.87)	99.05 **(56.53)**
Mean	**211.42**	**215.66**	**213.54**	**164.27 (22.47)**	**181.88 (16.00)**	**173.07 (19.23)**	**123.34 (42.08)**	**146.67 (32.68)**	**135.00 (37.38)**	**92.05 (55.84)**	**114.61 (46.71)**	**103.33 (51.27)**

	S.Em.±	C.D. at 1%	S.Em.±	C.D. at 1%	S.Em.±	C.D. at 1%	S.Em.±	C.D. at 1%
Treatment (T)	1.737	6.754	0.871	3.387	1.142	4.443	1.118	4.347
Storage (S)	1.098	NS	0.551	2.142	0.723	2.810	0.707	2.749
Interaction (TxS)	2.456	NS	1.232	4.791	1.616	6.284	1.581	6.147

T_1 – Vengurla-1 T_2 – Vengurla-4 T_3 – Vengurla-6 T_4 – Vengurla-7 T_5 – Vengurla-8

S_1 – Ambient temperature S_2 – Cold storage NS – Non-significant

Figures in parenthesis indicates per cent decrease of ascorbic acid to its original value

Table.7 Changes in tannins (%) of cashew apple juice during storage at ambient temperature (27-29°C) and cold storage (12 ± 1°C)

Treatments	0 month			2 months			4 months			6 months		
	S_1	S_2	**Mean**	S_1	S_2	**Mean**	S_1	S_2	**Mean**	S_1	S_2	**Mean**
T_1	0.36	0.38	**0.37**	0.32 (11.38)	0.24 (38.31)	0.28 **(24.85)**	0.21 (42.58)	0.16 (58.49)	0.18 **(50.54)**	0.15 (58.86)	0.08 (79.84)	0.11 **(69.35)**
T_2	0.39	0.36	**0.37**	0.31 (19.71)	0.27 (23.68)	0.29 **(21.70)**	0.25 (36.73)	0.16 (54.52)	0.20 **(45.63)**	0.16 (58.98)	0.08 (77.96)	0.12 **(68.47)**
T_3	0.24	0.25	**0.25**	0.21 (13.28)	0.16 (37.04)	0.18 **(25.16)**	0.14 (43.23)	0.08 (67.53)	0.11 **(55.38)**	0.10 (60.83)	0.06 (75.07)	0.08 **(67.95)**
T_4	0.37	0.36	**0.36**	0.31 (15.87)	0.24 (33.74)	0.27 **(24.81)**	0.22 (40.60)	0.15 (58.45)	0.18 **(49.53)**	0.15 (60.58)	0.09 (74.28)	0.12 **(67.43)**
T_5	0.35	0.35	**0.35**	0.31 (11.35)	0.27 (21.68)	0.29 **(16.52)**	0.24 (33.06)	0.22 (37.44)	0.23 **(35.25)**	0.15 (56.85)	0.08 (76.60)	0.12 **(66.73)**
Mean	**0.34**	**0.34**	**0.34**	**0.29 (14.32)**	**0.24 (30.89)**	**0.26 (22.61)**	**0.21 (39.24)**	**0.15 (55.29)**	**0.18 (47.26)**	**0.14 (59.22)**	**0.08 (76.75)**	**0.11 (67.98)**

	S.Em.±	C.D. at 1%	S.Em.±	C.D. at 1%	S.Em.±	C.D. at 1%	S.Em.±	C.D. at 1%
Treatment (T)	0.005	0.018	1.087	4.226	0.939	3.652	0.439	1.707
Storage (S)	0.003	NS	0.687	2.673	0.594	2.310	0.278	1.080
Interaction (TxS)	0.006	NS	1.537	5.977	1.328	5.165	0.621	2.414

T_1 – Vengurla-1 T_2 – Vengurla-4 T_3 – Vengurla-6 T_4 – Vengurla-7 T_5 – Vengurla-8

S_1 – Ambient temperature S_2 – Cold storage NS – Non-significant

Figures in parenthesis indicates per cent decrease of tannins to its original value

Table.8 Changes in alcohol (%) of cashew apple juice during storage at ambient temperature (27-29°C) and cold storage (12 ± 1°C)

Treatments	0 month			2 months			4 months			6 months		
	S_1	S_2	**Mean**	S_1	S_2	**Mean**	S_1	S_2	**Mean**	S_1	S_2	**Mean**
T_1	0.00	0.00	**0.00**	0.41	0.29	**0.35**	0.93	0.55	**0.74**	1.26	0.81	**1.04**
T_2	0.00	0.00	**0.00**	0.12	0.08	**0.10**	0.23	0.16	**0.20**	0.37	0.24	**0.31**
T_3	0.00	0.00	**0.00**	0.39	0.06	**0.23**	0.79	0.14	**0.47**	1.19	0.23	**0.71**
T_4	0.00	0.00	**0.00**	0.29	0.15	**0.22**	0.57	0.19	**0.38**	0.86	0.50	**0.68**
T_5	0.00	0.00	**0.00**	0.23	0.09	**0.16**	0.35	0.17	**0.26**	0.48	0.29	**0.39**
Mean	**0.00**	**0.00**	**0.00**	**0.29**	**0.13**	**0.21**	**0.57**	**0.24**	**0.41**	**0.83**	**0.41**	**0.62**
	S.Em.±	C.D. at 1%		S.Em.±	C.D. at 1%		S.Em.±	C.D. at 1%		S.Em.±	C.D. at 1%	
Treatment (T)	NS	NS		0.004	0.016		0.006	0.022		0.006	0.022	
Storage (S)	NS	NS		0.003	0.010		0.004	0.014		0.004	0.014	
Interaction (TxS)	NS	NS		0.006	0.023		0.008	0.032		0.008	0.032	

During 6 month of storage, interaction T_4S_2 (7.38 %) recorded minimum increase in titratable acidity and it was at par with T_3S_1 (9.35 %), T_1S_2 (13.64 %), T_2S_2 (8.91 %), T_3S_2 (13.43 %) and T_5S_2 (15.48 %), whereas T_2S_1 (24.14 %) showed maximum increase in titratable acidity, irrespective of storage conditions and treatments. The juice stored in cold storage showed minimum increase in titratable acidity as compared to ambient temperature. The low temperature and high humidity prevalent in cold storage might have restricted the growth and activity of microbes and hence less fermentation and formation of acids. Similar findings of increasing acidity were observed by Hussain *et al*., (2011) in apple and apricot blend juice and Shakoor e*t al*., (2013) in strawberry juice at refrigerated condition.

pH content of cashew apple juice was non-significant at initial day of storage (0 month) while significant results were observed at 2, 4 and 6 months of storage period (Table 5). During 6 month of storage, interaction T_3S_2 (2.13 %) recorded minimum decrease in pH and it was at par with T_1S_1 (4.57 %), T_3S_1 (3.59 %), T_1S_2 (3.17 %), T_2S_2 (3.59 %), T_4S_2 (3.62 %)and T_5S_2 (3.00 %), whereas T_2S_1 (8.93 %) showed maximum decrease in pH, irrespective of storage conditions and treatments. The ascorbic acid of cashew apple juice differs significantly with respect to different treatments during entire storage period (Table 6). At 6 months storage, interaction T_2S_2 (39.65 %) recorded minimum decrease in ascorbic acid and it was at par with T_3S_2 (45.76 %), whereas T_1S_1 (65.04%) showed maximum decrease in ascorbic acid, irrespective of storage conditions and treatments.

The data presented in Table 7 showed that tannin content was decreased from 0 month to 6 months of storage, irrespective of treatments and storage conditions. The minimum decrease in tannins was registered in interaction T_5S_1 (56.85 %) which was at par with T_1S_1 (58.86 %) and T_2S_1 (58.98 %), whereas T_1S_2 (79.84 %) showed maximum decrease in tannins, irrespective of storage conditions and treatments at 6 months storage. The decrease in tannin content of cashew apple juice during storage may be due to the precipitation and its oxidation by polyphenol oxidase. Similar findings of decreasing tannin were also observed by Vilasa Chandran *et al.*, (1984) in cashew apple juice. The alcohol content of cashew apple juice was increased from 0 month to 6 months of storage, irrespective of treatments and storage conditions. During 6 months storage, T_3S_2 (0.23 %) recorded minimum alcohol and it was at par with T_2S_2 (0.24 %), whereas maximum alcohol was noticed in T_1S_1 (1.26 %), irrespective of treatments and storage conditions.

Alcohol in ambient storage showed maximum increase and it may be due to higher rate of microbial fermentation as high temperature favourable for microbial growth was available at ambient temperature. This might have converted sugars into alcohol. Similar findings of increasing alcohol were reported by Quyen *et al*., (2013) in pineapple with an increase in temperature and storage time (Table 8).

From the study it was observed that, interaction T_3S_2 showed best results with five chemicals parameters (T.S.S., reducing sugars, total sugars, pH and alcohol) out of eight and it was at par with two other parameters (titratable acidity and ascorbic acid). Interaction T_2S_2 showed best result with ascorbic acid and it was at par with five parameters (T.S.S., reducing sugars, titratable acidity, pH and alcohol).

Even interaction T_4S_2 showed best result with titratable acidity and it was at par with three parameters (T.S.S., reducing sugars and pH). Hence, looking to the above findings

interaction T_3S_2 showed best results with respect to changes in chemical parameters of cashew apple juice during storage, followed by T_2S_2 and T_4S_2.

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References

Akinwale, T. D. (2000). Cashew apple juice. "It's uses in fortifying the nutritional quality of some tropical fruits". *European Food Research Technology*, 211: 205 – 207.

Cavalcante, A.A.M. B. Rubensam, Erdtmann, M. Brendel and J.A.P. Henriques (2005). Cashew (*Anacardium occidentale* L.) apple juice lowers mutagenicity of aflataxin B1 in *S. typhimurium*TA102 *Gen. Mol. Biol*., 28: 328-333.

Chempakam B. 1983. Distribution of ascorbic acid and ascorbic acid oxidase activity in the developing cashew apple (*Anacardium occidentale* L.). *J. Hortic. Sci.* 58: 447-448.

Hussain, I. A. Zeb and M. Ayub (2011). Evaluation of apple and apricot blend juice preserved with sodium benzoate at refrigeration temperature. *World J. of Agric. Sci*., 7(2): 136-142.

Melo-Cavalcante A.A. G. Rubensam, J.N. Picada, E.G. da Silva, F.J.C. Moreira, J.A.P. Henriques (2003). Mutagenicity, antioxidant potential and anti-mutagenic activity against hydrogen peroxide of cashew (*Anacardium occidentale* L.) apple juice and cajuina. *Env. Mol. Mutagen*,41: 360-369.

Morton, J., (1987). Emblica. *Fruits of warm climate*, pp: 213-217.

Ouyen, A. Joomwong and P. Rachtanapun (2013). Influence of storage temperature on ethanol content, microbial growth and other properties of Queen Pineapple fruit. *International J. Agril. and Biology*, 15(2):207-214.

Panse, V.G and P.V. Sukhatme (1985). Statistical methods for agricultural workers, I.C.A.R New Delhi.

Patil, U.P. (2001). Studies on extraction and preservation of jamun juice. A M.Sc. (Agri.) thesis submitted to MPKV, Rahuri, (M.S.), India.

Prabhu Desai (1991). Studies on juice making in ber (*Zizypus mauritiana* Lam.). M.Sc. (Agri.) thesis submitted to MPKV, Rahuri, (M.S.), India.

Shakoor, W., JavidUllah, AlamZeb and Z. Muhammad (2013). Effect of refrigeration temperature, sugar concentrations and different chemicals preservatives on the storage stability of strawberry juice. *International Journal of Engineering and Technology*, 13 (3):1-2.

VilasaChandran T., Gopikumar, K. and Arvindakshan, M. (1984). Storage studies on cashew apple juice. *Indian Cashew J*. 15 (4): 9-11, 14-16.