

“Standardization and evaluation of quality attributes and bioactive components of Ginger (*Zingiber officinale* Roscoe) and Kokum (*Garcinia indica* Choisy) based herbal tea”

Abstract:

The present investigation entitled “Standardization and evaluation of quality attributes and bioactive components of Ginger (*Zingiber officinale* Roscoe) and Kokum (*Garcinia indica* Choisy) based herbal tea” was carried out in the Central Instrumentation Laboratory, College of Horticulture, Rajendranagar, Hyderabad. The experiment was carried out with Completely Randomized Design (CRD) with two experiments, experiment-I consists of 7 treatments and three replications. and experiment -II consists of 8 treatments and 3 replications. Tea bags of 3.5grams will be prepared as per the treatments and Standard cup volume of 100 ml is considered for study. The results revealed that the treatment combination of ginger -kokum mix (first best T₇ Dry ginger powder 90 % + Dry Kokum powder 10 %), second best -T₃ (Dry ginger powder 50 % + Dry kokum powder 50 %) based on organoleptic evaluation were selected from experiment one and proceeded to experiment two for evaluation of ginger kokum based herbal tea. The results related to physico-chemical parameters and organoleptic evaluation indicated that, among the different herbal teas, the treatment T₃ (First best -90 % + Cardamom -10 %) recorded best with pH (4.54) of 0th day, T₂ (Second Best -100 % -Control) recorded highest titratable acidity (4.02 %) of 60th day, T₂ (Second Best -100 %) recorded best with Ascorbic acid (1.32 mg/100 g) of 0th day. T₄ (First best 90 % +Turmeric -10 %) at 0th day found to be best with total Phenol content (88.95 mg GAE/g). The maximum organoleptic score for overall acceptability (8.47) was in “Like very much range” on nine-point hedonic scale and acceptability index (91.04%) was recorded in treatment T₄: (First best-90 % +Tulasi-10 %) at the end of storage period.

Keywords: pH, Titratable acidity (%), Ascorbic acid content (mg /100 g), Total phenols and Organoleptic evaluation.

1.Introduction:

Herbal tea one of the most traditional and calming herbal medicines. Herbal tea is an infusion created from herbs rather than tea bush leaves; it is an extract made from a variety of dried seeds, leaves, barks, flowers, fruits, nuts, and roots that have varied medicinal characteristics.

Herbal teas are inherently caffeine-free, which is why they are more popular than other varieties of tea because they do not even have a trace of caffeine. Many different herbs or components are used to make herbal tea, and each one has a distinct meaning Chandrasekara and Shahidi. [1].

The Zingiberaceae family includes the therapeutic plant ginger (*Zingiber officinale* R. Ginger rhizomes are used as a spice and folk remedy for a number of illnesses. Ginger is unique in having wide range of natural components with great nutritional value. Ginger constitutes 5-6% of all spices eaten worldwide. Due to its ethnic medical properties and nutritional value, *Zingiber officinale*'s rhizome is widely utilised for both culinary and medicinal reasons worldwide Dissanayake et al. [2].

One of the significant indigenous tree spices and a member of the Clusiaceae family is kokum (*Garcinia indica* Choisy). The kokum fruit is either dark purple or scarlet with golden undertones when it is fully mature. Kokum fruit rind, and seeds have a variety of uses in the food and beverage industry as well as in manufacturing medicines. Kokum has palatable flavour with a sweet acidic (sour) taste, making it a well-liked culinary addition Swami et al. [3].

Different bioactive chemicals found in kokum fruit have anti-inflammatory, antibacterial, and antioxidant activities. Furthermore, kokum demonstrates anti-inflammatory effects. Anthocyanins, hydroxycitric acid, and garcinol are the three main bioactive substances found in kokum, and each of them has nutraceutical characteristics. Kokum rinds contain all of these substances and have anti-cancer and anti-obesity qualities, hence useful to human health Ranveer et al. [4].

2. Materials and Methods:

The plant material utilized for conducting the experiment viz., Dry ginger powder (*Zingiber officinal* Roscoe), Kokum (*Garcinia indica* Choisy), Turmeric powder (*Curcuma longa*), Cardamom (*Elettaria cardamomum*) was procured from local market. Tulsi leaves (*Ocimum sps*) were collected from MAPRS, SKLTSU.

Preparation of herbal tea: Tea bags were prepared by taking (3.5 g) of tea powder mix in each bag as per the treatments. Standard cup volume of 100 ml is considered for study.

EXPERIMENT: 1 "Standardization of ginger-kokum mix for herbal tea formulation".

TREATMENT COMBINATIONS

T₁ -Dry ginger powder – 100%

T₂ -Dry kokum powder -100 %

T₃ -Dry ginger powder -50 % +Dry kokum powder -50 %

T₄ -Dry ginger powder -60 % + Dry kokum powder - 40 %

T₅ -Dry ginger powder -70 % + Dry kokum powder - 30 %

T₆ -Dry ginger powder -80 %+ Dry kokum powder - 20 %

T₇ -Dry ginger powder -90 % + Dry kokum powder -10 %

EXPERIMENT:2 "Evaluation of ginger-kokum based herbal tea for quality and bioactive composition"

TREATMENT COMBINATIONS

T₁ - First best -100% (control)

T₂ - Second best -100% (control)

T₃ - First best - 90%+ cardamom powder -10%

T₄ - First best - 90% + tulsi powder -10%

T₅ - First best - 90 % + turmeric powder-10%

T₆ - Second best - 90% + cardamom powder-10%

T₇ - Second best - 90% + tulsi powder-10%

T₈ - Second best - 90%+ turmeric powder -10%

2.1pH:

The measurement of the herbal teas, pH values was made at 250⁰C through a pH electrode connected to an ion analyser. 50 ml of the herbal tea was taken and the pH measured using pH meter. The readings were performed in duplicate for each sample. Lunkes and Hashizume [5].

2.2TITRATABLE ACIDITY:

In the sequence of pH measurements, the samples which showed a pH value below 7.0 were submitted to titratable acidity analysis. Increments of 0.5 ml of 0.1N NaOH solution was

added, in a tea volume of 50 ml, until pH 7 was reached. The volume of 0.1N NaOH solution (in millilitres) necessary to achieve a neutral solution was recorded and it corresponded to titratable acidity of each sample. The procedure was also conducted in duplicate for each sample. Lunkes and Hashizume.

$$\text{Amount of 0.1N NaOH used/100 ml tea} = \frac{x}{\text{Amount of tea}} \times 100$$

Where x = Amount of NaOH x Amount of tea x 100

2.3 ASCORBIC ACID (mg /100g) estimation:

The ascorbic acid content was determined by 2, 6-dichlorophenol indophenol visual titration method as given by Ranganna [6]. and expressed in mg/100g.

Procedure

Ten grams of sample was blended with 3 per cent metaphosphoric acid and made up to 50 ml with 3 per cent HPO₃. The contents are filtered through Whatman No.1 filter paper. Ten milliliters of the HPO₃ extract were taken and titrated against standard 2, 6-Dichloro phenol indophenol dye to a pink end point given by Ranganna.

$$\text{Ascorbic acid mg/100g} = \frac{\text{Titre value} \times \text{Dye factor} \times \text{Volume make up}}{\text{Volume taken} \times \text{Weight of the sample}} \times 100$$

2.4 TOTAL PHENOLIC CONTENT

The total phenol content was estimated based on Folin–Ciocalteu (FC) method (Singleton and Rossi, 1965) with some slight modifications. 0.1 ml of the aliquot was diluted with 1.4 ml of Distilled water to which 0.5 ml of Folin Ciocalteu (FC) was added and test tubes were shaken well. Then 10 ml of sodium carbonate (20 %, w/v) was added. Similarly, this process was done for 0.2,0.3,0.4 ml aliquots and sample. These solutions were mixed well and incubated at room temperature for 60 minutes. After incubation, the absorbance was measured at 760 nm. A suitable calibration curve was prepared using Gallic acid and the results are expressed in milligram per gram (mg/ g) Gallic acid equivalent. 2 g each sample was crushed in pestle and mortar with 20 ml 80 % methanol. The extract was then centrifuged at 10000 rpm at 40C for 20 minutes. The supernatant was taken for determination of total phenolic content.

$$\text{Mg gallic acid Dilution equivalent per gram} = \frac{\text{O.D} \times \text{Standard curve factor} \times \text{volume made up}}{\text{Aliquot taken} \times \text{wt. Of sample}}$$

2.5 ORGANOLEPTIC EVALUATION (9-point hedonic scale)

The tea infusions were subjected to sensory evaluation for their acceptability using 9-point hedonic scale for colour, flavour, taste, consistency, overall acceptability and **acceptability index**. Each attribute was given a separate score of 9 points. From the quality point of view, higher product scoring was treated as more acceptable. Sensory evaluation panel consisted of 10 panelists and the panelists were instructed to evaluate the sample as per hedonic scale procedure as described by Ranganna in a format prepared for rating the teas as per the 9-point Hedonic scale.

Comment [L1]: Mention the method for evaluation of acceptability Index

Like extremely	9
Like very much	8
Like moderately	7
Like slightly	6
Neither like nor dislike	5
Dislike slightly	4
Dislike moderately	3
Dislike very much	2
Dislike extremely	1

3. Results and Discussion: the present investigation on “Standardization and evaluation of quality attributes and bioactive components of Ginger (*Zingiber officinale* Roscoe) and Kokum (*Garcinia indica* Choisy) based herbal tea” are discussed and presented below.

EXPERIMENT 1

3.1 pH

Among all of the treatments T₁: (Dry ginger powder 100 %) (5.72) recorded a significantly higher value followed by T₇: (Dry ginger powder - 90 % + Dry Kokum powder - 10 %) (4.04) Whereas, a significantly lower value recorded in T₂: (Dry Kokum powder - 100 %) (2.11). A similar range of pH was reported by Ali and Rani [7]. in dried ginger paste (Table 1).

3.2 TITRATABLE ACIDITY (%)

Titratable acidity of ginger-kokum mix formulations shows a significant maximum value in T₂: (Dry Kokum powder -100 %) (10.84 %) followed by T₃ (Dry ginger powder -50 % + Dry Kokum powder -50 %) (5.70 %) Whereas, significant lower value was recorded in T₇: (Dry ginger powder -90 % + Dry Kokum powder -10 %) (1.02%)(Table 1).

The maximum value was recorded in T₂ because the percentage of kokum powder composition is maximum in it. These results are in accordance with Raju [8].

3.3 ASCORBIC ACID CONTENT (mg /100 g)

Among all the treatments T₂: (Dry Kokum powder -100 %) (9.55 mg /100 g) recorded a significant maximum value followed by T₃: (Dry ginger powder -50 % + Dry Kokum powder -50 %) (8.23 mg /100 g) and minimum value is recorded in T₇: (Dry ginger powder -90 % + Dry Kokum powder -10 %) (1.08)(Table 1).

The amount of ascorbic acid is maximum in T₂ as it contains 100 % of kokum powder. These results are supported by Raju.

3.4 TOTAL PHENOLS (mg GAE /g)

Total phenols (mg GAE/g) of ginger - kokum mix formulations show significantly maximum value recorded in T₅: (Dry ginger powder - 70 % + Dry Kokum Powder - 30 %) (127.73 mg GAE /g) followed by T₄: (Dry ginger powder - 60 % + Dry Kokum powder -40 %) (119.25 mg GAE /g) and minimum value recorded in T₃: (Dry ginger powder -50 % + Dry Kokum powder -50 %) (68.84 mg GAE /g)(Table 2). A similar range of total phenols is found in ginger extracts by Stoilova et al.[9].

3.5 ORGANOLEPTIC EVALUATION (9-point hedonic scale)

3.5.1 COLOUR

Significant maximum score for colour was recorded in T₂: (Dry Kokum powder - 100 %) (8.24) followed by T₃: (Dry ginger powder -50 % + Dry Kokum powder - 50 %) (7.80) and minimum score was recorded in T₁: (Dry ginger powder -100 %) (4.75).

As the T₂: (Dry Kokum powder - 100 %) solely consists of kokum, the tea might have got brighter colour (Table 3).

3.5.2 FLAVOUR

Maximum score for flavour was found to be in T₇: (Dry ginger powder -90 % + Dry Kokum powder -10 %) (8.72) followed T₃: (Dry ginger powder - 50 % + Dry Kokum powder - 50 %) (8.02) and minimum was recorded in T₆: (Dry ginger powder - 80% + Dry Kokum powder -20 %) (4.09)(Table 3).

3.5.3 TASTE

Significant maximum score for taste was recorded T₇: (Dry ginger powder -90 % + Dry Kokum powder -10 %) (8.59) followed T₃: (Dry ginger powder -50 % + Dry Kokum powder - 50%) (8.57) and minimum value is recorded in T₂: (Dry Kokum powder -100 %) (3.52)(Table 3).

3.5.4 TEXTURE

Among all the treatments the T₇: (Dry ginger powder - 90 % + Dry Kokum powder - 10 %) (7.73) followed by T₃: (Dry ginger powder – 50 % + Dry Kokum powder -50%) (7.56) and minimum value is recorded in T₅: (Dry ginger powder -70 % + Dry Kokum Powder -30 %) (5.27)(Table 3).

3.5.5 OVERALL ACCEPTABILITY

Among all the treatments the maximum score was recorded in T₇: (Dry ginger powder -90 % + Dry Kokum powder -10 %) (8.66) followed by T₃: (Dry ginger powder - 50 % + Dry Kokum powder -50 %) (8.17) and minimum score was seen in T₂: (Dry Kokum powder -100 %) (5.76)(Table 3).

Comment [L2]: The overall acceptability of T₂ is lowest but how came its acceptability index is higher than other treatments

3.6 ACCEPTABILITY INDEX (%)

Among all the treatments the maximum value was reported in T₇: (Dry ginger powder - 90 % + Dry Kokum powder -10 %) (89.89) followed by T₃: (Dry ginger powder - 50 % + Dry Kokum powder -50 %) (89.14) and minimum value is shown in T₁: (Dry ginger powder - 100 %) (60.75)(Table 4).

Experiment-II: "Evaluation of ginger-kokum based herbal tea for quality and bioactive composition"

Based on the physico-chemical parameters, bio-chemical parameters and organoleptic evaluation, two best ginger-kokum mix formulations were selected for proceeding to experiment II. Observations were recorded on pH, Titrable acidity, Ascorbic acid content, total Phenols and organoleptic evaluation (9-point Hedonic scale).

3.7 pH

pH, titrable acidity and ascorbic acid content found to decrease in all the treatments during the storage period of sixty days on the 60th day of storage, pH was observed highest in T₃: (First best - 90 % + Cardamom -10 %) (4.49) and minimum was observed in T₂: (Second best - 100 % -(control) (2.83).

The pH values of herbal tea prepared from ginger and kokum decreased significantly as storage time increase. Fig. 1 and Fig.2 will help in understanding the range of pH, titrable acidity. The decrease in pH values with storage duration might be attributed to phenolic chemicals being transformed into monomeric phenolic acid, resulting in increased ionization in an acidic environment and a lowering of pH (Table 5). A similar, decreasing range of pH was also observed by Sawale et al. [10]. in Terminalia Arjuna herbal drink and Amol et al. [11]. in Hibiscus and Rose tea.

3.8 Titrable acidity and Ascorbic acid content:

Among all the treatments at 60th day of storage T₂: (Second best -100 %-(control) recorded maximum titrable acidity and ascorbic acid (4.02%,1.30mg/100g respectively) while minimum titrable acidity was observed in T₅: (First best - 90 % + Turmeric -10 % (1.75 %) and minimum ascorbic acid content was obtained in T₄: (First best -90 % + Tulasi -10 %) (0.30 mg /100g).

There was a considerable rise in titrable acidity values of ginger and kokum-based herbal tea with storage time. The reduction in pH and rise in acidity during storage might be the formation of acid by degradation of polysaccharides and oxidation of reducing sugars or by breakdown of pectic substances. Similar increasing trends were found in guava-lime-ginger RTS beverages during storage of 12 weeks by Hariharan et al. [12].

Ascorbic acid content decreases during the storage period of 0,30, 60 days. Fig.3 shows the decreasing trend of ascorbic acid. The decreasing trend of ascorbic acid was found mostly due to its oxidation and a substrate in non-enzymatic browning during the storage

period (Table 6). Similar readings are reported by Tayade et al. [13], in dehydrated kasuri methi (*Trigonella corniculata* L.).

3.9 Total phenolic content:

Total phenolic content showed decreasing trend during storage. Fig. 4 will help in studying range of phenols. Out of all treatments, T₄: (First best -90 % + Tulasi -10 %) recorded highest total phenols (87.30 mg GAE/g) and lowest was observed in T₇: (Second best 90 % + Tulasi -10 %) (67.12 mg GAE/g) on 60th day of storage.

The storage loss of phenolic compounds is mainly because of oxidative degradation due to external environmental conditions during the storage period. Similar results were obtained by Mandez and Flaque [14].

Policegoudra et al. [15], also reported a similar trend of decreasing phenolic compounds in mango ginger (*Curcuma amada*).

Out of all the treatments on 60th day, organoleptic score for colour was reported highest score in T₈: (Second best 90 % + Turmeric -10 %) (8.17) and minimum score was recorded in T₃: (First best -90 % + Cardamom -10 %) (6.10) on 60th day of storage (Table 7).

3.10 ORGANOLEPTIC EVALUATION (9-point hedonic scale)

The maximum organoleptic score for flavour is recorded in T₁: (First best -100 % -(control) (8.35) and minimum score was recorded in T₅: (First best -90 % + Turmeric -10 %) (6.67) on 60th day of storage. The maximum organoleptic score for taste and consistency was recorded in T₄: (First best -90 % + Tulasi -10 %) (8.80, 8.27 respectively). and minimum score is recorded in T₅: (First best -90 % + Turmeric -10 %) (6.42, 6.83 respectively). on 60th day of storage (Table 8).

On the 60th day of the storage period among all the treatments, the maximum organoleptic score for overall acceptability and acceptability index was recorded in T₄: (First best -90 % + Tulasi -10 %) (8.47, 91.04% respectively) and minimum value is reported in T₃: (First best -90 % + Cardamom -10 %) (6.37, 74.63% respectively) (Table 9).

Experiment-1

Table 1. pH, titratable acidity, ascorbic acid content of ginger - kokum mix formulation.

Treatments	pH	Titratable acidity %	Ascorbic acid content mg/100g
T ₁ Dry ginger powder -100%	5.72	0.60	1.37
T ₂ Dry Kokum powder -100%	2.11	10.84	9.55
T ₃ Dry ginger powder -50% + Dry Kokum powder -50%	2.92	5.70	8.23
T ₄ Dry ginger powder -60% + Dry Kokum powder -40%	3.19	4.45	5.27
T ₅ Dry ginger powder -70% + Dry Kokum Powder -30%	3.47	3.17	5.72
T ₆ Dry ginger powder -80% + Dry Kokum powder -20%	3.10	1.23	4.92
T ₇ Dry ginger powder -90% + Dry Kokum powder -10%	4.04	1.02	1.08
S.E(m)	0.08	0.07	0.18
CD at 5%	0.26	0.22	0.56

Treatments	Phenols (mg GAE/g)
T ₁ Dry ginger powder -100%	72.47

Table 2. Total phenols of ginger - kokum mix formulation.

T ₂ Dry Kokum powder -100%	89.18
T ₃ Dry ginger powder -50% + Dry Kokum powder -50%	68.84
T ₄ Dry ginger powder -60% + Dry Kokum powder -40%	119.25
T ₅ Dry ginger powder -70% + Dry Kokum Powder -30%	127.73
T ₆ Dry ginger powder -80% + Dry Kokum powder -20%	83.13
T ₇ Dry ginger powder -90% + Dry Kokum powder -10%	74.58
S.E(m)	0.98
CD at 5%	2.98

UNDER PEER REVIEW

Table3. Organoleptic sensory evaluation (9-point Hedonic Scale) of ginger - kokum mix formulation.

Treatments	Colour	Flavour	Taste	Consistency	Overall acceptability
T ₁ Dry ginger powder -100%	6.62	6.89	6.71	7.11	6.28
T ₂ Dry Kokum powder -100%	8.24	6.40	3.52	6.95	5.76
T ₃ Dry ginger powder -50% + Dry Kokum powder -50%	8.15	8.02	8.57	7.56	8.17
T ₄ Dry ginger powder -60% + Dry Kokum powder - 40%	7.16	5.56	5.26	5.48	6.42
T ₅ Dry ginger powder -70% + Dry Kokum Powder -30%	4.75	5.31	6.81	5.27	6.38
T ₆ Dry ginger powder -80% + Dry Kokum powder -20%	6.12	4.09	4.75	6.34	6.39
T ₇ Dry ginger powder -90% + Dry Kokum powder -10%	6.75	8.72	8.59	7.73	8.66
S.E(m)	0.13	0.06	0.11	0.11	0.12
CD at 5%	0.41	0.20	0.36	0.33	0.38

Table 4. Acceptability index (%) of ginger - kokum mix formulation.

Treatments	Acceptability index (%)
T ₁ Dry ginger powder -100%	60.75
T ₂ Dry Kokum powder -100%	68.61
T ₃ Dry ginger powder -50% + Dry Kokum powder -50%	89.14
T ₄ Dry ginger powder -60% + Dry Kokum powder - 40%	66.40
T ₅ Dry ginger powder -70% + Dry Kokum Powder -30%	63.38
T ₆ Dry ginger powder -80% + Dry Kokum powder -20%	61.56
T ₇ Dry ginger powder -90% + Dry Kokum powder -10%	89.89

Experiment-2

Table 5. pH and titratable acidity of ginger and kokum based herbal tea.

Treatments	pH			Titratable acidity (%)		
	0 th day	30 th day	60 th day	0 th day	30 th day	60 th day
T ₁ First best -100% -(control)	4.04	3.96	3.94	1.65	1.63	1.69
T ₂ Second best - 100% -(control)	2.92	2.92	2.83	3.85	3.92	4.02
T ₃ First best -90% + Cardamom - 10%	4.54	4.51	4.49	1.61	1.71	1.78
T ₄ First best -90 % + Tulasi - 10%	4.27	4.23	4.10	1.68	1.73	1.90
T ₅ First best -90% + Turmeric - 10%	4.13	3.13	3.12	1.71	1.75	1.75
T ₆ Second best 90% + Cardamom -10%	3.21	3.20	3.08	3.70	3.73	3.77
T ₇ Second best 90%+ Tulasi - 10%	3.24	3.18	3.16	3.26	3.26	3.59
T ₈ Second best 90 % + Turmeric -10%	3.20	3.14	3.13	3.13	3.13	3.15
S.E(m)	0.11	0.08	0.08	0.07	0.07	0.07
CD at 5%	0.34	0.24	0.24	0.21	0.21	0.21

Table 6. Ascorbic acid content and moisture content of ginger and kokum based herbal tea.

Treatments	Ascorbic acid content (mg/100 g)		
	0 th day	30 th day	60 th day
T ₁ First best -100% -(control)	0.58	0.53	0.52
T ₂ Second best - 100% -(control)	1.32	1.31	1.30
T ₃ First best -90% + Cardamom - 10%	0.41	0.41	0.40
T ₄ First best -90 % + Tulasi - 10%	0.31	0.30	0.30
T ₅ First best -90% + Turmeric -10%	0.36	0.36	0.35
T ₆ Second best 90% + Cardamom -10%	0.34	0.33	0.31
T ₇ Second best 90%+ Tulasi -10%	0.41	0.40	0.40
T ₈ Second best 90 % + Turmeric -10%	0.41	0.41	0.40
S.E(m)	0.01	0.01	0.01
CD at 5%	0.04	0.03	0.04

Table 7.Total phenols of ginger and kokum based herbal tea.

Treatments	Total phenols (mg GAE/g)		
	0 th day	30 th day	60 th day
T ₁ First best -100% -(control)	74.58	74.38	74.11
T ₂ Second best - 100% -(control)	68.84	68.60	68.41
T ₃ First best -90% + Cardamom - 10%	73.30	73.17	73.05
T ₄ First best -90 % + Tulasi - 10%	88.95	87.61	87.30
T ₅ First best -90% + Turmeric -10%	72.32	72.22	72.04
T ₆ Second best 90% + Cardamom -10%	68.11	68.07	67.87
T ₇ Second best 90%+ Tulasi -10%	67.61	67.43	67.12
T ₈ Second best 90 % + Turmeric -10%	67.89	67.41	67.37
S.E(m)	0.43	0.27	0.30
CD at 5%	1.30	0.83	0.91

Table 8. Organoleptic sensory evaluation (9-point Hedonic scale) of ginger and kokum based herbal tea.

Treatments	Colour			Flavour			Taste			Consistency			Overall acceptability		
	0 th day	30 th day	60 th day	0 th day	30 th day	60 th day	0 th day	30 th day	60 th day	0 th day	30 th day	60 th day	0 th day	30 th day	60 th day
T ₁ First best -100% -(control)	6.75	6.47	6.33	8.72	8.47	8.35	8.59	8.42	8.23	7.73	7.45	7.32	8.66	8.35	8.27
T ₂ Second best - 100% -(control)	8.15	8.12	8.11	8.02	7.88	7.75	8.57	8.42	8.31	7.56	7.51	7.42	8.17	8.17	8.10
T ₃ First best -90% + Cardamom - 10%	6.90	6.63	6.10	8.67	7.47	7.40	6.53	6.43	6.42	7.73	7.43	7.30	7.27	6.87	6.37
T ₄ First best -90 % + Tulasi - 10%	7.96	7.23	7.20	8.73	8.53	8.23	8.90	8.93	8.80	8.53	8.40	8.27	8.90	8.87	8.47
T ₅ First best -90% + Turmeric -10%	7.90	7.85	7.83	6.67	6.43	6.20	6.50	6.57	6.47	7.20	7.17	7.13	7.37	7.27	7.07
T ₆ Second best 90% + Cardamom -10%	8.06	8.04	8.01	8.27	8.13	7.90	7.43	7.33	6.97	7.23	7.23	7.23	6.96	6.87	6.40
T ₇ Second best 90%+ Tulasi -10%	8.04	8.01	8.00	7.47	7.20	7.13	7.69	7.08	6.57	7.10	6.97	6.83	7.20	7.17	7.07
T ₈ Second best 90 % + Turmeric -10%	8.23	8.20	8.17	7.63	7.38	7.30	8.63	8.63	8.63	8.13	8.13	8.03	8.77	8.47	8.33
S.E(m)	0.10	0.15	0.08	0.11	0.07	0.12	0.15	0.17	0.14	0.13	0.11	0.13	0.08	0.08	0.09
CD at 5%	0.30	0.46	0.25	0.35	0.23	0.36	0.47	0.53	0.42	0.39	0.35	0.39	0.24	0.26	0.37

Table 9. Acceptability index (%) of ginger and kokum based herbal tea.

Treatments	Acceptability index (%)		
	0 th day	30 th day	60 th day
T ₁ First best -100% -(control)	89.90	87.02	85.56
T ₂ Second best - 100% -(control)	89.14	87.88	86.55
T ₃ First best -90% + Cardamom - 10%	82.44	77.41	74.63
T ₄ First best -90 % + Tulasi - 10%	96.30	93.26	91.04
T ₅ First best -90% + Turmeric -10%	78.22	76.59	75.11
T ₆ Second best 90% + Cardamom - 10%	85.18	83.70	81.34
T ₇ Second best 90%+ Tulasi -10%	84.27	80.54	78.30
T ₈ Second best 90 % + Turmeric -10%	91.99	90.78	89.63

Conclusion:

1. On the present research work it can be concluded that T₄-(First best -90 % + Tulasi - 10%) and T₈ (Second best 90 % + Turmeric -10%) developed herbal teas showed highest phenolics and best sensorial attributes .
2. Furthermore, the treatments also performed well in physico-chemical analysis.
3. Storability of the herbal teas was well within the acceptable limit up to 2 months storage at an ambient temperature.

Future works

1. further studies are required with respect to packaging studies and commercialization of the product.
2. Standardization of new tea compositions by adding other ingredients to ginger-kokum based herbal tea.

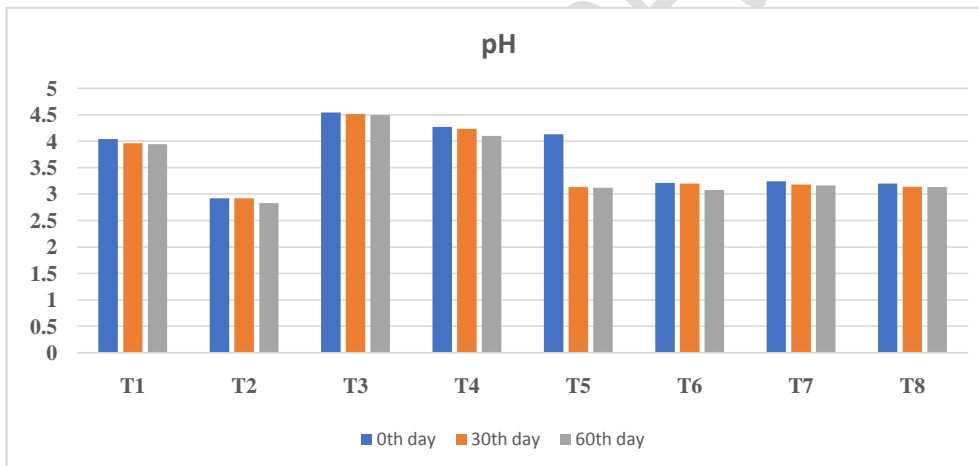


Fig. 1. pH of ginger and kokum based herbal tea

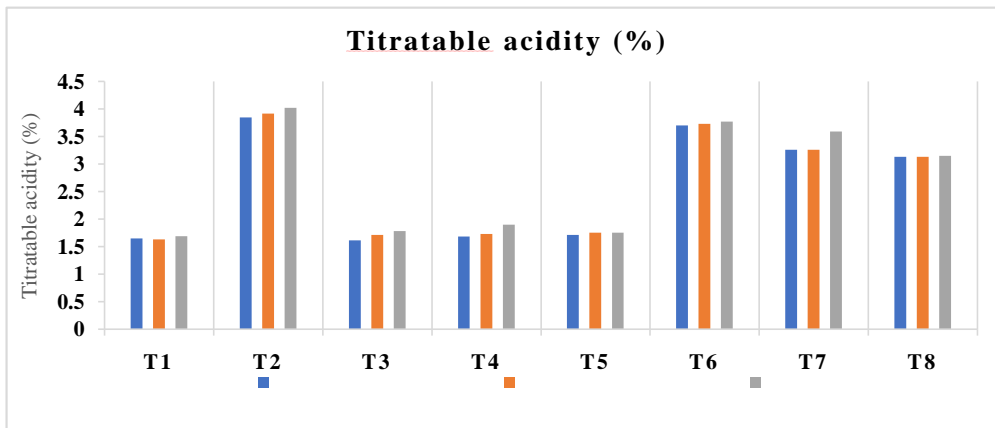


Fig. 2. Titratable acidity of ginger and kokum based herbal tea.

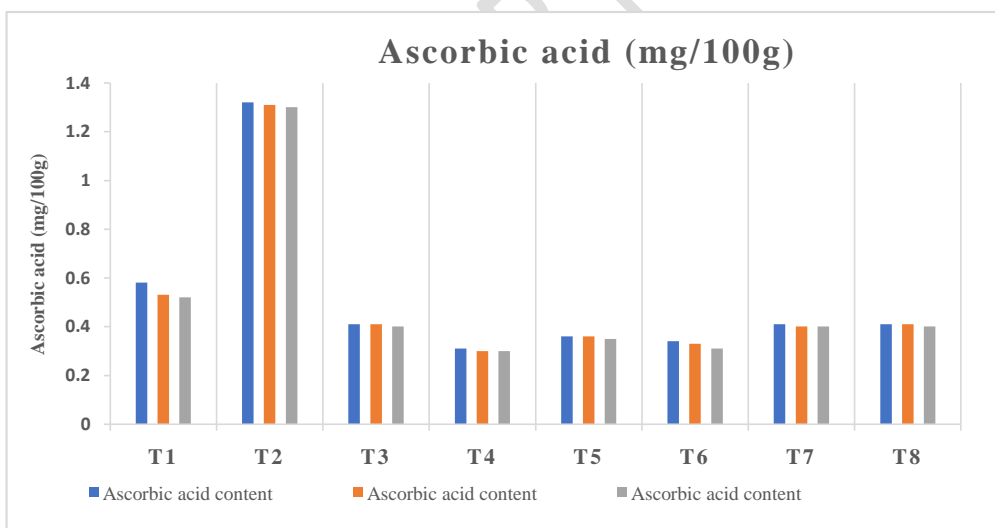


Fig. 3. Ascorbic acid of ginger and kokum based herbal tea.

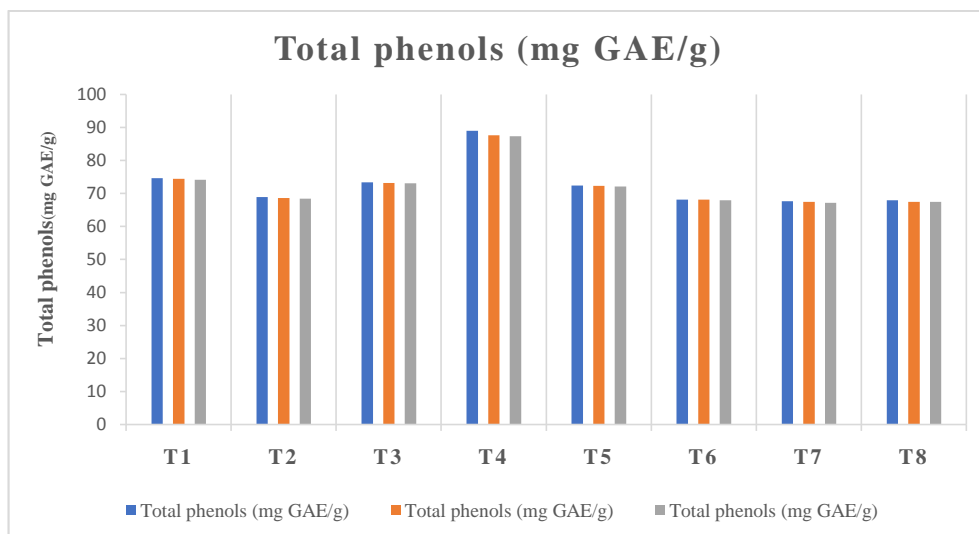


Fig. 4. Total phenols of ginger and kokum based herbal tea.

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