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**Rakesh Gehlot**  
 Professor, Centre of Food  
 Science and Technology,  
 CCS Haryana Agricultural  
 University, Hisar, Haryana,  
 India

**Rekha**  
 Assistant Professor, Centre of  
 Food Science and Technology,  
 CCS Haryana Agricultural  
 University, Hisar, Haryana,  
 India

**Monika**  
 Ph.D., Centre of Food Science  
 and Technology,  
 CCS Haryana Agricultural  
 University, Hisar, Haryana,  
 India

**Sandeep Kumar**  
 Research Scholar, Centre of  
 Food Science and Technology,  
 CCS Haryana Agricultural  
 University, Hisar, Haryana,  
 India

**Pranjali**  
 Research Scholar, Centre of  
 Food Science and Technology,  
 CCS Haryana Agricultural  
 University, Hisar, Haryana,  
 India

**Corresponding Author:**  
**Sandeep Kumar**  
 Research Scholar, Centre of  
 Food Science and Technology,  
 CCS Haryana Agricultural  
 University, Hisar, Haryana,  
 India

## Development and evaluation of nutritious and functional beverage from bottle gourd, mint leaves, lime and chia seeds

Rakesh Gehlot, Rekha, Monika, Sandeep Kumar and Pranjali

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### Abstract

The nutritious and functional beverage was developed and evaluated for changes in its physico-chemical, microbiological and sensory parameters at monthly interval for three months storage period. Data reveal that yields of pulp in bottle gourd fruit was 77.36% while mint twigs and lime had 73.80% and 38.70% paste/juice yield respectively. Bottle gourd fruits, mint leaves and lime fruits had TSS (5.8, 3.0 and 7.5%), ascorbic acid content (144.40, 180.20 and 38.40 mg/100 g), total chlorophyll (144.40, 180.20, 38.40 mg/100 g), total phenols (85.33, 410.24 and 62.67 mg/100 g) and total antioxidant activity (69.55, 74.68 and 84.80%), respectively. Chia seeds contained proteins (16.86%), fat (31.18%) and fibre (23.62%) due to the supplementation of chia seeds. Spiced bottle gourd-mint-lime RTS drink variant supplemented with 2% chia seeds had maximum overall acceptability score (8.59). The scores for colour and appearance, flavour, taste, mouthfeel and overall acceptability in the beverage decreased significantly during storage, however, the product was found acceptable even at three months storage. Total soluble solids and acidity increased significantly while ascorbic acid, total phenols, total antioxidant activity and total chlorophyll decreased significantly during the storage period.

**Keywords:** Bottle gourd, mint, lime, chia seeds, physico-chemical, sensory parameter, storage

### 1. Introduction

Fruits and vegetables play a crucial role in our diet, supplying essential nutrients like vitamins, minerals, fiber, and sugars. Regular intake of these lowers the risk of cancer, heart disease, premature aging, stress, and fatigue mainly because they contain antioxidants such as  $\beta$ -carotene and ascorbic acid, which help combat oxidative stress.

Bottle gourd (*Lagenaria siceraria*) belongs to the Cucurbitaceae family and is known by names like Calabash, Doodhi, and Lauki in different regions of India. Initially light green, its color turns pale brown as it ripens. Shaped like a bottle, the fruit contains white pulp and is one of the most economical sources of nutrients, boasting natural antioxidants. It also provides a good amount of vitamin B complex and choline, along with a decent quantity of vitamin C (Gajera & Joshi, 2015) [8].

Mint (*Mentha viridis* L.), belonging to the Lamiaceae family, is commonly known as 'Pudina'. Its leaves have a delightful fresh, aromatic, and sweet flavor with a refreshing aftertaste, making them popular in beverages, jellies, syrups, candies, ice creams, teas, and yogurts as a flavoring agent. Mint leaves are rich in essential vitamins and minerals crucial for maintaining overall health. They are known to alleviate symptoms of indigestion, heartburn, and irritable bowel syndrome by relaxing intestinal muscles. Mint also acts as a potent antioxidant, protecting against the formation of cancerous cells, cleanses the blood effectively, and aids in clearing skin disorders such as acne (Aflatuni *et al.*, 2005) [1].

Lime (*Citrus aurantifolia*) is a significant medicinal plant belonging to the Rutaceae family. Limes are widely consumed worldwide for their tartness, distinctive aroma, and tangy juice. In Asian countries, limes are utilized in pickling, cooking, and traditional medicine. They contain alkaloids, carotenoids, essential oils, flavonoids, phenolic acids, and triterpenoids as secondary metabolites. Limes are valued for their antibacterial, anticancer, antidiabetic, antifungal, antihypertensive, anti-inflammatory, and antioxidant properties.

Furthermore, they offer protective benefits for the heart, liver, bones, and urinary system (Narang & Jiraungkoorskul, 2016) [10].

*Salvia hispanica*, commonly known as Chia, is an herbaceous plant with a vascular appearance and semi-oval seeds covered in a smooth, glossy peel that ranges in color from black and brown to gray, spotted black, or white. Chia seeds are rich in nutrients such as 30.21 g/100 g of oil content, 25.32 g/100 g of proteins, 37.5 g/100 g of dietary fiber, and 35.06 g/100 g of major insoluble fiber, making them a valuable functional food in human nutrition (da Silva *et al.*, 2017) [7].

Given the nutritional and functional significance of bottle gourd fruits, mint leaves, lime fruit, and chia seeds, an experiment was conducted to establish processing parameters for developing and evaluating value-added sweet and spicy ready-to-serve (RTS) drink variations incorporating these ingredients.

## 2. Materials and Methods

### 2.1 Procurement of raw materials

- i) Bottle gourd was procured from Department of Vegetable Science, COA, CCSHAU, Hisar.
- ii) Mint twigs, lime fruits, chia seeds, spices and other ingredients were procured from local market, Hisar.

### 2.2 Collection of bottle gourd pulp

The bottle gourd fruits were washed with clean running water thoroughly, peeled off and sliced. The peels were discarded, and fruit slices were pressure cooked with small quantity of water (1:10) for 8-10 minutes and blended in a mixer to obtain homogeneous pulp. The bottle gourd pulp was used for preparation of value added ready-to-serve (RTS) drink variants.

### 2.3 Collection of mint paste

Fresh mint twigs were washed under clean tap water thoroughly for removal of dirt particles. Mint leaves were separated from twigs and ground in mixer grinder by mixing 100 ml water to 1 kg leaves for making smooth paste and utilizing in preparation of value added ready-to-serve (RTS) drink variants.

### 2.4 Collection of lime juice

Ripe lime fruits were washed, cut in two halves and squeezed to extract the juice for preparation of value added ready-to-serve (RTS) drink variants.

### 2.5 Collection of chia seeds paste

Chia seeds were soaked in warm water (1:10) overnight, ground to fine paste and mixed @ 2% with sweet and spiced ready-to-serve (RTS) drink variants for developing a nutritious and functional beverage.

### 2.6 Preparations of sweet and spiced RTS drink variants

Bottle gourd-mint-lime blend (80:15:5) was optimized for preparation of sweet and spiced RTS drink variants. TSS and acidity were analyzed in bottle gourd-mint-lime blend and sugar syrup was prepared with a gentle boiling using requisite recipe ingredients (sugar, citric acid and water for sweet RTS drink variant; and sugar, citric acid, water, salts, spices and other ingredients for spiced RTS drink variant by adjusting 12% TSS and 0.22% acidity in RTS drink (w/w basis) as per standardized recipe. Sugar syrup was cooled,

strained through muslin cloth and mixed with bottle gourd-mint-lime blend and chia seeds paste. The beverages were homogenized properly, strained through muslin cloth, filled in pre sterilized 200 ml capacity glass bottles, leaving 2.5 cm headspace and sealed with crown corks. The sealed glass bottles were pasteurized at  $85 \pm 5$  °C for 20 minutes, cooled in air, labelled and stored at room temperature for evaluation of physico-chemical and sensory characteristics at monthly intervals for three months.

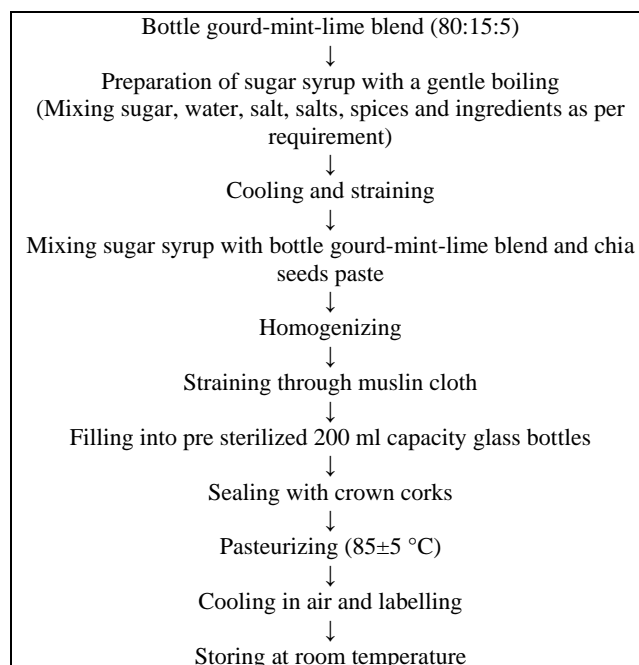


Fig 1: Flow diagram for preparation of sweet and spiced RTS drinks variants

## 3. Estimation of physico-chemical characteristics

### 3.1 Yield of bottle gourd pulp, mint paste and lime juice (%)

The yield of bottle gourd pulp was calculated by dividing weight of bottle gourd pulp with weight of fruit and multiplying by 100. Similarly, yield of mint paste and lime juice was calculated by dividing weight of mint paste and lime juice with weight of mint twigs and lime fruits, and multiplying by 100. The values were expressed in per cent.

### 3.2 Total soluble solids (%)

Total soluble solids (TSS) were estimated by hand refractometer (0-32%) at ambient temperature for bottle gourd-mint-lime blend and RTS drink variants, and the values were expressed as per cent TSS.

### 3.3 Acidity (%)

The acidity was determined as per the method given by Ranganna (2017) [13]. Acidity was calculated from the volume of alkali used and the results were expressed as grams of anhydrous citric acid present per 100 g or ml of sample.

### 3.4 Ascorbic acid (mg/100 g or ml)

Ascorbic acid was determined as per the method given by Ranganna (2017) [13].

### 3.5 Total phenols (mg/100 g or ml)

Total phenols (expressed as tannins) were estimated as per the method described by the Amorium *et al.* (1997) [3].

### 3.6 Total antioxidant activity (% DPPH scavenging activity)

Antioxidant activity was measured using 2,2-diphenyl-1-picrylhydrazyl (DPPH) dye as per the procedure described by Shimada *et al.* (1992) [15].

### 3.7 Total chlorophyll (mg/l)

Total chlorophyll was estimated as per the method of Arnon (1949) [4].

### 3.8 Protein (%)

Protein was estimated using micro-Kjeldhal method (AOAC, 2005) with KELPLUS nitrogen estimation system.

### 3.9 Fat (%)

Fat was estimated by Soxhlet extraction apparatus using method of Ranganna (2017) [13].

### 3.10 Fibre (%)

Fibre was also estimated by the method of Ranganna (2017) [13].

## 4. Sensory evaluation (9-point hedonic scale)

Sensory evaluation of RTS drink variants was done immediately after preparation and at monthly intervals for three months storage period by a panel of ten semi-trained judges, using 9-point hedonic scale as described by Ranganna (2017) [13]. The products were evaluated for colour and appearance, taste, flavour, mouthfeel and overall acceptability. The overall acceptability of RTS drink variants was based on mean scores obtained from all the sensory parameters. The samples with mean scores of 6 and above out of 9 were considered acceptable.

## 5. Results

### a) Physico-chemical characteristics of bottle gourd fruit, mint leaves, lime juice and chia seeds

Bottle gourd fruits, mint leaves, lime fruits and chia seeds were analyzed for various physico-chemical characteristics. Data (Table 1) reveal that yield of pulp in bottle gourd fruit was 77.36%, while mint twigs and lime had 73.80% and 38.70% paste/juice yield. Bottle gourd fruits, mint leaves and lime fruits had TSS (5.8, 3.0 and 7.5%), ascorbic acid content (144.40, 180.20 and 38.40 mg/100 g), total chlorophyll (144.40, 180.20 and 38.40 mg/100 g), total phenols (85.33, 410.24 and 62.67 mg/100 g) and total antioxidant activity (69.55, 74.68 and 84.80%), respectively. Chia seeds contained proteins (16.86%), fat (31.18%) and fibre (23.62%).

### b) Standardization of blends and recipes ingredients for sweet and spiced bottle gourd-mint-lime RTS drink variants

Among various bottle gourd-mint-lime blends (85:10:5, 80:15:5, 75:20:5 and 70:20:10), RTS drink variant developed by using 30 per cent bottle gourd-mint-lime (80:15:5) blend, and adjusting 12 per cent TSS and 0.22 per cent acidity was found most acceptable. Common salt (0.20%), rock salt (0.20%), black salt (0.20%), black pepper powder (0.05%), chat masala (0.40%), roasted cumin powder (0.10%) and small cardamom powder (0.06%) were standardized to develop spiced bottle gourd-mint-lime RTS drink variant. Spiced bottle gourd-mint-lime RTS drink variant supplemented with 2% chia seeds had maximum overall acceptability score (8.59), followed by sweet bottle

gourd-mint-lime RTS drink variant supplemented with 2% chia seeds (8.38).

## 6. Storage studies

### 6.1 Total soluble solids (%)

There was a significant rise in the total soluble solids (TSS) content of sweet and spiced ready-to-serve (RTS) drink variants made from bottle gourd, mint, and lime (with and without 2% chia seeds) after three months of storage (Table 2). Akinola *et al.* (2018) [2] observed an increase in TSS in orange juice treated with sodium benzoate, while TSS levels remained consistent in juice treated with potassium sorbate.

### 6.2 Acidity (%)

During three months of storage, there was a notable increase in acidity observed in the sweet and spiced ready-to-serve (RTS) drink variants made from bottle gourd, mint, and lime, both with and without 2% chia seeds (Table 2). Significant variations in acidity levels were also noted among different formulations of the bottle gourd-mint-lime RTS drinks. The interaction between treatment combinations and storage duration also showed significant effects. Rathod *et al.* (2014) [14] similarly documented an increase in acidity in bael-aonla RTS drinks over a 45-day storage period.

### 6.3 Ascorbic acid (mg/100 g or ml)

The data presented in Table 2 indicate a significant reduction in ascorbic acid content from initial levels (2.06 to 1.17 and 2.21 to 1.32 mg/100 ml, and 2.35 to 1.47 and 2.49 to 1.76 mg/100 ml) in sweet and spiced bottle gourd-mint-lime RTS drink variants, both with and without 2% chia seeds, over a three-month storage period. This decline could be attributed to factors such as the extent of thermal processing, air trapped in the bottle headspace, storage temperature, and levels of atmospheric or dissolved oxygen. Buvaneshwari *et al.* (2020) [6] also noted a decrease in ascorbic acid in banana pseudostem RTS drinks stored at both ambient and refrigerated temperatures for 45 days. These findings align with those reported by Rathod (2014) [14] for bael-aonla RTS drinks.

### 6.4 Total phenols (mg/100 g or ml)

It is clear from the data (Table 2) that total phenols declined from (28.48 to 26.44 and 29.64 to 27.88 mg/100 ml) and (32.26 to 30.14 and 33.44 to 31.34 mg/100 ml) of sweet and spiced bottle gourd-mint-lime RTS drink variants prepared without and with 2% chia seeds during three months storage. Decrease in total phenols was reported by Punam *et al.* (2012) [12] in bael-mango RTS drink and squash. The decrease in the total phenolic content of beverages might be due to its involvement in the formation of polymeric compounds by complexation with protein during storage.

### 6.5 Total chlorophyll (mg/l)

Total chlorophyll declined from (33.24 to 32.78 and 31.68 to 31.14 mg/100 ml) and (28.20 to 27.64 and 25.76 to 25.04 mg/100 ml) of sweet and spiced bottle gourd-mint-lime RTS drink variants (without and with 2% chia seeds), respectively during three months storage (Table 2). Bochnak-Niedzwiecka *et al.* (2020) [5] developed vegetable based powdered beverages. The high temperature of rehydration of beverage powder (30% of carrot, 30% of

pumpkin and 10% parsley leaves) adversely affected the colour of beverages.

### 6.6 Antioxidant activity (% scavenging activity)

The data in Table 2 show that there was significant decrease in antioxidant activity (17.62 to 15.14 and 18.48 to 16.24%) and (19.28 to 17.18 and 19.72 to 17.56%) of sweet and spiced bottle gourd-mint-lime-chia RTS drink variants (without and with 2% chia seeds), respectively during three months' storage. Owolade *et al.* (2017) [11] measured antioxidant activity with DPPH free radical scavenging method and observed that 100% pineapple juice had highest antioxidant activity (81.07%), which decreased (34.6%) upon storage. Pineapple and carrot juice blend (50:50) was found most acceptable; however, the antioxidant activity reduced (54.16 to 32.02%) during 60 days storage.

### 6.7 Protein (%)

Data (Table 2) reveal significant increase in protein (0.054 to 0.345 and 0.062 to 0.347%), of sweet and spiced bottle gourd-mint-lime RTS drink variants (without and with 2% chia seeds), respectively during three months storage. The addition of chia seeds increased the levels of crude protein with 4.26% (Kowaleski *et al.*, 2020) [9].

### 6.8 Fat (%)

Fat in RTS drink variants shows increasing trend (0.046 to

0.612 and 0.056 to 0.624%) of sweet and spiced bottle gourd-mint-lime RTS drink variants by supplementing 2% chia seeds (Table 2). The addition of chia seeds increased the levels of lipids with 5.37% (Kowaleski *et al.*, 2020) [9].

### 6.9 Fibre (%)

Fibre content was found to be increased (0.122 to 0.496 and 0.280 to 0.648%) in sweet and spiced bottle gourd-mint-lime RTS drink variants by supplementing 2% chia seeds (Table 2). The addition of chia seeds increased the levels of dietary fibre with 2.58% (Kowaleski *et al.*, 2020) [9].

### 7. Sensory evaluation during storage

Sensory quality of fruit beverages is the main parameter for deciding its marketability. Significant decrease in sensory scores for colour and appearance, taste, mouthfeel, flavour and overall acceptability of bottle gourd-mint-lime RTS drink variants was noticed during three months storage.

There was decrease in all sensory attributes that affected overall acceptability of RTS drink variants during three months' storage (Table 3). Data also revealed that spiced RTS drink variants with 2% chia seeds maintained good sensory quality, having higher acceptability scores at the end of storage. Results are in accordance with the findings of. Buvaneshwari *et al.* (2020) [6] who recorded higher sensory score (7.8) for lemon flavoured banana pseudo stem beverage stored at refrigerated temperature for 45 days.

**Table 1:** Physico-chemical characteristics of bottle gourd fruits, mint leaves and lime fruits

Sr. No.	Parameters*	Bottle gourd fruits	Mint leaves	Lime fruits	Chia seeds
1.	Recovery of pulp/paste/juice (%)	77.36±1.82	73.80±1.95	38.70±1.10	-
2.	Total soluble solids (%)	5.80±0.02	3.00±0.00	7.50±0.00	-
3.	Acidity (%)	0.07±0.00	0.16±0.01	5.77±0.01	-
4.	Ascorbic acid (mg/100 g)	4.02±0.08	4.32±0.09	39.40±0.20	-
5.	Total chlorophyll (mg/100 g)	14.40±0.20	180.20±5.70	38.40±0.80	-
6.	Total phenols (mg/100 g)	85.33±1.60	410.24±8.60	62.67±1.40	-
7.	Antioxidant activity (%)	69.55±0.20	74.68±0.20	84.80±0.30	-
8.	Protein	-	-	-	16.86%
9.	Fat	-	-	-	31.18%
10.	Fibre	-	-	-	23.62%

\*The values are mean ± S.D. of three replicates

**Table 2:** Effect of storage on physico-chemical characteristics of sweet and spiced bottle gourd-mint-lime-chia seeds RTS drink variants

RTS drink* (80 Bottle gourd:15 Mint: 5 Lime)	Storage (months)	TSS	Acidity	Ascorbic acid	Total phenols	Total chlorophyll	Anti-oxidant activity	Protein	Fat	Fibre
		(%)		(mg/100 ml)			(%)			
Sweet (without 2% chia seeds)	0	12.000	0.220	2.06	28.48	33.240	17.62	0.054	0.046	0.122
	1	12.100	0.222	1.76	28.06	33.080	16.86	0.050	0.045	0.114
	2	12.200	0.225	1.47	27.56	32.960	16.02	0.047	0.044	0.102
	3	12.400	0.232	1.17	26.44	32.780	15.14	0.043	0.042	0.088
Sweet (with 2% chia seeds)	0	12.000	0.220	2.21	29.64	31.680	18.48	0.345	0.612	0.496
	1	12.200	0.221	1.93	29.12	31.480	17.88	0.342	0.610	0.484
	2	12.400	0.224	1.62	28.62	31.320	17.12	0.338	0.607	0.478
	3	12.500	0.229	1.32	27.88	31.140	16.24	0.334	0.605	0.466
Spiced (without 2% chia seeds)	0	12.000	0.220	2.35	32.26	28.200	19.28	0.062	0.056	0.280
	1	12.100	0.223	2.06	31.54	28.060	18.74	0.058	0.054	0.264
	2	12.300	0.228	1.76	30.98	27.860	18.06	0.053	0.053	0.252
	3	12.500	0.234	1.47	30.14	27.640	17.18	0.049	0.050	0.238
Spiced (with 2% chia seeds)	0	12.000	0.220	2.49	33.44	25.760	19.72	0.347	0.624	0.648
	1	12.300	0.224	2.21	32.86	25.520	19.02	0.344	0.621	0.642
	2	12.600	0.230	2.06	32.12	25.300	18.34	0.340	0.619	0.639
	3	12.800	0.238	1.76	31.34	25.040	17.56	0.337	0.616	0.636
CD at 5%	Treatment	0.03	0.002	NS	0.03	0.041	0.03	0.002	0.011	0.004
	Storage	0.03	0.002	0.67	0.03	0.041	0.03	0.002	0.011	0.004
	T×S	0.06	0.004	NS	0.05	NS	0.06	NS	NS	0.009

\*RTS drink variants prepared using 30% pulp, and adjusting 12% TSS and 0.22% acidity; NS-Non-significant

**Table 3:** Effect of storage on sensory characteristics of bottle gourd-mint-lime-chia seeds RTS drink variants

RTS drink* (80 Bottle gourd:15 Mint: 5 Lime)	Storage (months)	Colour and appearance	Taste	Flavour	Mouthfeel	Overall acceptability
		9-point hedonic scale				
Sweet (without 2% chia seeds)	0	8.10	8.05	8.15	8.10	8.10
	1	7.90	7.95	7.85	7.85	7.89
	2	7.75	7.65	7.60	7.75	7.69
	3	7.40	7.55	7.45	7.55	7.49
Sweet (with 2% chia seeds)	0	8.30	8.40	8.30	8.50	8.38
	1	8.25	8.30	8.25	8.40	8.30
	2	8.15	8.05	8.10	8.10	8.10
	3	7.95	7.80	7.90	7.95	7.90
Spiced (without 2% chia seeds)	0	8.00	8.10	8.30	8.40	8.20
	1	7.90	8.00	8.20	8.25	8.09
	2	7.75	7.80	8.00	8.05	7.90
	3	7.50	7.70	7.80	7.85	7.69
Spiced (with 2% chia seeds)	0	8.55	8.60	8.55	8.65	8.59
	1	8.25	8.45	8.35	8.50	8.39
	2	8.10	8.30	8.20	8.35	8.24
	3	7.95	8.15	8.05	8.20	8.09
CD at 5%	Treatment	0.11	0.12	0.10	0.13	0.07
	Storage	0.11	0.12	0.10	0.13	0.07
	TxS	NS	NS	NS	NS	NS

\*RTS drink variants prepared using 30% pulp, and adjusting 12% TSS and 0.22% acidity; NS-Non-significant

## 8. Conclusion

Nutritious and functional beverage can be prepared from bottle gourd fruit, mint leaves, lime fruits and chia seeds using bottle gourd pulp, mint paste and lime juice (80:15:5 ratio) and 2% chia seeds by following the standardized recipe (using 30% pulp, and adjusting 12% TSS and 0.22% acidity). For spiced RTS drink variants, spices (0.20% common salt, 0.20% rock salt, 0.20% black salt, 0.05% black pepper powder, 0.40% chat masala, 0.10% roasted cumin powder and 0.06% small cardamom powder) were optimized. Spiced bottle gourd-mint-lime RTS drink variant supplemented with 2% chia seeds had maximum overall acceptability score (8.59).

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