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Effect of Incorporation of Fresh turmeric rhizome on quality and sensory characteristics of kinnow based RTS Beverage

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ABSTRACT

Post-harvest processing is an integral part of turmeric harvesting and lack of such facilities results in huge post-harvest losses. It involves high labour requirement, more processing cost and energy. Hence, there is need for development of technology to utilize the fresh turmeric rhizome which benefits to the farmer as it reduces the processing cost. A practical and economical way to use these fruits and vegetables is to blend two or more fruit and vegetable juices to create nutritious ready-to-serve (RTS) beverages. In addition to improving the product's flavour and taste, blending also increases its medicinal and health advantages. Therefore, the present investigation was undertaken with the objective to develop ready to serve beverage from fresh turmeric rhizome and kinnow blends and to analyze quality and sensory parameters of the developed beverage. Freshly harvested turmeric rhizomes were washed and cleaned by removing all the dirt and impurities. Then peeling was carried out for obtaining turmeric juice. After removing the peel, the rhizomes were cut into small pieces for the extraction of juice through juice extractor. The obtained juice then filtered through muslin cloth to obtain juice. The extracted juice was then utilized for formulation of Ready to Serve beverage at the concentration of 0, 5, 10, 15 and 20, 25 and 30% along with kinnow juice as per FSSAI specifications. Prepared RTS was packaged in glass bottles, stored under ambient conditions and analyzed for various quality parameters at a regular interval of 30 days. The results revealed that with the incorporation of turmeric juice mean TSS, titratable acidity, total sugar and ascorbic acid content decreased from 10.56 to 10.16oB, 0.426 to 0.318%, 6.45 to 5.31% and 26.20 to 19.82 mg/100ml, respectively. In general, during storage period of 90 days the TSS, titratable acidity and total sugars showed an increasing trend whereas, ascorbic acid showed a decreasing trend. Based on the sensory evaluation it was observed that fresh turmeric rhizome can be blended with kinnow juice in the ratio of 20:80 for formulation of best quality RTS beverage with minimal changes in quality parameters. The prepared fresh turmeric rhizome blended RTS beverage can be stored upto 90 days.

Keywords: *Kinnow, Fresh turmeric rhizome, Quality, RTS, Sensory, Titratable acidity, Ascorbic acid*

Introduction

Turmeric belongs to the Zingiberaceae family of perennial rhizomatous herbaceous plants and originates from tropical South Asia. There are 133 species of Curcuma in the world. It is known by the names Indian saffron and Haldi. India is the country that produces, consumes, and exports the most turmeric globally. In Ayurvedic medicine, it is a well-established treatment for a variety of respiratory conditions, such as allergies, bronchial hyperactivity, and asthma; liver illnesses, anorexia, rheumatism, diabetic wounds, runny nose, cough, and sinusitis (1).

Curcumin, a nutraceutical component of turmeric, is well-known around the world for its medicinal advantages and functional qualities. Curcumin possesses antifungal, antiviral, anti-inflammatory, and antioxidant properties. Curcumin is not harmful to people, according to studies. (2). Curcumin has long been used as a good food coloring and as a medicinal ingredient in a number of medications for conditions ranging from jaundice to other liver disorders, ulcers, parasitic infections, skin diseases, sprains, joint inflammation, colds, and flu. It has antiviral, anticancer, antitumor, hepatoprotective, antibacterial, blood-purifying, stomachic, and anti-inflammatory properties (3). Additionally, curcumin has the amazing ability to modulate the immune system, prevent or treat Alzheimer's disease, and repair abnormalities caused by cystic fibrosis (4).

Kinnow Mandarin (*Citrus reticulata*) is one of the most popular citrus fruit having appealing taste , attractive bright colour and flavour. Growing this crop has brought farmers a profitable price. Its appealing color, unique flavor, and abundance of calcium, phosphorus, βcarotene, vitamin C, and vitamin B make it useful for industrial and therapeutic purposes as well. Following extraction, the chemical complex limonite-a-ring lactone, which is non-bitter, changes into the bitter molecule limonin, which causes kinnow mandarin juice to turn bitter. Thus, it is believed that combining two or more fruit juices with spice extract to create nutritious ready-to-serve (RTS) drinks is a practical and cost-effective way to use kinnow juice (5). Using kinnow fruit in value-added goods like juice, nectar, squash, and RTS drinks has a lot of potential. These citrus-based beverages are arguably the most well-known and widely consumed fruit drinks worldwide (6).

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New value-added beverage varieties that are combined with kinnow and aonla may boost the nation's socioeconomic standing while also improving flavor and taste. Although aonla and kinnow fruits are not frequently used on tables, they are both incredibly nutritious. Under these circumstances, value-added products are the only remaining alternative to garner significant attention, indicating a growing understanding of these items' potential in the marketplace (7). Fruit farmers and the beverage sector would greatly profit from the invention of any process for its economical use. These could be especially helpful in areas with low employment, food shortages, and poor nutrition that results in nutrient deficiencies. Product creation with kinnow and aonla that adds nutritional value may contribute to consumers' improved health.

Material and Methods

Preparation of fresh turmeric pulp

The fresh rhizomes of turmeric were thoroughly cleaned and rinsed to get rid of all the debris. After that, peeling was done, followed by cutting the rhizomes into pieces and ground in a mixer or grinder.

Extraction of kinnow juice

Kinnow fruits were washed thoroughly for the elimination of undesirable contaminants, such as dust and soil particles. Then they were cut into 2 pieces and juice was extracted using a manual juicer.

Preparation of turmeric-lime blended RTS

The turmeric and kinnow blended RTS beverage was prepared with varying the proportion of turmeric pulp and kinnow juice at various level viz., T_1 (100:00:: Kinnow juice: Turmeric juice), T_2 (95:05:: Kinnow juice: Turmeric juice), T_3 (90:10:: Kinnow juice: Turmeric juice), T_4 (85:15:: Kinnow juice: Turmeric juice), T_5 (80:20:: Kinnow juice: Turmeric juice), T_6 (75:25:: Kinnow juice: Turmeric juice) and T_7 (70:30:: Kinnow juice: Turmeric juice) to form highly nutritious and delightful RTS. Total soluble solids and acidity of the nectar were adjusted to 10°Brix and 0.3 per cent by using sugar and lemon/citric acid, followed by heating at 85°C for10 minutes. Afterwards, the nectar was filled into pre-sterilized glass bottles of 250 ml capacity, keeping 1.5-2.0 cm head space and crown corked. The bottles were pasteurized for 15 min. at 85ºC cooled labelled and stored under ambient conditions. The RTS was analysed for various traits at 0, 30, 60 and 90 days.

Methods of analysis

Total soluble solids (TSS) were determined by using hand refractometer (0-32°B), and the results were expressed as degree brix (°B). Titratable acidity was estimated by titrating a known quantity of sample (10 ml) against standard solution of 0.1 N sodium hydroxide to a light pink colour using few drops of phenolphthalein as an indicator (8). The vitamin 'C' (ascorbic acid) content of the juice was estimated by visual titration method with 2, 6-dichlorophenolindonenol dye solution (8). Sugars were determined as per methods described by Ranganna (9). Microbiological study was carried out by a series of dilution and spread plate method (9). In order to find out the consumer preference of juice blends the overall acceptability of RTS was done by a panel of ten semi-trained judges using 9 point hedonic scale (10). The cost of production of the product was determined by taking into consideration, the cost or raw materials, packaging materials etc. used in the preparation of product. All estimations were carried out in triplicate, determinations were made for each attribute and data pertaining to the quality, sensory and microbial population were statistically analyzed by using completely randomized design.

Results and Discussion

The fresh kinnow and turmeric have TSS 12.00±1.55 and 6.93±0.58°B, 1.32±0.15 and 0.20±0.01 per cent of titratable acidity, 3.54±0.78 and 2.88±0.21 per cent of reducing sugar, 5.78±0.89 and 4.50±0.49 per cent of total sugar and 28.08±1.56 and 22.47±1.04 mg per 100 g of ascorbic acid, respectively. Singh *et al.* (11) reported similar results in kinnow fruit. Dhumale *et al*. (12) also observed similar results in turmeric.

The highest mean TSS of 10.56°B was found in treatment T_1 followed by treatment T_2 having TSS value of 10.49°B whereas, lowest mean TSS of 10.16°B was recorded in T_7 (Table 1). The TSS of blended RTS decreased with the addition of fresh turmeric rhizome which might be due to lower concentration of TSS in the raw material. There was significant increase in mean TSS values with storage period of 90 days from 10.00°B to 10.64°B. The increase in TSS of RTS with storage could be due to conversion of polysaccharides into soluble sugar and formation of water soluble pectin from protopectin (13). According to Singh and Gaikwad (14) hydrolysis of polysaccharide into monosaccharides and oligosaccharides might also be responsible for increase in TSS during storage.

The blending and storage have significant effect on titratable acidity of RTS beverage (Table 1). The mean titratable acidity was found maximum in T_1 as 0.246 per cent and minimum in treatment T_7 as 0.318 per cent which might be due to higher acidity in kinnow. The mean titratable acidity showed a significant increase during 90 days of storage period from 0.300 to 0.453 per cent. The increase in titratable acidity might be possibly due to rapid conversion of proteins into amino acids (15). Ahmad *et al.* (16) also reported increase in titratable acidity during storage in guava nectar which might be due to accelerated degradation of pectin substances in nectar.

The maximum mean value of reducing sugar was recorded in T_1 as 4.10 per cent and the lowest mean value of 2.98 per cent was recorded in T_7 (Table 2). With the incorporation of fresh turmeric rhizome in the RTS, reducing sugar content decreased which might be due to lower concentration of reducing sugar in fresh turmeric rhizome. With the progress in storage period, significant increase in reducing sugar content was observed from 3.14 to 3.82 per cent in blended RTS. The increase in reducing sugar might be due to inversion of sucrose into glucose and fructose under the acidic conditions (17) and also due to hydrolysis of polysaccharides and inversion of non-reducing sugar during processing and storage (15).

The total sugars (Table 2) varied significantly with blending and storage. The highest mean total sugars of 6.45 per cent was recorded in T_1 while the lowest mean total sugar was found in treatment T_7 as 5.31 per cent. The total sugar per cent decreased with the addition of fresh turmeric rhizome. The mean value of total sugars during 90 days storage, showed an increase from 5.61 to 6.14 per cent. The increase in total sugar content was attributed to the conversion of insoluble compounds and inversion of non-reducing sugars to reducing sugars by heating (18). Sharma *et al.* (19) also reported an increasing trend in total sugar of guava-jamun blended RTS and squash during storage period of three months, which might possibly be due to hydrolysis of polysaccharides like starch, pectin etc. into simple sugars.

Ascorbic acid is also known as vitamin C and is one of the important nutritive components of human diet. The maximum mean value of ascorbic acid (Fig 1) was recorded as 26.20 mg per 100 ml in treatment T_1 while the minimum mean ascorbic acid of 19.82 mg per 100 ml was recorded in treatment T_7. There was significant difference among the treatments with respect to ascorbic acid which might be due to variation in composition of raw materials added. Significant decline in ascorbic acid content during storage from 23.59 to 22.14 mg per 100 ml was observed which might be due to oxidation of ascorbic acid into dehydro-ascorbic acid by oxygen (16). The reduction could also be due to destruction of ascorbic acid during processing and subsequently during the storage period due to its oxidation (20). The ascorbic acid loss might also be because of the fact that ascorbic acid being sensitive to oxygen, light, heat and easily oxidized in presence of oxygen by both enzymatic and non-enzymatic catalyst (21).

The highest mean colour score was recorded in T_7 as 8.21 and the lowest mean score of 7.43 was recorded in T_1 (Fig 2). Increasing trend was observed in colour score when blended with fresh turmeric rhizome which could be attributed to yellow colour contributed by raw materials. The colour scores decreased with the progression of storage period from 8.02 to 7.52 which might be due to degradation of colour pigment and browning caused by copolymerization of organic acids of the product (22). The decrease in colour score during storage might also be due to the action of acidity which enhances the hydrolytic reaction causing browning and acid also enhances the caramelization and maillard reaction in product (23).

The mean value of taste score was recorded maximum in T_4 with value of 7.96 and the minimum mean value of 7.11 was recorded in T_7 (Fig 2). The incorporation of turmeric improved the taste of RTS upto a certain limit (15%) but its higher concentration degraded the taste. Significant decrease in taste score was observed which varied from 8.00 to 7.04 during storage period of 90 days. The decrease in taste scores might be due to loss of sugar-acid balance responsible for taste during storage (22). The decline in taste scores could also be due to development of acidity and caramelization (23).

Among blends, T_4 showed maximum mean aroma score of 8.17 and the minimum mean value of 7.35 was recorded in T_7 (Fig 2). Addition of turmeric enhanced the taste score significantly upto 15 per cent and thereafter decreased the aroma score. During storage period of 90 days, the mean score for aroma declined from 7.99 to 7.53 which might be due to certain enzymatic, physiological or biological changes. The reduction in aroma scores with advancement of storage period might also be due to the decline in volatile aromatic compounds (24).

The mean consistency score was recorded highest as 7.96 in treatment T_4 whereas, treatment T_7) recorded the lowest mean consistency score of 7.11 (Fig 2). An increase in consistency score was observed when fresh turmeric was added but higher concentration decreased the consistency of nectar. The consistency scores decreased significantly from 8.00 to 7.04, during 90 days of storage in blended RTS. The decrease in consistency scores might be due to the interaction between phenols and protein as well as the formation of cation complexes with pectin and phenols (22).

The cost of production of kinnow-fresh turmeric blended RTS of T_4(85:15:: Kinnow juice: Turmeric juice) is based upon cost of all the ingredients used and some other factors (Table 3). The cost was calculated on the basis of current market prices of all the ingredients in the market. The cost of production per 250 ml bottle came out to be Rs. 30.46. Since the cost of production has been calculated on laboratory scale basis, some reduction in the cost of production on large scale can be expected.

Conclusion

It can be concluded that good quality kinnow- fresh turmeric RTS could be prepared by blending 85 per cent kinnow juice with 15 per cent fresh turmeric juice. The prepared RTS was found to be the organoleptically acceptable and can be stored upto 90 days without many changes in quality parameters. Therefore, it is concluded that the processing technique developed for the production of turmeric RTS is technologically feasible, which will benefit consumers with regard to the novel product having nutraceutical and therapeutic potential as well as provide growers with greater economic returns.

Future scope of the study: Fresh turmeric is a good source of nutrients and can serve as a functional ingredient for development of different value added products. A further study on the packaging material that retains the best sensory and nutritional content of developed products is needed.

Conflict of interest: The authors declare no conflict of interest

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Table 1: Quality characteristics of Kinnow and Turmeric Juice

Parameter	Kinnow Juice	Turmeric Juice
TSS (ºBx)	12.00±1.55	6.93±0.58
Titratable Acidity (%)	1.32±0.15	0.20±0.01
Reducing sugars (%)	3.54±0.78	2.88±0.21
Total sugars (%)	5.78±0.89	4.50±0.49
Ascorbic acid (mg/100ml)	28.08±1.56	22.47±1.04

Table 2. Effect of blending and storage on TSS (°Brix) and titratable acidity (% as citric acid) of Kinnow- Turmeric RTS

Blends	TSS (°Brix)				Mean (Blends)	Titratable acidity (% as citric acid)				Mean (Blends)
	Storage period (Days)					Storage period (Days)				
	0	30	60	90		0	30	60	90	
T_1	10.00	10.51	10.79	10.96	10.56	0.300	0.385	0.443	0.579	0.426
T_2	10.00	10.44	10.63	10.89	10.49	0.300	0.368	0.429	0.520	0.404
T_3	10.00	10.39	10.55	10.73	10.41	0.300	0.355	0.401	0.512	0.392
T_4	10.00	10.32	10.44	10.60	10.34	0.300	0.342	0.376	0.489	0.376
T_5	10.00	10.26	10.34	10.52	10.28	0.300	0.329	0.355	0.380	0.341
T_6	10.00	10.17	10.28	10.41	10.21	0.300	0.316	0.333	0.351	0.325
T_7	10.00	10.08	10.22	10.37	10.16	0.300	0.304	0.326	0.344	0.318
Mean (Storage)	10.00	10.31	10.46	10.64		0.300	0.342	0.380	0.453	
Effects C.D. ($p \leq 0.05$) TSS Titratable acidity Blends 0.02 0.028 Storage 0.02 0.020 Blends × Storage 0.04 0.056										

Table 3. Effect of blending and storage on Reducing sugar (%) and Total sugar (%) of Kinnow- Turmeric RTS

Blends	Reducing sugar (%)				Mean (Blends)	Total sugar (%)				Mean (Blends)
	Storage period (Days)					Storage period (Days)				
	0	30	60	90		0	30	60	90	
T_1	3.78	3.98	4.23	4.42	4.10	6.19	6.36	6.55	6.71	6.45
T_2	3.54	3.69	3.91	4.14	3.82	6.01	6.17	6.32	6.48	6.24
T_3	3.28	3.50	3.72	3.96	3.61	5.82	5.96	6.14	6.30	6.06
T_4	3.11	3.37	3.58	3.80	3.46	5.60	5.79	5.94	6.11	5.86
T_5	2.96	3.19	3.41	3.67	3.30	5.41	5.57	5.75	5.99	5.68
T_6	2.75	3.03	3.20	3.49	3.11	5.23	5.38	5.54	5.78	5.48
T_7	2.62	2.88	3.11	3.32	2.98	5.04	5.20	5.42	5.61	5.31
Mean (Storage)	3.14	3.37	3.59	3.82		5.61	5.77	5.95	6.14	
Effects C.D. $(p \leq 0.05)$ Reducing sugar Total sugar Blends 0.02 0.02 Storage 0.03 0.01 Blends × Storage 0.05 0.02										

Table 4. Cost of production of kinnow-turmeric blended RTS

Ingredients	Rate @ (₹)	T_4(85:15:: Kinnow juice: Turmeric juice) Quantity (g)	Amount (₹)
Kinnow	50/kg	1 kg	50
Turmeric	100/kg	90 g	9.0
Sugar	40/kg	144 g	5.6
Glass bottles (250 ml)	4/ bottle	4	12
Labels	0.15/label	4	0.60
Crown Corks	0.25/cork	4	1.00
Total cost of ingredients			78.20
Overhead charges (fuel and electricity)	@ 15%		11.73
Total input cost			89.93
Machinery depreciation @ 10% on the total machinery cost of 20,000 for 300 working days in a year	@ 10%		2000
Machinery depreciation for two days			6.66
Profit @15 of total variable cost and fixed cost	@ 15%		14.48
GST @ 12 of total variable cost, fixed cost and profit	@ 12%		10.79
Grand total for 100ml product			121.86
Cost per bottle of 250 ml (₹)			30.46

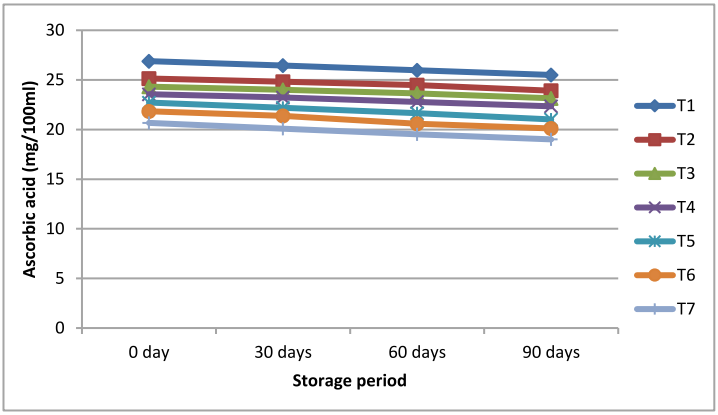
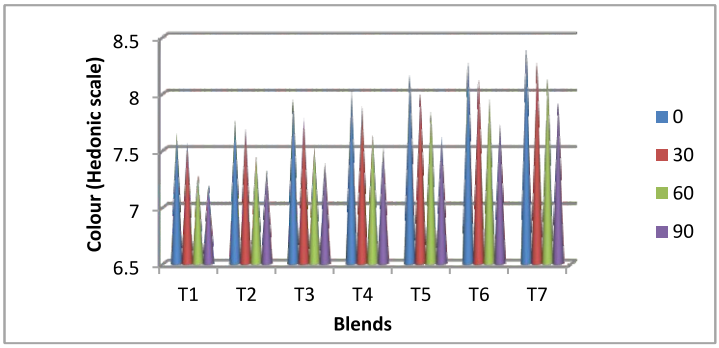


Figure 1: Ascorbic acid content of kinnow-turmeric blended RTS at different storage intervals



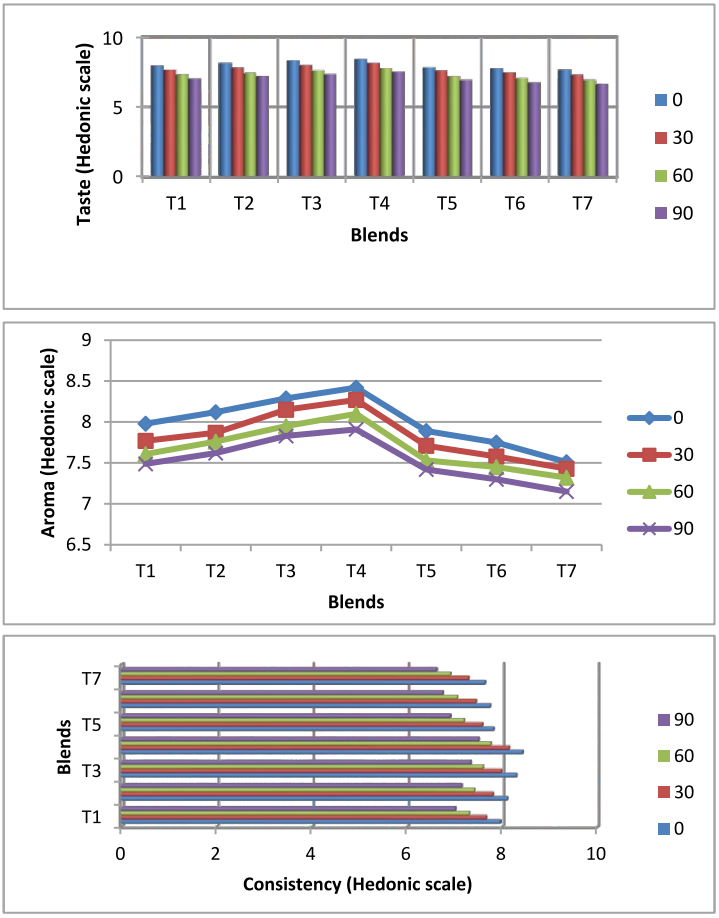


Figure 2: Sensory characteristics of kinnow-turmeric blended RTS beverage

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