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Quality of lemon nectar blended with ginger: A study

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Abstract
Beverages from fruits and vegetables are preferred for combating several diseases. Quality enhancement of beverages is highly demanded by the food industry. Blending of nectar is one of the best methods to enhance its acceptability. Apart from fresh consumption, there is huge scope for processing of different beverages from lemon in the Northern part of West Bengal. Nectar is one of the under exploited product prepared from lemon which can easily be blended with other crops for reducing its bitterness and improving qualitative parameters. In the present experiment lemon juice was blended with ginger, at a mixture ratio of 50:50(T1), 60:40(T2), 70:30(T3), 80:20(T4), and 90:10(T5). Our study revealed that the lemon based blended nectar was highly acceptable up to 3 months under ambient condition. Among different treatments, blending of 80% lemon juice with 20% ginger extract (T4) was considered to be the most appropriate for manufacturing nectar as potential nutritional drink.

Keywords: Beverages, nectar, blending, lemon, ginger

Introduction
The lemon, *Citrus limon* (L.) Osbeck, belonging to the family Rutaceae, is one of the important fruit crops with excellent source of vitamin C (31%), one of the most important antioxidants in nature (World healthiest foods, 2009). India produces 3148 thousand metric tons of lemon per year (Hort. Stat., 2018) [10] out of which raw fruit is freshly consumed and also utilized in preparation of value added products like squash, cordial, syrup, marmalade, pickle, salted lime and dried peel.

Lemon is a dominant crop in the Northern part of West Bengal. There are three major flowering seasons in lemon, among which 60% fruit production comes from *Mrig Bahar* that is harvested during winter, leading to huge production. However, due to low demand of lemon during winter season, the post harvest loss is much higher, which can be reduced by different types of processing only. Processed products prepared from lemon are mainly pickles and beverages like juice, cordial, nectar, RTS, squash etc. Among these nectar is one of the most under exploited product which can be improvised by blending it with other crops leading to a significant value addition option. Besides, blending may also reduce bitterness of lemon nectar which is the major bottle neck in its popularisation.

In the present experiment lemon juice was blended with ginger, one of the major horticultural crops of Northern part of West Bengal, to improve taste, aroma, palatability, nutritive value as well as reducing the bitterness.

Research methods
Present investigation was carried out at the laboratory of Department of Pomology and Postharvest Technology, Faculty of Horticulture, Uttar Banga Krishi Viswavidyalaya, Pundibari, Coochbehar, West Bengal in two consecutive years of 2016 and 2017.

Preparation of nectar: The following flow chart depicts preparation of nectar

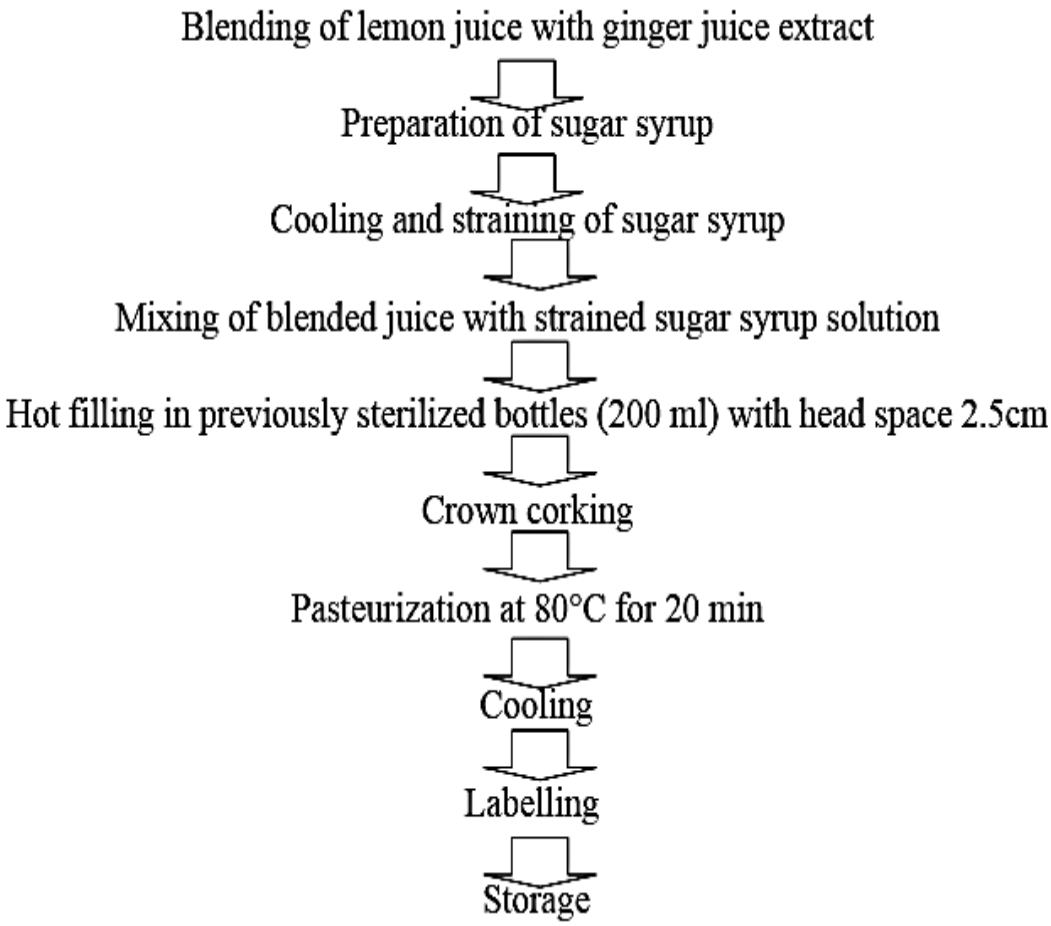


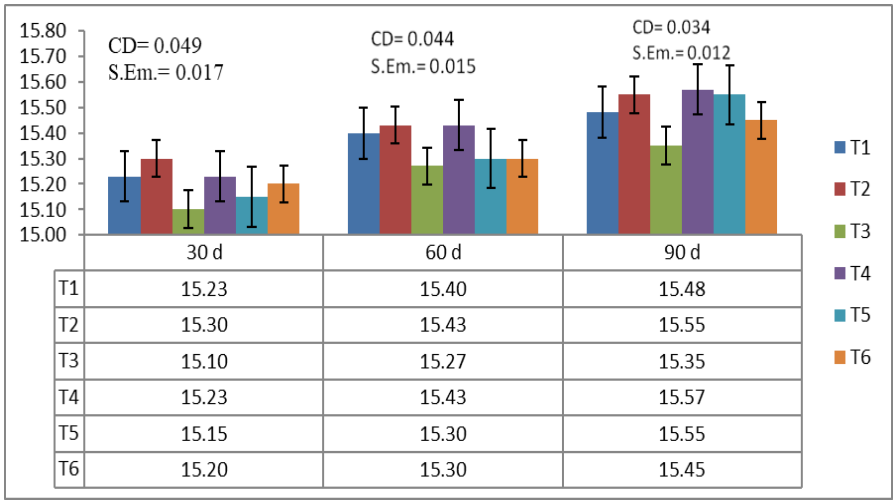
Fig 1: Flow chart for the preparation of nectar

Treatments: Following treatment combinations were opted during the experiment.

T_1: 50% lemon juice + 50% ginger juice extract.
T_2: 60% lemon juice + 40% ginger juice extract.
T_3: 70% lemon juice + 30% ginger juice extract.
T_4: 80% lemon juice + 20% ginger juice extract.
T_4: 90% lemon juice + 10% ginger juice extract.
T_6: 100% lemon juice + 0% ginger juice extract (control).

Pooled data of 2016 and 2017 was used for presenting the paper and Complete Randomized Design (CRD) method was followed for statistical analysis.

Research Findings and Discussion

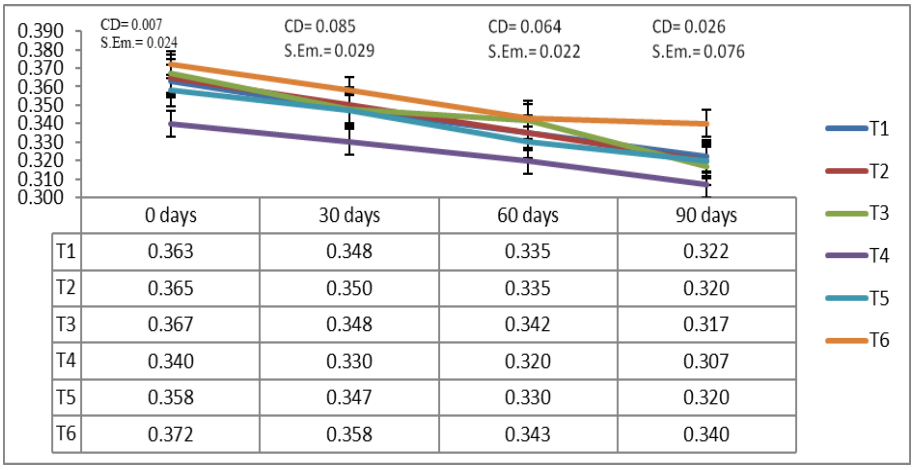


	30 d	60 d	90 d
T1	15.23	15.40	15.48
T2	15.30	15.43	15.55
T3	15.10	15.27	15.35
T4	15.23	15.43	15.57
T5	15.15	15.30	15.55
T6	15.20	15.30	15.45

Fig 2: Effect of different treatments on the TSS (°B) during storage of blended nectar

Observations revealed that the TSS was significantly different among the treatments during different storage intervals. TSS increased in all treatments including control during the storage period. According to the pooled data it was found that during initial stage (i.e. 0 days of storage) TSS content of the nectar was 15°B (at per FPO specification) that increased to a maximum value of 15.57°B in case of nectar prepared by 80% lemon juice blended with 20% ginger juice extract (T4), after

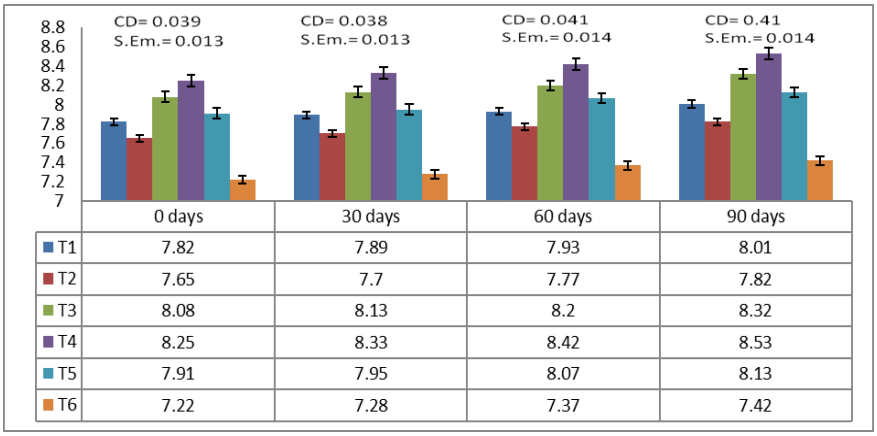
three months of storage (90 days).While, the minimum brix value (15.35°B) was recorded in T3 (70% lemon juice + 30% ginger juice). Increase in brix content of nectar during storage might have happened due to hydrolysis of polysaccharides into soluble form of starch i.e monosaccharide or disaccharide (Barwal and Shera, 2009; Nayak *et al.*, 2011) [2, 19].



	0 days	30 days	60 days	90 days
T1	0.363	0.348	0.335	0.322
T2	0.365	0.350	0.335	0.320
T3	0.367	0.348	0.342	0.317
T4	0.340	0.330	0.320	0.307
T5	0.358	0.347	0.330	0.320
T6	0.372	0.358	0.343	0.340

Fig 3: Titratable acidity (%) during storage of blended nectar as influenced by different treatments

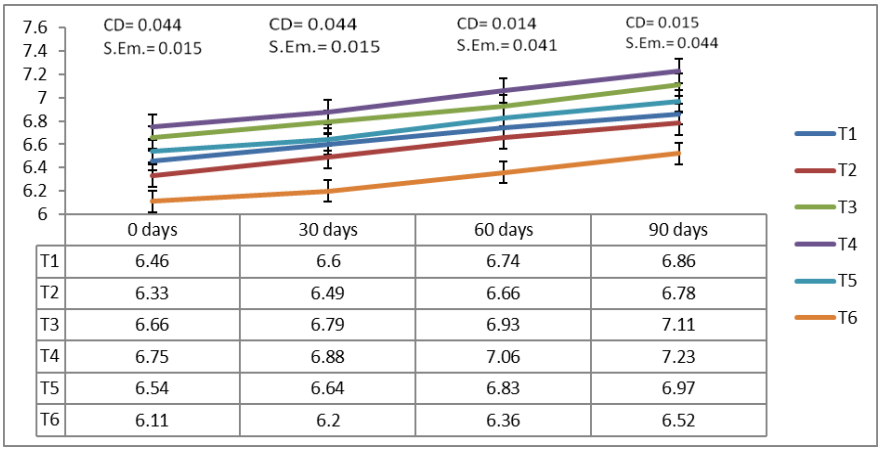
Titratable acidity of the prepared nectar varied significantly among all the treatments, with a decreasing trend during the storage period. Pooled data exhibited that titratable acidity was highest in 100% lemon juice (T6) with a result of 0.372% initially and 0.340% at 90 DAS. The minimum (0.307%) was found in T4 (80% lemon juice + 20% ginger juice extract). Reduction of titratable acidity during storage of nectar might be a result of chemical interaction between organic constituents of fruit juice induced by temperature and action of enzymes. Kumar *et al.*, (1992) [15] also reported the same observation while studying on blending of lemon juice. Amerine *et al.*, (1980) [1] also reported that decrease in titratable acidity may be due to precipitation of different acids in the form of their respective salts.



	0 days	30 days	60 days	90 days
T1	7.82	7.89	7.93	8.01
T2	7.65	7.7	7.77	7.82
T3	8.08	8.13	8.2	8.32
T4	8.25	8.33	8.42	8.53
T5	7.91	7.95	8.07	8.13
T6	7.22	7.28	7.37	7.42

Fig 4: Effect of different treatments on the total sugar (%) during storage of blended nectar

Total sugar of the prepared nectar varied significantly among all the treatments, with an increasing trend during the storage period. Pooled data exhibited that Total sugar was highest in 80% lemon juice and 20% ginger juice (T4) with a result of 8.25% initially and 8.53% at 90 DAS. The minimum (7.22%) was found in T6 (100% lemon juice).

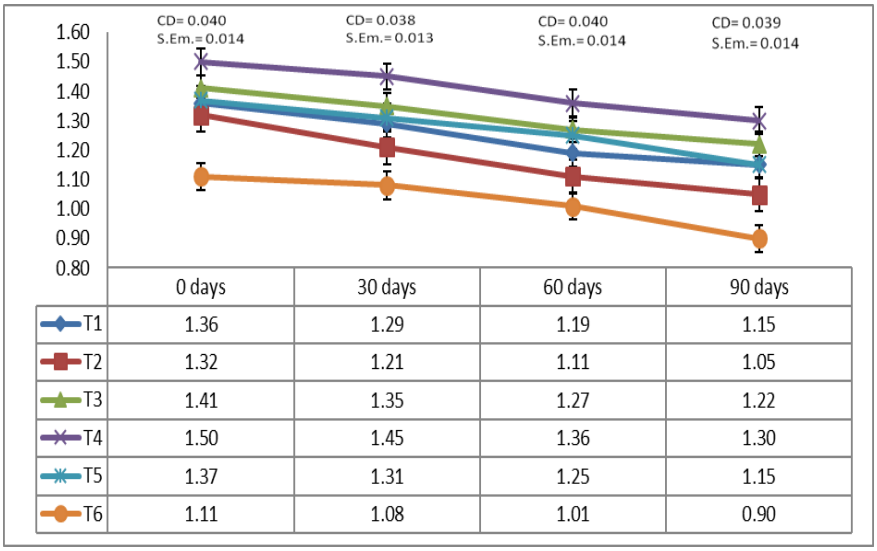


	0 days	30 days	60 days	90 days
T1	6.46	6.6	6.74	6.86
T2	6.33	6.49	6.66	6.78
T3	6.66	6.79	6.93	7.11
T4	6.75	6.88	7.06	7.23
T5	6.54	6.64	6.83	6.97
T6	6.11	6.2	6.36	6.52

Fig 5: Reducing sugar (%) during storage of blended nectar as influenced by different treatments

Observation in reducing sugar during storage of nectar revealed that, reducing sugar varied significantly among different treatments. Initially reducing sugar was found to be the highest (6.75%) in 80% lemon juice blended with 20% ginger juice extract (T4) and lowest (6.11%) in 100% lemon juice (T6). However, at the end of storage period the maximum reducing sugar (7.23%) was found in 80% Lemon juice and 20% ginger juice extract (T4) and the minimum (6.52%) was found in T6 (control).

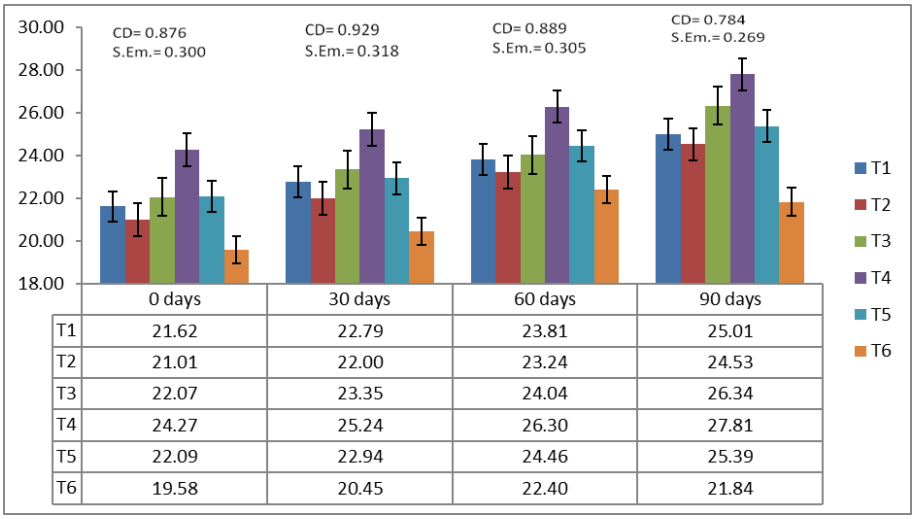
The increase in total sugar and reducing sugar during storage period of 90 days might be attributed to hydrolysis of starch into sugars which was also in conformity with Barwal and Shera, (2009) [2]. Similar results were also reported by Deka and Sethi (2001) [6] in mango juice blends and by Bharadwaj and Mukherjee (2011) [3] in kinnow blends, the same observation was found by Ranote and Bains, (1982) [23] in kinnow juice and Mehta and Bajaj, (1983) [17]; Purthi, (1978) [22] in citrus juice.



	0 days	30 days	60 days	90 days
T1	1.36	1.29	1.19	1.15
T2	1.32	1.21	1.11	1.05
T3	1.41	1.35	1.27	1.22
T4	1.50	1.45	1.36	1.30
T5	1.37	1.31	1.25	1.15
T6	1.11	1.08	1.01	0.90

Fig 6: Effect of different treatments on the non reducing sugar (%) during storage of blended nectar

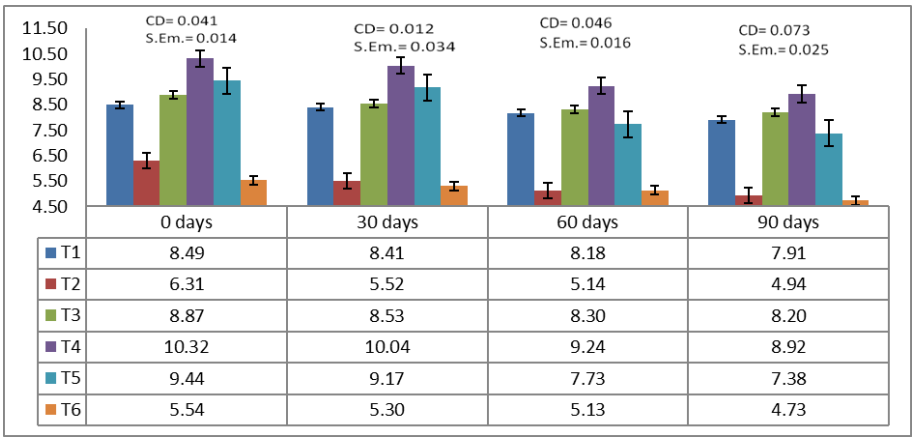
Observations revealed that the non reducing sugar was significantly different among the treatments during different storage intervals. Non reducing sugar decreased in all treatments including control during the storage period. According to the pooled data it was found that during initial stage (i.e. 0 days of storage) non reducing sugar content of the nectar was 1.50% that decreased to a maximum value of 1.30% in case of nectar prepared by 80% lemon juice blended with 20% ginger juice extract (T4), after three months of storage (90days). While, the minimum non reducing sugar (0.90%) was recorded in T6 (100% lemon juice). Decrease in non reducing sugar content of nectar during storage might have happened due to acid hydrolysis of polysaccharides (Patil *et al.;* 2011) [20]. The similar type of decreasing trend in non reducing sugar was also observed by Jain *et al.* (2007) [12] in Aonla nectar and Thakre (2007) [25] in papaya-banana blend nectar.



	0 days	30 days	60 days	90 days
T1	21.62	22.79	23.81	25.01
T2	21.01	22.00	23.24	24.53
T3	22.07	23.35	24.04	26.34
T4	24.27	25.24	26.30	27.81
T5	22.09	22.94	24.46	25.39
T6	19.58	20.45	22.40	21.84

Fig 7: Sugar-acid ratio during storage of blended nectar as influenced by different treatments

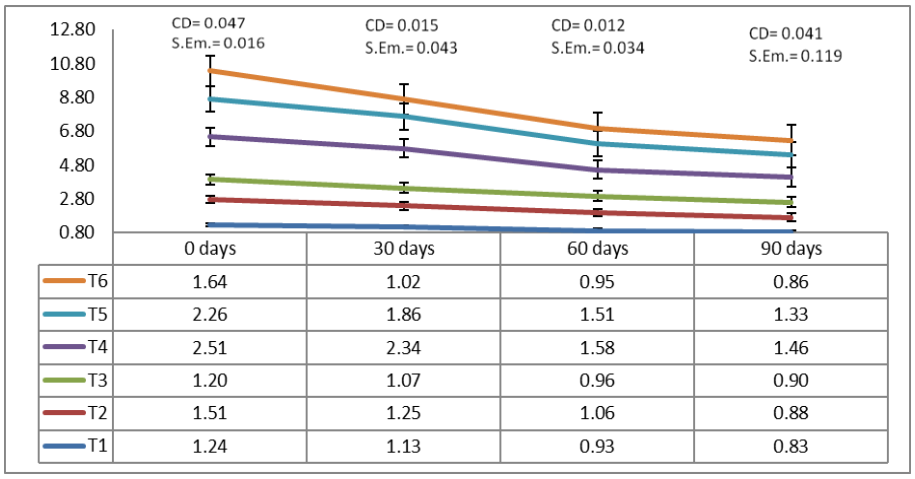
Observations revealed that the sugar-acid ratio was significantly different among the treatments during different storage intervals. Sugar-acid ratio increased in all treatments including control during the storage period. According to the pooled data it was found that during initial stage (i.e. 0 days of storage) sugar-acid ratio varies between 19.58 to 21.62 that increased to a maximum value of 27.81 in case of nectar prepared by 80% lemon juice blended with 20% ginger juice extract (T4), after three months of storage (90days).While, the minimum sugar-acid ratio (21.84) was recorded in T6 (100% lemon juice).



	0 days	30 days	60 days	90 days
T1	8.49	8.41	8.18	7.91
T2	6.31	5.52	5.14	4.94
T3	8.87	8.53	8.30	8.20
T4	10.32	10.04	9.24	8.92
T5	9.44	9.17	7.73	7.38
T6	5.54	5.30	5.13	4.73

Fig 8: Effect of different treatments on the Vitamin C (mg/ 100 ml) during storage of blended nectar

Vitamin C content of the prepared nectar varied significantly among all the treatments, with a decreasing trend during the storage period. Pooled data exhibited that Vitamin C content was highest in 80% lemon juice and 20% ginger juice (T4) with a result of 10.32 mg/ 100 ml initially and 8.92 mg/ 100 ml. The minimum (4.73 mg/ 100 ml) was found in T6 (100% lemon juice).

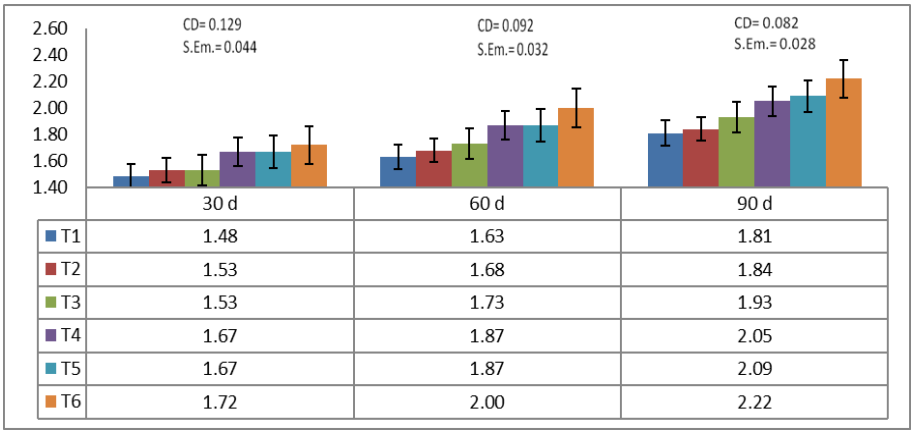


	0 days	30 days	60 days	90 days
T6	1.64	1.02	0.95	0.86
T5	2.26	1.86	1.51	1.33
T4	2.51	2.34	1.58	1.46
T3	1.20	1.07	0.96	0.90
T2	1.51	1.25	1.06	0.88
T1	1.24	1.13	0.93	0.83

Fig 9: β-carotene (µg/100ml) during storage of blended nectar as influenced by different treatments

β-carotene of the prepared nectar varied significantly among all the treatments, with a decreasing trend during the storage period. Pooled data exhibited that β-carotene content was highest in 80% lemon juice and 20% ginger juice (T4) with a result of (2.51 µg/100ml) initially and 1.64 µg/100ml. The minimum (0.83 µg/100ml) was found in T6 (100% lemon juice).

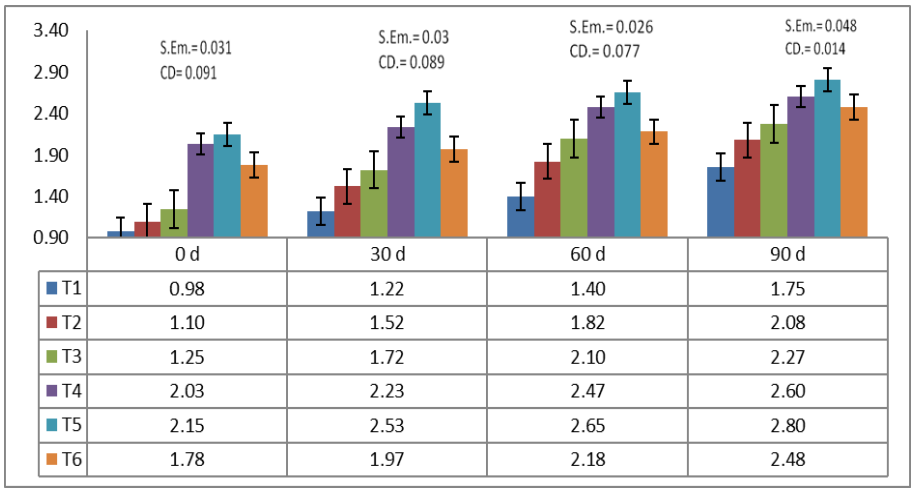
The result of lemon based blended nectar indicated that, the ascorbic acid and carotene in both the year decreased with increased in duration of storage for 90 days which might be due to high temperature and light during storage (Nayak *et al.*, 2011) [19] while Mehta and Tomar (1979) [18]; Jain *et al.*, (1984) [11] and Tandon *et al.*, (2007) [24] reported decreased in ascorbic acid content might be attributed to the increase in tannin. These results are in agreement with the findings of Kinh *et al.*, (2001) [14] and Muhammad *et al.*, (2011) who reported a decrease in ascorbic acid content in apple pulp. Chen *et al.*, (1995) [4] and Gama and Sylos (2007) [8], also reported that the vitamin A content decreased along with increasing temperature and heating time.



	30 d	60 d	90 d
T1	1.48	1.63	1.81
T2	1.53	1.68	1.84
T3	1.53	1.73	1.93
T4	1.67	1.87	2.05
T5	1.67	1.87	2.09
T6	1.72	2.00	2.22

Fig 10: Effect of different treatments on the microbial count ($\times 10^3$ cfu/ml) during storage of blended nectar

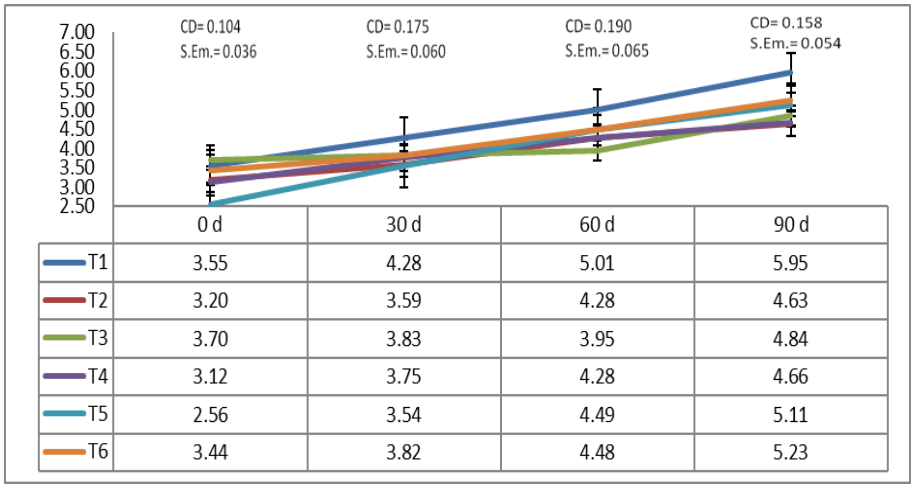
Microbial count of the prepared nectar was significantly different. However an increasing trend in total plate count was observed. Pooled data reveals that in initial day of storage the total plate count was found 0, however it increased to maximum (2.22×10^3 cfu/ml) after 90 DAS which was observed in the treatment combination 100% lemon juice (T6) while, the minimum was recorded in 50% lemon juice and 50% ginger juice extract T1 (1.81×10^3 cfu/ml). The increase in microbial count of blended nectar during advancement of storage. The microbial count was found to be highest in nectar blended with lower percentage of ginger as the storage period advances. Similar results were also reported by Bharadwaj and Mukherjee (2011) [3] in kinnow juice blend. This result is similar with the findings of Ejechi *et al.*, (1998) [7] who reported that heating mango juice to 55°C for 15 minutes and supplementing it with nutmeg and ginger markedly inhibited microbial growth. Similar results were also reported by Deka (2000) [5] who notified negligible growth of moulds and yeast in lime-aonla and mango-pineapple spiced RTS beverages. Spoilage was further reduced during storage from the inhibitory effect of micro-organisms and anti-oxidative properties of spices.



	0 d	30 d	60 d	90 d
T1	0.98	1.22	1.40	1.75
T2	1.10	1.52	1.82	2.08
T3	1.25	1.72	2.10	2.27
T4	2.03	2.23	2.47	2.60
T5	2.15	2.53	2.65	2.80
T6	1.78	1.97	2.18	2.48

Fig 11: Sedimentation rate (cm/ 10 cm of liquid column) during storage of blended nectar as influenced by different treatments

Sedimentation rate of the prepared nectar varied significantly among all the treatments, with an increasing trend during the storage period. Pooled data exhibited that sedimentation rate was highest in 90% lemon juice and 10% ginger juice (T5) with a result of 2.15 cm/10cm of liquid column initially and 2.80 cm/ 10 cm of liquid colum at 90 DAS. The minimum (1.75 cm/ 10 cm of liquid column) was found in T6 (100% lemon juice).



	0 d	30 d	60 d	90 d
T1	3.55	4.28	5.01	5.95
T2	3.20	3.59	4.28	4.63
T3	3.70	3.83	3.95	4.84
T4	3.12	3.75	4.28	4.66
T5	2.56	3.54	4.49	5.11
T6	3.44	3.82	4.48	5.23

Fig 12: Effect of different treatments on the changes of haziness (% transmittance) during storage of blended nectar

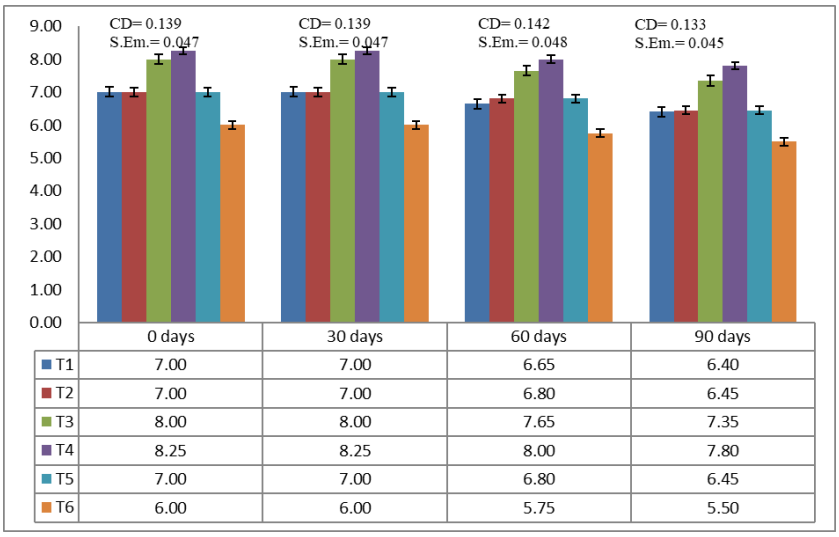
Haziness of the prepared nectar varied significantly among all the treatments, with an increasing trend during the storage period. Pooled data exhibited that haziness was highest in 50% lemon juice and 50% ginger juice (T1) with a result of 3.70% transmittance initially and 5.95% transmittance at 90 DAS. The minimum (4.66% transmittance) was found in T4 (80% lemon juice and 20% ginger juice).

The haziness was found to decrease which was depicted clearly which an increase of percent transmittance, while the sedimentation rate was increasing as the storage period increases. Juice turbidity may be decreased due to the action of pectinase on the pectin layers encapsulating the protein core of proteinaceous pectin particles in suspension. This action resulted in an electrostatic agglomeration of oppositely charged particles that may lead to transient turbidity increase and subsequently result in precipitation of agglomerated complex resulting in decreased turbidity. Similar results were achieved by

Grassim and Fauqembergue (1999) [9] that increased enzyme concentration, incubation time and

incubation temperature might decrease the turbidity due to polygalactocheronase action that

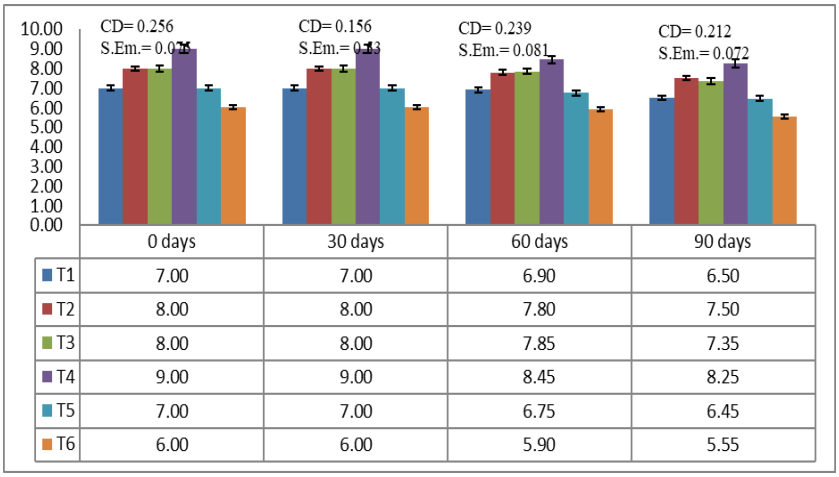
corresponding to the hydrolysis of pectin substances and causing pectin protein complex to flocculate.



	0 days	30 days	60 days	90 days
T1	7.00	7.00	6.65	6.40
T2	7.00	7.00	6.80	6.45
T3	8.00	8.00	7.65	7.35
T4	8.25	8.25	8.00	7.80
T5	7.00	7.00	6.80	6.45
T6	6.00	6.00	5.75	5.50

Fig 13: Flavour (as per Hedonic scale) during storage of blended nectar as influenced by different treatments

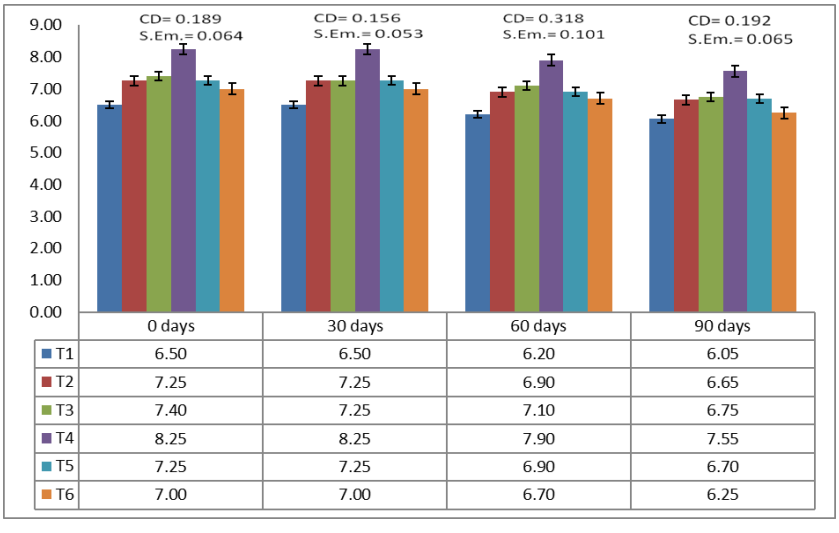
Flavour of the prepared nectar varied significantly among all the treatments, with a decreasing trend during the storage period. Pooled data exhibited that overall acceptability was highest in 80% lemon juice and 20% ginger juice (T4) with a score of 8.25 initially and 7.80 finally (i.e. after 90 days of storage). The minimum (5.50) was found in T6 (100% lemon juice).



	0 days	30 days	60 days	90 days
T1	7.00	7.00	6.90	6.50
T2	8.00	8.00	7.80	7.50
T3	8.00	8.00	7.85	7.35
T4	9.00	9.00	8.45	8.25
T5	7.00	7.00	6.75	6.45
T6	6.00	6.00	5.90	5.55

Fig 14: Effect of different treatments on the changes of bitterness (as per hedonic scale) during storage of blended nectar

Bitterness of the prepared nectar varied significantly among all the treatments, with a decreasing trend during the storage period. Pooled data exhibited that Bitterness score was highest in 80% lemon juice and 20% ginger juice (T4) with a score of 9 initially and 8.25 finally (i.e. after 90 days of storage). The minimum (5.55) was found in T6 (100% lemon juice).



	0 days	30 days	60 days	90 days
T1	6.50	6.50	6.20	6.05
T2	7.25	7.25	6.90	6.65
T3	7.40	7.25	7.10	6.75
T4	8.25	8.25	7.90	7.55
T5	7.25	7.25	6.90	6.70
T6	7.00	7.00	6.70	6.25

Fig 15: Overall acceptability (as per Hedonic scale) during storage of blended nectar as influenced by different treatments

Overall acceptability of the prepared nectar varied significantly among all the treatments, with a decreasing trend during the storage period. Pooled data exhibited that overall acceptability was highest in 80% lemon juice and 20% ginger juice (T4) with a score of 8.25 initially and 7.55 finally (i.e. after 90 days of storage). The minimum (6.05) was found in T1 (50% lemon juice and 50% ginger juice).

The loss in organoleptic quality of the product is obvious as the storage period

advances. The temperature plays an important role in inducing certain biochemical changes

in the product which leads to the formation of off flavour and discolouration and thus, musking the original flavour and colour of the product. The findings of Khurdiya and Anand (1981) [13] also support the contention that acceptability of beverage phalsa goes down when stored at room temperature. The same findings were also reported by Kumar and Singh (2001) [16] in aonla squash and by Prasad and Mali (2000) [21] in pomegranate squash.

Conclusion

The study revealed that the ginger blended lemon nectar can be stored upto 3 months at room temperature and remain acceptable both organoleptically and biochemically. The blending of 80% lemon juice and 20% ginger juice extract (T4) had maintained all the quality parameters hence the formulation with 80% lemon juice and 20% ginger juice extract was considered to be the most appropriate for manufacturing nutritional and functional drinks. The effect of ginger extract as an alternative of chemical preservative in prepared blended beverages.

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