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Protocol for Development of Neuro-beverage by Brahmi (*Bacopa monnieri) and* Kokum (*Garcinia indica)* for Sensorial Attributes and Bio-chemical Parameters

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ABSTRACT: The rapid increase in neurodegenerative disorder incidence has necessitated the development of newer drugs. Ayurvedic herbal medications are increasingly researched due to their biosafety profile and usefulness in cognitive impairment. Brahmi (*Bacopa monnieri*) is used as tonic extensively in traditional Indian medicinal system ''Ayurveda''. The saponins are the major compounds in brahmi which are responsible for enhancing the nerve impulse transmission. Kokum (*Garcinia indica*) is an ancient fruit which is widely consumed in the form of *sharbat* in a Western ghats of India. It is a fruit tree of culinary, pharmaceutical and nutraceutical uses. Drumstick (*Moringa oleifera*) known for their abundant content of antioxidants, including polyphenols and carotenoids. These antioxidants hold promise in the prevention of various chronic degenerative conditions (CDDs). In this investigation, nutritious brahmi juice, kokum juice and drumstick juice (as a constant) were exploit at various combinations (100 : 0 : 0, 0 :100 : 0, 90 : 10 :0, 10 : 90 : 0, 80 : 10 : 10, 10 : 80 : 10, 60 : 30 : 10 and 30 : 60 : 10) for syrup and RTS preparation. Treatment T_2 (100 % kokum juice: 8.16) recorded best for colour and appearance. In syrup, the highest value (61.83 ºBrix) for TSS was observed in T_3 (90 % brahmi juice +10 % drumstick leaves juice). In case of RTS, the highest value (15.50 ºBrix) for TSS was observed in T_7 (60 % brahmi juice + 30 % drumstick leaves juice). In case of syrup, the lowest value (3.24 %) for titratable acidity was observed in T_1 (100 % brahmi juice) and in RTS, the highest mean value of titratable acidity was recorded in T_2 (100 % kokum juice: 1.53 %). In case of syrup, the treatment T_3 (90 % brahmi juice +10 % drumstick leaves juice) recorded highest (18.96) for brix to acid ratio. Similar trend was also observed in RTS. Remarkably, the maximum value for pH was recorded by treatment T_1 (100 % brahmi juice: 4.38). Same trend was observed in RTS also the maximum value was recorded by treatment T_1 (100 % brahmi juice: 5.72) for pH.

Keywords: Brahmi, kokum, drumstick leaf, neuro-beverage and RTS.

INTRODUCTION

The natural products have been used in the treatment of various chronic human pathological conditions because as they have high medicinal properties. In traditional medicine, it is believed that food and medicine share the same origin but differ in their use and application. The plant, plant extracts and isolated bacosides have been extensively investigated for their memory and cognition enhancing effects. As per the World Health Organization, traditional medicine encompasses "the entirety of knowledge, abilities and procedures grounded in the theories, convictions and life experiences of diverse cultures, utilized to preserve well-being and to avoid, identify, enhance or manage physical and mental ailments". To preserve their health and well-being, many populations in developing nations have turned back to using traditional botanicals.

India holds great promise for discovering new plant-based medications that are necessary to treat a variety of human illnesses. Research conducted by Morales *et al.* (2017) and Gahtori and Paliwal (2021) demonstrates that traditional phytotherapy has been utilizing the therapeutic qualities of many plant species for ages. It's

fairly common for individuals to sip tonic soups before dinner. They are thought to have the ability to strengthen the immune system and slow down the aging process. It is the most conventional and pure healthcare system.

Brahmi or *Bacopa monnieri*, is a perennial creeping herb that is native to the wetlands of Eastern and Southern India, Africa, Australia, Asia, Europe, and North and South America. It is a member of the Scrophulariaceae family. Also referred to as Indian penny wort, herb of grace or water hyssop. Since they are thought to be safer than their synthetic counterparts, ayurvedic and other herbal drugs are becoming more and more popular as reported by Gohil and Patel (2010). Bacosides extracted from *Bacopa monnieri* stand out as noteworthy therapeutic agents among nootropic herbs. In India, Ayurvedic medical practitioners and traditional healers have highly valued this herb, known as brahmi, for nearly 3000 years. It is renowned for its revitalizing properties, as highlighted by Chaudhari *et al.* (2017) and Pattnaik *et al*. (2023).

Kokum (*Garcinia indica*) is a time-honored fruit with a storied history of being consumed in the Western Ghats of India, often in the form of "sharbat". This adaptable fruit tree occupies a distinctive role in the realms of culinary, pharmaceutical and nutraceutical applications. The kokum fruit possesses a spectrum of attributes, encompassing antioxidant, acidulant and appetite-stimulating qualities. These features endow it with the potential to address a variety of health concerns, including but not limited to cancer, paralysis, aging, obesity and ulcers.

The drumstick leaf stands out as the plant's most potent component. Athletes often consume it as one of the most discreet performance-enhancing products, as noted by Vahini in 2018. Renowned for their rich antioxidant profile, drumstick leaves contain ample amounts of polyphenols and carotenoids. The potential of these antioxidants extends to the prevention of diverse chronic degenerative conditions (CDDs) as noticed by Rotella *et al.* (2023).

Amidst current nutritional trends emphasizing the development of health-promoting foods, referred to as functional foods, the sought-after attributes include antioxidant properties and anthocyanins in dietary elements. Furthermore, there is a renewed research interest in phytomedicines, as they are perceived to offer advantages compared to traditional pharmaceutical drugs.

Drinks are a great way to stay cool and refreshed in the summertime heat. These drinks are becoming more well-liked than synthetic drinks, which presently hold a sizable share of the national market, because of their nutritious makeup. Of the wide variety of processed foods made from fruits and vegetables, drinks are one of the most popular. In comparison to many artificial and carbonated drinks, these beverages are quickly digested, deliver substantial refreshment, effectively quench thirst, stimulate the appetite, and have greater nutritional advantages. This emphasizes their potential in the beverage business as healthier substitutes (Thirukkumar and Vennila 2019).

Therefore, combining two or more fruit juices to make Ready-To-Serve (RTS) beverages and neuro-beverages is thought to be an easy and affordable way to fully utilize the potential of these fruits. This method, which combines brahmi juice with kokum, may have neuroprotective benefits. Therefore, the purpose of the study was to make RTS and neuro-beverage by combining with drumstick leaf juice, kokum juice, and brahmi juice.

MATERIALS AND METHODS

Extraction of juices for the neuro-beverage syrup

Brahmi leaves were collected from the MHREC, UHS field and removed roots. Further, washed with tap water and shade dried to remove surface moisture. After that, leaves were grinded in a blender and filtered through fine sieve to obtain the brahmi juice. Further juice was used to prepare the different syrups as per the treatments mentioned in the Table 1.

Kokum rinds were washed under running tap water, then one part of kokum was soaked in four parts of water (1:4) for overnight, then next day boiled for 45 minutes. After that boiled rinds were blended in a blender and juice was extracted, filtered through muslin cloth and stored in clean airtight bottles until further use for the study.

Drumstick leaves were washed under running tap water to remove the dust and other foreign matter. Again, the leaves were rewashed with sterile solution and again in treated water (boiled at 100 ^{o}C and cooled). Then they were blanched for 10 min at 90 ^{o}C. Blanched leaves were slurred in a blender by 1:1 ratio by using water. Drumstick leaves juice was filtered through muslin cloth, centrifuged and supernatant juice was pasteurized at 62 ^{o}C for 30 min. Juice was stored in clean airtight bottles and used for further experiment. Juice was used to prepare the different syrups as per the treatments mentioned in Table 1.

Table 1: Treatment composition of neuro – beverage.

Herbal name Treatments	Brahmi Juice (%)	Kokum juice (%)	Drumstick leaf juice (%)	Sugar (g)
T_1	100	-	-	60 ^{o}Brix
T_2	-	100	-	
T_3	90	-	10	
T_4	-	90	10	
T_5	80	10	10	
T_6	10	80	10	
T_7	60	30	10	
T_8	30	60	10	

Sugar was purchased from grocery shop at Bagalkot.

Preparation of neuro-beverage

The juices of brahmi, kokum, and drumstick were meticulously extracted and blended according to the specified treatments outlined in Table 1. To achieve a consistent brix level of 60 ºBrix, the mixture was carefully combined with sugar syrup. The final product was then filled into 200 ml glass bottles.

Physicochemical properties of neuro-beverage syrup

Total soluble solids, titratable acidity, pH and brix to acid ratio of neuro-beverage and neuro-beverage based RTS were analyzed.

Organoleptic evaluation (9-point hedonic scale)

Organoleptic evaluation is the assessment of products using human senses like sight, smell, taste, touch and hearing. The developed neuro-beverage syrup was diluted with water (1:4) to make into RTS and evaluated by the panel of semi trained panel (n=10). The RTS was evaluated for colour, taste, flavour, texture/consistency and overall acceptability on a nine-point hedonic scale, where 9 = like extremely, 8 = like very much, 7 = like moderately, 6 = like slightly, 5 = neither like nor dislike, 4 = dislike slightly, 3 = dislike moderately, 2 = dislike very much, 1 = dislike extremely.

Statistical analysis. The data generated in the experimentation were noted and subjected to statistical analysis using standard procedure. The standard errors (SE) and critical differences (CD) at 1 percent level of significance were calculated for comparison of treatments and presented in the respective tables.

RESULTS AND DISCUSSION

The statistics on organoleptic evaluation of neuro-beverage syrup based RTS is presented in Table 2 and Fig 1. The physico-chemical properties of neuro-beverage syrup and syrup based RTS were mentioned in Table 3 and Table 4.

1. Sensory evaluation

The sensory attributes of the prepared RTS were assessed through a 9-point hedonic scale rating test. This evaluation aids in gauging consumer acceptability and provides valuable insights for refining the product formulation.

Colour and appearance. The inclusion of brahmi, kokum, and drumstick leaf juice in the neuro-beverage-based ready-to-serve (RTS) led to significant variations in color and appearance values. The range for the color and appearance of the neuro-beverage-based RTS exhibited a notable difference, ranging from 7.33 to 8.16.

The color is a crucial parameter influencing consumer preferences. The outcomes for the color variable revealed the highest numeric score in treatment T_2 (100 % kokum juice: 8.16), followed by T_4 (90 % kokum juice + 10 % drumstick leaves juice: 8.06). The lowest sensory score (7.33) for color and appearance was observed in T_7 (60 % brahmi juice + 30 % kokum juice + 10 % drumstick leaves juice). This observation may be attributed to the higher percentage of kokum, known for its rich anthocyanin pigment, resulting in a brighter color that is readily accepted by the panelists. These findings align with previous studies on sweet orange and pomegranate blended RTS beverages by Byanna and Gowda (2013) and on brahmi extractive juice analysis by Pawar and Jadhav (2015).

Consistency. The sensory evaluation of the neuro-beverage-based ready-to-serve revealed a non-significant difference in terms of consistency. Nevertheless, the highest consistency score (7.71) was noted in treatment T_6 (10 % brahmi juice + 80 % kokum juice + 10 % drumstick leaf juice), while the lowest (7.29) consistency was recorded in T_7 (60 % brahmi juice + 30 % kokum juice + 10 % drumstick leaf juice).

Taste. The sensory evaluation findings regarding the taste of the neuro-beverage-based ready-to-serve, influenced by the inclusion of brahmi, kokum, and drumstick leaf juice, indicated a non-significant difference. Taste scores ranged from 7.18 to 7.66, with the highest score (7.77) observed in T_6 (10 % brahmi juice + 80 % kokum juice + 10 % drumstick leaf juice) and the lowest (7.18) in T_7 (60 % brahmi juice + 30 % kokum juice + 10 % drumstick leaf juice).

Flavour. The sensory evaluation scores for the flavor of the neuro-beverage-based ready-to-drink solution revealed a non-significant difference. The scores varied from 7.13 to 7.77, with the highest score attributed to treatment T_1 (100 % brahmi juice: 7.77), while the lowest score was recorded for treatment T_6 (10 % brahmi juice + 80 % kokum juice + 10 % drumstick leaf juice: 7.13).

Overall acceptability. The overall acceptability of the ready-to-serve (RTS) prepared by incorporating brahmi, kokum, and drumstick leaf juice showed a non-significant difference. Nonetheless, treatment T_6 (10 % brahmi juice + 80 % kokum juice + 10 % drumstick leaf juice) received the highest score (7.72), while the lowest score (7.10) was observed in treatment T_1 (100 % brahmi juice).

The sensory scores for consistency, flavor, taste, and overall acceptability exhibit a non-significant difference among all the treatments. This suggests that all the treatments were well perceived by the consumers across these parameters, indicating general acceptability.

Physio-chemical parameters of neuro-beverage syrup and syrup based RTS

A. Total soluble solids (º Brix)

Neuro-beverage syrup. The information concerning the total soluble solids (TSS) affected by the inclusion of varying levels of brahmi, kokum, and drumstick leaf juice in the neuro-beverage, is outlined in Table 3. The statistical analysis indicated a notable distinction among the treatments in relation to TSS.

The highest total soluble solids (TSS) value, reaching 61.83 ºBrix, was observed in T_3 (90 % brahmi juice + 10 % drumstick leaf juice), comparable to T_8 (30 % brahmi juice + 60 % kokum juice + 10 % drumstick leaf juice: 61.33 ºBrix), T_5 (80 % brahmi juice + 10 % kokum juice + 10 % drumstick leaf juice: 61.28 ºBrix), and T_1 (100 % brahmi juice: 60.73 ºBrix). In contrast, T_4 (90 % kokum juice + 10 % drumstick leaf juice)

recorded the significantly lowest value (59.93 ºBrix) and it was on par with T_6 (10 % brahmi juice + 80 % kokum juice + 10 % drumstick leaf juice: 60.29 ºBrix) and T_7 (60 % brahmi juice + 30 % kokum juice + 10 % drumstick leaf juice: 60.49 ºBrix).

Neuro-beverage syrup based RTS. Table 4 presents the data concerning the total soluble solids (TSS), influenced by the incorporation of varying levels of brahmi, kokum, and drumstick leaf juice in the RTS. The statistical analysis indicates a significant difference among the treatments in relation to TSS.

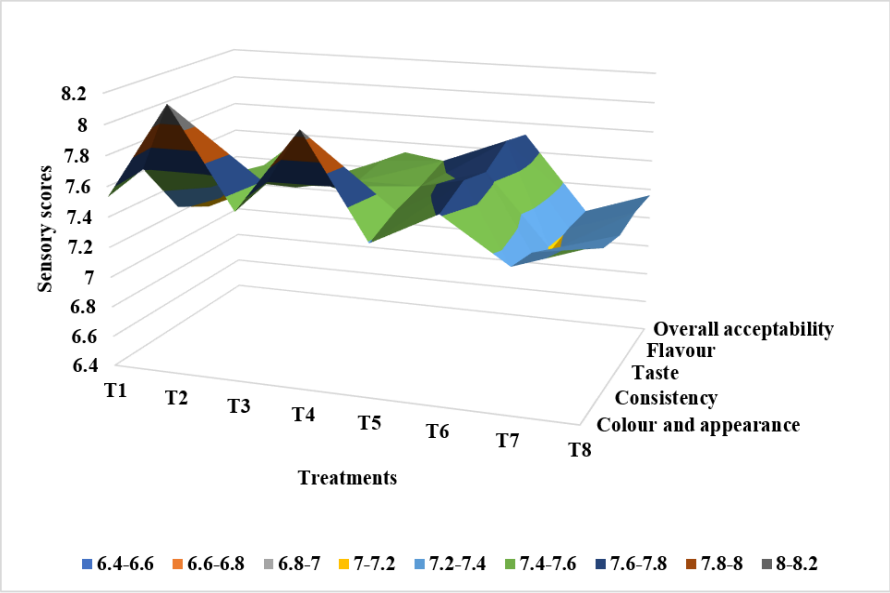
The highest value (15.50 ºBrix) was observed in T_7 (60 % brahmi juice + 30 % drumstick leaf juice), which was comparable to T_3 (90 % brahmi juice + 10 % drumstick leaf juice: 15.37 ºBrix), T_7 (60 % brahmi juice + 30 % kokum juice + 10 % drumstick leaf juice: 15.23 ºBrix), T_8 (30 % brahmi juice + 60 % kokum juice + 10 % drumstick leaf juice: 15.03 ºBrix), and T_1 (100 % brahmi juice: 14.49 ºBrix). Conversely, the treatment T_6 (10 % brahmi juice + 80 % kokum juice + 10% drumstick leaf juice) recorded significantly lowest value (14.37 ºBrix) for TSS, followed by T_4 (90 % kokum juice + 10 % drumstick leaf juice: 14.40 ºBrix).

Table 2: Effect of different formulations Sof brahmi, kokum and drumstick leaf juice on sensory evaluation of neuro-beverage RTS.

Treatment	Colour and appearance	Consistency	Taste	Flavour	Overall acceptability
T_1	7.53[d]	7.61	7.24	7.77	7.10
T_2	8.16[a]	7.61	7.52	7.47	7.52
T_3	7.51[d]	7.58	7.45	7.39	7.21
T_4	8.06[b]	7.60	7.53	7.57	7.53
T_5	7.39[f]	7.48	7.53	7.60	7.43
T_6	7.61[c]	7.71	7.66	7.13	7.72
T_7	7.33[g]	7.29	7.18	7.21	7.21
T_8	7.48[e]	7.36	7.32	7.36	7.36
Mean	**7.63**	**7.53**	**7.43**	**7.44**	**7.38**
S. Em±	**0.47**	**0.20**	**0.23**	**0.31**	**0.28**
CD at 1%	**0.02**	**NS**	**NS**	**NS**	**NS**

Note: Similar alphabets within the column represent non-significant differences at ($p<0.01$)

T1 (100 % brahmi juice)
T2 (100 % kokum juice)
T3 (90 % brahmi juice + 10 % drumstick leaf juice)
T4(90 % kokum juice + 10 % drumstick leaf juice)
T5 (80 % brahmi juice + 10 % kokum juice + 10 % drumstick leaf juice)
T6 (10 % brahmi juice + 80 % kokum juice + 10 % drumstick leaf juice)
T7 (60 % brahmi juice + 30 % kokum juice + 10 % drumstick leaf juice)
T8 (30 % brahmi juice + 60 % kokum juice + 10 % drumstick leaf juice)



T1 (100 % brahmi juice)
T2 (100 % kokum juice)
T3 (90 % brahmi juice + 10 % drumstick leaf juice)
T4 (90 % kokum juice + 10 % drumstick leaf juice)
T5 (80 % brahmi juice + 10 % kokum juice + 10 % drumstick leaf juice)
T6 (10 % brahmi juice + 80 % kokum juice + 10 % drumstick leaf juice)
T7 (60 % brahmi juice + 30 % kokum juice + 10 % drumstick leaf juice)
T8 (30 % brahmi juice + 60 % kokum juice + 10 % drumstick leaf juice)

Fig. 1. Effect of different formulations of brahmi, kokums and drumstick leaf juice on sensory evaluation of neuro-beverage RTS.

Table 3: Effect of different formulations of brahmi, kokum and drumstick leaf juice on bio- chemical parameters of neuro-beverage syrup.

Treatment	TSS (°Brix)	TA (%)	Brix to acid ratio	pH
T_1	60.73^{ab}	3.24^{d}	18.74^{a}	4.28^{a}
T_2	60.47^{b}	3.47^{a}	17.42^{c}	2.36^{g}
T_3	61.83^{a}	3.26^{d}	18.96^{a}	4.24^{b}
T_4	59.93^{b}	3.43^{a}	17.47^{c}	2.37^{g}
T_5	61.28^{a}	3.28^{cd}	18.68^{ab}	3.53^{c}
T_6	60.29^{b}	3.40^{ab}	17.73^{c}	2.43^{f}
T_7	60.47^{b}	3.30^{c}	18.32^{b}	2.96^{d}
T_8	61.33^{a}	3.34^{bc}	18.36^{b}	2.57^{e}
Mean	**60.79**	**3.30**	**18.21**	**3.09**
S. Em±	**0.3**	**0.05**	**0.12**	**0.02**
CD at 1%	**1.26**	**0.07**	**0.51**	**0.03**

Note: Similar alphabets within the column represent non-significant differences at (p<0.01)
T1 (100 % brahmi juice)
T2 (100 % kokum juice)
T3 (90 % brahmi juice + 10 % drumstick leaf juice)
T4(90 % kokum juice + 10 % drumstick leaf juice)
T5 (80 % brahmi juice + 10 % kokum juice + 10 % drumstick leaf juice)
T6 (10 % brahmi juice + 80 % kokum juice + 10 % drumstick leaf juice)
T7 (60 % brahmi juice + 30 % kokum juice + 10 % drumstick leaf juice)
T8 (30 % brahmi juice + 60 % kokum juice + 10 % drumstick leaf juice)

Table 4: Effect of different formulations of brahmi, kokum and drumstick leaf juice on bio-chemical parameters of neuro-beverage syrup based RTS.

Treatment	TSS (° Brix)	Titratable Acidity (%)	Brix to acid ratio	pH
T_1	14.97^{a}	1.32^{c}	11.34^{a}	5.72^{a}
T_2	14.53^{b}	1.53^{a}	9.49^{c}	2.88^{f}
T_3	15.37^{ab}	1.33^{bc}	11.55^{a}	5.59^{b}
T_4	14.40^{c}	1.49^{a}	10.82^{b}	2.87^{f}
T_5	15.23^{ac}	1.32^{c}	11.54^{a}	4.08^{c}
T_6	14.37^{c}	1.37^{b}	10.49^{b}	3.00^{e}
T_7	15.50^{a}	1.34^{b}	11.57^{a}	3.63^{d}
T_8	15.03^{a}	1.35^{b}	11.13^{ab}	3.01^{e}
Mean	**14.92**	**1.39**	**10.99**	**3.85**
S. Em±	**0.21**	**0.03**	**0.17**	**0.02**
CD at 1%	**0.87**	**0.04**	**0.71**	**0.02**

Note: Similar alphabets within the column represent non-significant differences at (p<0.01)
T1 (100 % brahmi juice)
T2 (100 % kokum juice)
T3 (90 % brahmi juice + 10 % drumstick leaf juice)
T4(90 % kokum juice + 10 % drumstick leaf juice)
T5 (80 % brahmi juice + 10 % kokum juice + 10 % drumstick leaf juice)
T6 (10 % brahmi juice + 80 % kokum juice + 10 % drumstick leaf juice)
T7 (60 % brahmi juice + 30 % kokum juice + 10 % drumstick leaf juice)
T8 (30 % brahmi juice + 60 % kokum juice + 10 % drumstick leaf juice)

The TSS value represents the quantity of sugar and soluble minerals found in fruits and vegetables, with sugars typically comprising 80-85 percent of the soluble solids. The data indicated that there was no significant difference among the treatments in terms of TSS.

B. Titratable acidity (%)

Neuro-beverage syrup. The findings presented in Table 3 regarding the titratable acidity of the neuro-beverage syrup, incorporating brahmi, kokum, and drumstick leaf juice, demonstrate a significant variation among the different treatments.

The titratable acidity results in Table 3 indicated that the lowest value (3.24 %) was observed in T_1 (100 % brahmi juice), which was comparable to T_3 (90% brahmi juice + 10 % drumstick leaf juice: 3.26 %) and T_5 (80 % brahmi juice + 10 % kokum juice + 10 % drumstick leaf juice: 3.28 %). Conversely, the highest mean value of titratable acidity was recorded in T_2 (100 % kokum juice: 3.47 %), which was on par with T_4 (90 % kokum juice + 10 % drumstick leaf juice: 3.43 %) and T_6 (80 % brahmi juice + 10 % kokum juice + 10 % drumstick leaf juice: 3.40 %).

Neuro-beverage syrup based RTS. The results presented in Table 4 regarding the titratable acidity of neuro-beverage syrup-based RTS, with the incorporation of brahmi, kokum, and drumstick leaf juice, demonstrate a notable difference among the various treatments.

The lowest titratable acidity value (1.32 %) was observed in T_1 (100 % brahmi juice) and it was comparable with T_5 (80 % brahmi juice + 10 % kokum

juice + 10 % drumstick leaf juice: 1.32 %) and T_1 (90 % brahmi juice + 10 % drumstick leaf juice: 1.33 %). In contrast, the highest mean value of titratable acidity was recorded in T_2 (100 % kokum juice: 1.53 %), which was on par with T_4 (90 % kokum juice + 10 % drumstick leaf juice: 1.49 %).

The presence of kokum juice can elevate the titratable acidity in beverages due to the inclusion of hydroxycitric acid (HCA), a major acid found in kokum. When incorporated into beverages, kokum increases their overall acidity, measured as titratable acidity. Consequently, treatments with higher concentrations of kokum resulted in elevated titratable acidity. Similar findings have been reported in sweet orange and pomegranate RTS beverages by Byanna *et al*. (2013), aloe vera-lemon-orange blend RTS by Bolaji and Akanbi (2017), ginger and lime juice blends by Hariharan and Mahendran (2016), nutraceutical herbal summer drinks by Garg and Ahuja (2015) and whey-based herbal beverages by Kanchana *et al*. (2021).

C. Brix to acid ratio

Neuro-beverage syrup. Table 3 presents the variation in the brix to acid ratio of the neuro-beverage syrup, influenced by the inclusion of brahmi, kokum and drumstick leaf juices.

The data indicates a significant difference in the brix to acid ratio among the treatments. Treatment T_3 (90 % brahmi juice + 10 % drumstick leaf juice: 18.96) exhibited a significant ratio and it was on par with T_1 (100 % brahmi juice: 18.74) and T_5 (80 % brahmi juice + 10 % kokum juice + 10 % drumstick leaf juice: 18.68). Conversely, the minimum value (17.42) for the brix to acid ratio was recorded in T_2 (100 % kokum juice), which was on par with T_4 (90 % kokum juice + 10 % drumstick leaf juice: 17.47) and T_6 (80 % brahmi juice + 10 % kokum juice + 10% drumstick leaf juice: 17.73).

Neuro-beverage syrup based RTS. The variations in the brix to acid ratio of neuro-beverage syrup-based RTS, as influenced by the incorporation of brahmi, kokum and drumstick leaf juice, are outlined in Table 4.

The data indicates a significant difference in the brix to acid ratio among the treatments. Specifically, treatment T_7 (60 % brahmi juice + 30 % kokum juice + 10 % drumstick leaf juice) recorded the significantly maximum value (11.57) for the brix to acid ratio which was on par with T_3 (90 % brahmi juice + 10 % drumstick leaf juice: 11.55), T_5 (80 % brahmi juice + 10 % kokum juice + 10 % drumstick leaf juice: 11.54), T1 (100 % kokum juice: 11.34) and T_8 (30 % brahmi juice + 60 % kokum juice + 10 % drumstick leaf juice: 11.13). The minimum value (9.49) for the brix to acid ratio was recorded in T_2 (100 % kokum juice).

The brix to acid ratio is frequently regarded as a more refined index of juice acceptability compared to either sugar or acid alone, as noted in studies by Hassan *et al.* (2016), Combrink *et al.* (1974) and Coombe *et al.* (1980). Evaluations of neuro-beverage syrup suggest that it is readily accepted by consumers when supplemented with citric acid and sugars, enhancing both acidity and taste. Achieving an optimal balance of sugar and acid is crucial for obtaining an acceptable taste.

D. pH

The pH is a scale utilized to indicate the acidity or basicity of an aqueous solution. Solutions with higher concentrations of H+ ions are considered acidic and typically have lower pH values, while solutions with a pH less than 7 are categorized as acidic, and those with a pH greater than 7 are considered basic or alkaline.

Neuro-beverage syrup. Table 3 provides the data regarding the pH content of the neuro-beverage syrup as influenced by the incorporation of brahmi, kokum, and drumstick leaf juice.

Notably, the highest pH value was recorded in treatment T_1 (100 % brahmi juice: 4.38), followed by T_3 (90 % brahmi juice + 10 % drumstick leaf juice: 4.24). Conversely, the minimum pH value (2.36) was observed in T_2 (100 % kokum juice), which was on par with T_4 (90 % kokum juice + 10 % drumstick leaf juice: 2.37).

Neuro-beverage syrup based RTS. The data concerning the pH content of neuro-beverage syrup-based RTS, influenced by the incorporation of brahmi, kokum, and drumstick leaf juice, is outlined in Table 4.

Notably, treatment T_1 (100 % brahmi juice) recorded the maximum pH value of 5.72, followed by T_3 (90 % brahmi juice + 10 % drumstick leaf juice: 5.59). In contrast, the minimum pH value of 2.87 was observed in T_4 (90% kokum juice + 10 % drumstick leaf juice), which was on par with T_2 (100 % kokum juice: 2.88) and followed by T_6 (10 % brahmi juice + 80 % kokum juice + 10 % drumstick leaf juice: 3.00) and T_8 (30 % brahmi juice + 60 % kokum juice + 10 % drumstick leaf juice: 3.01).

This may be attributed to the elevated content of brahmi, which reduces the acidity of the syrup and raises the pH. Conversely, the lower pH in certain treatments can be attributed to the higher concentration of kokum juice, a rich source of hydroxycitric acid, contributing to increased acidity in the syrup and consequently lowering the pH of the beverages. Similar findings have been reported in studies on brahmi juice by Mishra *et al.* (2015), sweet orange and pomegranate juices RTS by Byanna *et al.* (2013), pineapple mint beverage by Kumar *et al.* (2017), mint-based herbal beverage by Satpute *et al.* (2018), kokum-blended RTS beverage using aonla and ginger by Hegde *et al.* (2018a), syrup, squash and RTS prepared from kokum fruits by Raorane *et al.* (2014), kokum carbonated drink by Hegde *et al.* (2018b), pomegranate and plum blended carbonated drink by Masoumi *et al.* (2018).

CONCLUSION

1. T_6 (10 % brahmi juice + 80 % kokum juice + 10 % drumstick leaf juice) and T_2 (100 % kokum juice) had a better acceptability by the panelists.
2. Among the treatments T_1, T_3, T_5, T_7 and T_8 showed best results with respect to bio-chemical parameters.

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