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Quality parameters of foxtail and little millet incorporated fruit beverages

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Abstract
In this work effect of addition of germinated foxtail and little millet flours on the nutritional quality and sensory properties of mango and pomegranate RTS beverages were investigated. The results revealed that total polyphenols content was 16.87-39.30 and 10.66-48.61% high in mango and pomegranate beverages incorporated with foxtail and little millet flour, respectively compared to control. Antioxidant activity was found to be affected by the addition of flours. Compared to control, the sucralose added mango beverage had 79% less total soluble solids (TSS). The sensory evaluation showed that the millet flours incorporated beverages were found acceptable at lower concentration only. Replacement of sucrose with fructooligosaccharide (FOS) did not change the perception of sweetness. The results indicate that these millets being rich in bioactive compounds can be incorporated into the fruit beverages and sugar can be replaced by FOS and sucralose to provide low calorie and a nutritionally rich beverage.

Keywords: Antioxidants, bioactive compounds, fruit juices, sensory analysis

1. Introduction

Fruits are known for their ability to reduce the risk of development of various diseases due to the presence of bioactive compounds having antioxidant potential. Bioactive compounds, such as phenolic acids, flavonoids, oligosaccharides, dietary fibre, vitamins and minerals are present in large quantities in fruits (Karasawa and Mohan, 2018) [1]. The health benefits and an inverse association between regular consumption of fruits and fruit-based products with chronic diseases, such as different types of cancer, cardiovascular, macular and neurodegenerative diseases has been corroborated by many *in vitro* and *in vivo* studies (Angelino *et al*., 2019; Henning *et al*., 2017) [2, 3]. Mango (*Mangifera indica*), known as the king of fruits is a very popular tropical fruit which can be attributed to its aroma, taste and nutritional quality. India stands first in the world in production of mango and produces about 20.31 MMT during 2019-20. (www.static.pib.gov.in). Mango contains many bioactive compounds such as phenolic acids, terpenoids, carotenoids, and fatty acids (Sogi *et al*., 2013) [4]. These bioactive compounds have exhibited antioxidant, antimicrobial, anti-inflammatory, and anticancer activity (Quintana *et al*., 2021) [5]. Pomegranate (*Punica granatum* L.) is a pome fruit cultivated in various parts of the world. India produced about 3.18 MMT during 2019-20. (www.static.pib.gov.in) Juice, seeds and peel of pomegranate have exhibited high antioxidant activity (Derakshan *et al*., 2018) [6].

It is well established fact that consumption of fruits are beneficial to health and now even millets are receiving attention due to their health benefits owing to nutritional quality. Even though, they are not being used as a main cereal in the diet in many developed countries, millets are being used as ingredients as a gluten free cereal in the development of processed foods, such as breads, cakes, biscuits, malt etc. Studies have reported that consumption of millets will help in managing diabetes mellitus on account of their carbohydrate, fibre and amino acid content (Kam *et al*., 2016) [7]. Meta-analysis of consumption of millets on lipid profile showed reduction in Low Density Lipoprotein, Very Low-Density Lipoprotein and increase in the levels of High Density Lipoprotein which is beneficial for managing the associated risk of developing hypertension and atherosclerotic cardiovascular diseases (Anitha *et al*., 2021) [8]. Recently FAO has declared year 2023 as an 'International Year of Millets', owing to its nutritional importance in human health. Consumption of fruit beverages is showing a growing trend at the global level. It has been estimated that packaged fruit and vegetable juice market to reach $199.4 billion by 2027 globally.

(https://www.globenewswire.com/ accessed on 16.2.2022). Among beverages, functional beverages have become a health improvement strategy for health-conscious consumers. Many categories of functional beverages, such as dairy, fruit and vegetable-based drinks, sport drinks, energy drinks, tea and tea-based beverages have become popular due to the presence of bioactive compounds that are essential for human health (Nazir *et al*., 2019) [9]. The functional beverage market size is expected to reach $140. 7 billion by 2027 globally, with a market growth of 8% Cumulative Annual Growth Rate as per the forecast period during 2021 (https://www.globenewswire.com/ accessed on 11.2.2022). In fact, addition of non-traditional ingredients such as minerals, probiotics, various artificial ingredients, and raw fruit are in demand as functional beverages as consumers always look for new ingredient in terms of nutrient, taste, flavour and appearance.

In this context blending of fruit products with other fruits/vegetable products has been reported by various researchers to increase the sensory and physico-chemical properties, nutritional value and shelf life of beverages. Mango cv. Amrapali was blended with another mango cv. Totapuri to increase the color of the beverage by Khurdiya (1993) [10]. Pineapple has been blended with carrot that resulted in increased β- carotene content as well as its retention during six months of storage period (Dhaliwal and Hira, 2004) [11]. Recently, mango beverage has been found to be a good substrate for culturing probiotic strains for developing a probiotic mango beverage. (Ranjitha *et al*., 2018) [12]. The study showed that fruit beverage is a good commodity for the preparation of probiotic beverage with good sensory characteristics and high polyphenols. A mixed fruit beverage was developed using pomegranate, amla and muskmelon in different combinations and a combination of 57, 5, and 38%, respectively, scored high organoleptic ally (Bhalerao *et al*., 2020) [13]. Millets have been used to prepare milk and fruit based; alcoholic and nonalcoholic beverages by barnyard, foxtail and kodo millet (Arya and Shakya 2021) [14]. Addition of millets into butter milk along with sprouted legumes improved the iron, calcium and antioxidant activity (Agrahar-Murugkar *et al*., 2020) [15]. Despite the health benefits of millets and fruits; there has been a little or no attempt made on development of fruit-based millet beverages from mango and pomegranate fruits. Furthermore, sucrose is predominantly added for the development of fruit beverages. However, higher consumption of sugars has been linked to adverse health consequences, such as diabetes, obesity and coronary heart diseases resulted in increasing trend for the consumption of low-calorie beverages with reduced sucrose or with artificial sweeteners (Anderson *et al*., 2012) [16]. Studies have shown that sucrose can be replaced by alternative sweeteners or sugar substitute, such as sucralose and fructooligosachharides (FOS) to reduce the total soluble solids (TSS) or calorie content of the beverage (Cadena and Bolini, 2012; Reis *et al*, 2017; Renuka *et al*, 2009) [17-19]. Therefore, by considering the above facts, the present study was aimed to develop beverages by using two millets, such as foxtail and little millets, and mango and pomegranate fruits for the development of ready-to-serve (RTS) beverage. As per the best of our knowledge, no literatures are available on the development of fruit-based millet beverages.

2. Materials and Methods

2.1 Materials

Foxtail (*Setaria italica*) and Little millet (*Panicum sumatrense*) were procured from a local market in Bengaluru, India and stored under cool and dried condition until use. In this experiment, germinated millet flours were used. The chemicals used in the study were of analytical grade and were procured from Himedia Laboratories Pvt. Ltd (Bengaluru, India) and Sigma Aldrich-Merck (St. Louis, Missouri, USA). FOS was procured from Arun & Co, Mumbai (Meiji Co., Ltd. Tokyo, Japan) and Sucralose from ProFoods™ was procured online through Amazon India.

2.1.1 Preparation of germinated millet flour

The seeds were cleaned manually and washed with tap water repeatedly until the dirt was removed. The two millets were treated separately in hot water (85 °C) with the ratio of 1:3 for 40 sec followed by dipping in cold water (20-25 °C) for a minute. Subsequently, one part of each millet was soaked in three parts of 2000 ppm chlorinated water, separately for two hours. After decanting the chlorinated water, millets were soaked in demineralized (Reverse Osmosis) water with a ratio of 1:5 for 22 h (Afify *et al*., 2012; Bari *et al*., 2010) [20, 21]. The seeds were removed from the soaked water and spread in a thin layer on a wet blotting paper placed on a perforated stainless-steel tray covered by another similar tray at a temperature of 28±1 °C and 90±1% relative humidity for 48 h in a germination chamber. After germination, the millets were dried in a hot-air oven at 50 °C for 4-5 h. The root and shoot portions were manually removed by gently scrubbing the millets between palms. The germinated millets were ground into fine flour using blender (Usha Mixer Grinder, 500 watts, Usha Int Ltd, New Delhi, India). The millet flours were stored in HDPE bags at 4 °C until use.

2.1.2 Preparation of fruit juice

Mango pulp was prepared from the cv. Alphonso obtained from the experimental field at ICAR-Indian Institute of Horticultural Research, Bengaluru. Pomegranate fruits were procured from the market. Pomegranate fruits free from infestation were selected and arils were removed manually after removal of peels. The juice was extracted by crushing the arils in a blender and crushed seeds were removed by filtration through muslin cloth. Thus, the juice obtained was used for further studies.

2.2 Methods

2.2.1 Optimization of mango and pomegranate RTS beverage by incorporating millet flour

RTS beverage was prepared as per the procedure given in Figure 1. Mango RTS beverage was prepared by keeping the pulp concentration constant and adjusting the TSS to 18 °B and acidity was adjusted to 0.2% with citric acid. Water was added to make up the volume. Pomegranate beverage was prepared by using whole juice extract. Since, TSS of control had 15 °B, it was adjusted to 15 °B for other treatments wherever required and titratable acidity was adjusted to 0.3%. In both the beverages, sugar was substituted by FOS and sucralose in different treatments. The percent of FOS and sucralose was fixed based on the sensory acceptance from the preliminary work. Germinated foxtail and little millet flours were added separately at different concentrations. The prepared beverage was filled in pre-sterilized glass bottles (200 ml) and pasteurized at 85 °C for 15 min in a water bath. The bottles were removed from water bath and stored at room temperature. The treatment details for the preparation of RTS beverages are presented in Tables 1 and 2. The prepared RTS beverages were analyzed for TSS, phenols and antioxidant activity by DPPH and FRAP method, mentioned elsewhere in the paper. Microminerals iron and zinc were also analyzed. Sensory evaluation was done using 9-point hedonic scale.

2.2.2 Total Soluble Solids

Total Soluble Solids in RTS beverages was recorded by using digital refractometer (ATAGO pocket refractometer, Japan) and the observations were recorded and expressed in terms of degree Brix (°B). The zero error in the refractometer was adjusted with distilled water before recording TSS.

2.2.3 Total polyphenols

Total polyphenol content was analyzed in beverages as per the method described by Panwar *et al*. (2016) [22]. About 2 g of sample was extracted with 80% methanol in distilled water, vortexed for a minute and stored overnight. Sample was then centrifuged for 15 min at 600 x *g* (Sorvall ST 8R, Thermo Scientific, Germany). The volume of the supernatant was made up to 15 ml with 80% methanol. Subsequently, 0.5 ml of the supernatant was taken in a test tube in which 0.2 ml of 1 N Folin-Ciocalteu reagent was added to which immediately 3.3 ml of distilled water and 1 ml of saturated sodium carbonate solution were added. The test tubes were shaken manually and stored for 30 min under dark. The absorbance of the sample was read at 700 nm (T70 Dual Beam UV-VIS Spectrometer, PG Instruments Ltd, UK) and calculated using a standard calibration curve (R^2=0.999) made using gallic acid (0–0.1 mg/ml). The results were expressed as gallic acid equivalent (GAE).

2.2.4 Determination of DPPH free radical scavenging activity

Antioxidant activity was determined in the beverages using 2, 2-diphenyl-1-picrylhydrazyl (DPPH) as a free radical as per the method described by Kang and Saltveit (2002) [23]. About 0.5 ml of methanol (80%) extracted sample was taken in a test tube. Acetate buffer (10 mM) followed by 0.2 mM DPPH solution was added to the sample. Absorbance of the sample was read at 517 nm (T70 Dual Beam UV-VIS Spectrometer, PG Instruments Ltd, UK) after incubating for 30 m under dark. The decrease in absorbance with addition of sample was used for determination of antioxidant activity. A calibration curve was prepared using ascorbic acid at different concentrations ranging from 20-100 µg/ml. The results were expressed as ascorbic acid equivalent antioxidant capacity (AEAC).

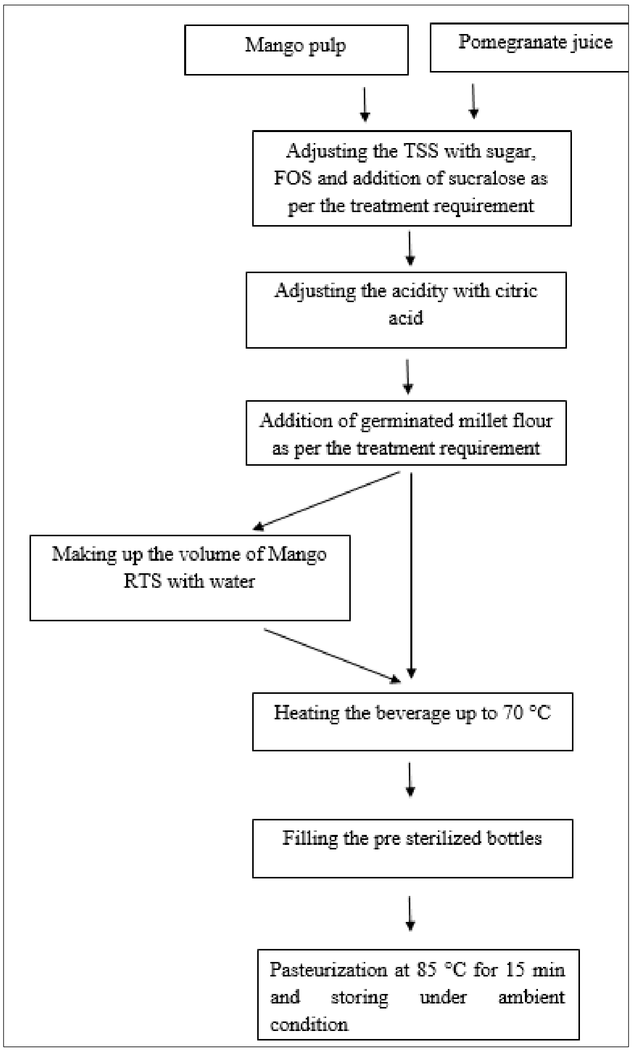

Fig 1: Flowchart for the preparation of millet incorporated beverages

Table 1: Germinated millet flour incorporated mango RTS formulation

Fruit	Flour	Treatment	Sugar (%)	FOS (%)	Sucralose (ppm)	Millet flour (%)
Mango	Foxtail millet	MC	18	-	-	0
		MFT1	14	4	-	1
		MFT2	-	-	100	1
		MFT3	14	4	-	1.5
		MFT4	-	-	100	1.5
		MFT5	14	4	-	2
		MFT6	-	-	100	2
	Little millet	MC	18	-	-	0
		MLT1	14	4	-	1
		MLT2	-	-	100	1
		MLT3	14	4	-	1.5
		MLT4	-	-	100	1.5
		MLT5	14	4	-	2
		MLT6	-	-	100	2

MC (mango control), MFT (mango foxtail millet treatment), MLT (mango little millet treatment)

Table 2: Germinated millet flour incorporated pomegranate RTS formulation

Fruit	Flour	Treatment	Sugar (%)	FOS (%)	Sucralose (ppm)	Millet flour (%)
Pomegranate	Foxtail millet	PoC	-	-	-	0
		PoFT1	-	-	-	1
		PoFT2	-	-	100	1
		PoFT3	7.5	7.5	-	2
		PoFT4	-	-	100	2
		PoFT5	7.5	7.5	-	3
		PoFT6	-	-	100	3
	Little millet	PoC	-	-	-	0
		PoLT1	-	-	-	1
		PoLT2	-	-	100	1
		PoLT3	7.5	7.5	-	2
		PoLT4	-	-	100	2
		PoLT5	7.5	7.5	-	3
		PoLT6	-	-	100	3

PoC (pomegranate control), PoFT (pomegranate foxtail millet treatment), PoLT (pomegranate little millet treatment)

2.2.5 Determination of Reducing power assay
The reducing power assay of beverages was assessed as per the method described by Benzie and Strain (1996) [24]. In this method, the antioxidants present in the sample reduce iron from ferric to ferrous form. Briefly, 1 g of sample was extracted with 80% methanol in distilled water. About 0.4 ml of aliquot was taken in a test tube, 3.6 ml of FRAP (Ferric Reducing Antioxidant Potential) reagent was added and kept for incubation at room temperature for 30 min. The absorbance was read at 593 nm. A standard curve was developed with ascorbic acid (20-100µg/ml) and the results were expressed as ascorbic acid equivalent antioxidant capacity (AEAC).

2.2.6 Iron and Zinc analysis
A modified method of Crosby (1977) [25] was adopted for dry ashing of beverage. One gram of beverage sample was weighed into a porcelain crucible and dry-ashed in a muffle furnace by stepwise increase in temperature up to 500 °C within 1 h and then leaving to ash at this temperature for additional 12 h. The residue was dissolved in 1 M nitric acid, filtered into a 25 mL volumetric flask using Whatman filter paper and made up to the mark with the nitric acid (1 M) solution. The concentrations of Fe and Zn in the digested samples were analyzed using the Atomic Absorption Spectrophotometer (Perkin Elmer Model 3300, USA) according to the method described in AOAC (1995) [26].

2.2.7 Sensory evaluation
Sensory evaluation was performed by scientists and research scholars of the laboratory. The sensory panelists included healthy male and female aged between 25 and 55 y. The samples were given with the codes and were evaluated by the participants after 2-3 h of having breakfast. All the participants were previously exposed to the mango and pomegranate beverages. Participants were asked to assess the beverages based on colour, flavour, mouthfeel, taste and overall acceptability using a 9-point hedonic scale consisting of dislike extremely = 1, dislike very much = 2, dislike moderately= 3, dislike slightly = 4, neither like nor dislike = 5, like slightly = 6, like moderate = 7, like very much = 8and like extremely = 9 (Larmond,1977) [27].

2.2.8 Statistical analysis
All the analysis was conducted in triplicates. Statistical analysis was done using the one-way analysis of variance (ANOVA) and Fisher's LSD values were calculated at P (0.05). Statistical analysis was performed using SPSS IBM 22.0 statistical software.

3. Results and Discussion
3.1 Total soluble solids in RTS beverages
Total soluble solids, expressed in °Brix is the amount of soluble solids present in the final beverage contributed from both fruit and added sugar. As most of the soluble solids in

the fruit and syrup come from sugar, the soluble solids may be regarded as sugar for practical purposes (Featherstone, 2014) [28]. The TSS of Mango and Pomegranate RTS beverages is presented in Table 3 and 4**.** In mango RTS beverage, treatments MFT1, MFT3 and MFT5 had TSS varying between 17.8 to 17.9 °B, whereas TSS varied from 4.5 to 4.7 °B in treatments MFT2, MFT4 and MFT6,compared to control (21.6 °B). In the treatments MFT1, MFT3 and MFT5 4% of cane sugar was replaced with FOS, even though the FOS has total soluble solid strength of 0.9 °B, it has not contributed to TSS of the beverage. In contrast to this, the treatmentsMFT2, MFT4 and MFT6 showed less TSS as there was no addition of sugar instead only sucralose was added. However, the TSS was contributed from the fruit pulp present in the beverage. Similar trend was observed for little millet incorporated mango beverage. Bajwa and Mittal (2015) [29] replaced sucrose with sucralose to achieve 6% sugar to prepare mango flavored milk drink. The TSS of flavored milk where only sucrose was added was found to be 13.9 °B; however, when sucrose was replaced with 25% of sucralose, TSS was 12.3 °B. In pomegranate beverage, fresh juice had 15 °B and therefore PoFT1, PoFT3 and PoFT5 were adjusted to 15 °B by adding 50% of sucrose and 50% of FOS. For treatments PoFT2, PoFT4 and PoFT6, sucralose was added. Similar addition was followed for beverages prepared with little mill*et al*so. Santana *et al*. (2020) [30] also did not observe much difference between sucrose (12 °B) and sucralose added (11 °B) clarified cashew juice.

3.2 Total polyphenolic content of RTS beverages

Polyphenols are secondary metabolites abundantly present in fruits with proven health promoting activity. In the present study, total polyphenols content of germinated foxtail and little millet incorporated mango and pomegranate beverages are presented in Tables 3 and 4. Mango beverage with germinated foxtail millet flour showed 18.54 to 31% increase in polyphenols content compared to control. As the per cent incorporation of millet flour increased, the phenol content also showed an increasing trend. However, the phenol content was observed less in treatments, where sucralose was added. In case of little millet flour added beverage, the increase in phenol content ranged between 12.50 and 39.30% in comparison to control. Even though the phenol content showed an increasing trend with increasing addition of little millet flour, it was less compared to foxtail millet flour incorporated beverages. These variations may be due to the fact that high polyphenol content was observed in germinated foxtail millet compared to germinated little millet flour (unpublished data).

As shown in the result the pomegranate beverage with foxtail and little millet had 34.65-48.61 and 10.66-38% more polyphenols content than the control, respectively. The values obtained were at par with the results obtained by Gil *et al*. (2000) [31] wherein the authors found 211mg/100 ml of total polyphenols in juice extracted from fresh arils of pomegranate.

3.3 Antioxidant activity in RTS beverages

The phytochemicals present in fruits, such as polyphenols exhibit antioxidant activity (Gil *et al*., 2000) [31]. The antioxidant activity of phenols was found to alter intestinal microbiota which is beneficial to human health (Henning *et al*., 2017) [3]. The antioxidant activity of millet incorporated beverages are presented in Table 3 and 4. The antioxidant activity of mango beverage increased up to 8.90 and 34.62% with foxtail and little millet flour, respectively by DPPH method. However, high ferric reducing antioxidant potential was observed in both foxtail and little millet incorporated beverages.

The antioxidant activity of pomegranate beverage with incorporation of both foxtail and little millet were higher, compared to mango beverage since pomegranate fruit itself is rich in phenolic content contributing to high antioxidant activity. The redox potential of foxtail and little millet incorporated pomegranate beverages was about 306 and 84.69% higher, compared to control, respectively. The study by Teleszko and Wojdylo (2015) [32] described that the fruits and vegetables which were having high polyphenol content showed strong antioxidant activity. The antioxidant activity of beverages in this study varied depending on the polyphenol content of fruits.

Table 3: TSS, Total phenols, DPPH, FRAP, Fe and Zn in mango beverage incorporated with germinated foxtail and little millet flour at different concentrations

Foxtail millet incorporated mango beverage						
Treatments	**TSS (°B)**	**Total phenols (mg GAE/100g)**	**DPPH (mg AEAC/g)**	**FRAP(mg AEAC/g)**	**Fe (ppm)**	**Zn(ppm)**
MC	21.60	36.84	0.45	0.15	8.44	1.51
MFT-1	17.80	45.45	0.47	0.43	8.39	1.85
MFT-2	4.47	44.26	0.45	0.30	7.45	1.82
MFT-3	17.90	44.61	0.49	0.23	8.03	1.93
MFT-4	4.53	43.67	0.46	0.18	7.05	1.82
MFT-5	17.93	48.27	0.46	0.17	9.99	2.16
MFT-6	4.73	47.87	0.47	0.13	6.90	1.88
SEd	0.07	1.00	0.007	0.004	0.81	0.13
CD(P=0.05)	0.15	2.16	0.015	0.009	1.74	0.29
Little millet incorporated mango beverage						
MC	21.60	32.24	0.52	0.15	8.44	1.52
MLT-1	17.77	37.78	0.60	0.15	7.15	1.83
MLT-2	4.43	36.27	0.56	0.16	6.33	1.89
MLT-3	18.17	39.17	0.70	0.17	8.42	2.17
MLT-4	4.47	37.68	0.57	0.18	7.15	2.11
MLT-5	18.37	44.91	0.45	0.17	7.80	1.66
MLT-6	4.90	37.88	0.41	0.16	6.67	1.74
S.Ed	0.06	0.45	0.03	0.002	0.5	0.21
CD(P=0.05)	0.14	0.98	0.06	0.005	1.09	NS

Table 4: TSS, Total phenols, DPPH, FRAP, Fe and Zn content in pomegranate beverage incorporated with germinated foxtail and little millet flour at different concentrations

Treatments	TSS (°B)	Total phenols (mg GAE/100g)	DPPH (mg AEAC/g)	FRAP (mg AEAC/g)	Fe (ppm)	Zn(ppm)
Foxtail millet incorporated pomegranate beverage						
PoC	16.47	129.90	5.91	1.29	1.20	0.43
PoFT-1	16.07	185.29	5.59	1.77	1.49	0.29
PoFT-2	15.83	192.87	5.48	3.56	0.70	0.41
PoFT-3	16.00	193.04	5.45	2.76	2.49	0.69
PoFT-4	16.07	187.76	5.38	4.17	2.07	0.46
PoFT-5	16.27	185.79	5.33	3.37	1.56	0.66
PoFT-6	16.83	174.91	5.21	5.23	1.76	0.72
S.Ed	0.04	6.90	0.03	0.09	0.09	0.01
CD(P=0.05)	0.09	14.80	0.07	0.19	0.19	0.03
Little millet incorporated pomegranate beverage						
PoC	16.47	129.90	5.91	1.29	1.20	0.43
PoLT-1	14.73	179.36	5.80	1.96	0.84	0.41
PoLT-2	15.03	177.21	5.57	3.62	1.93	0.34
PoLT-3	15.07	163.86	5.69	2.78	1.80	0.31
PoLT-4	15.40	159.57	5.43	4.04	2.05	0.33
PoLT-5	15.57	143.75	5.30	3.08	4.23	0.53
PoLT-6	15.03	178.86	4.94	5.58	1.65	0.62
S.Ed	0.05	0.19	0.0003	0.0007	0.20	0.01
CD(P=0.05)	0.11	0.42	0.0005	0.0015	0.43	0.03

3.4 Iron and zinc content in RTS beverages

Iron deficiency is the most common micronutrient deficiency prevailing in the world. Iron from the diet is the principal source of iron in the body apart from stored iron in liver. Studies have been done to fortify beverages with iron and it was shown that the bioaccessibility of iron could be improved (De Almeida *et al*., 2003; Perales *et al*., 2007) [33, 34]. In the present study, not much variation was observed in iron content in foxtail and little millet flour incorporated mango beverages compared to control (Table 3 and 4). However, in pomegranate beverage with foxtail and little millet showed 107 and 252% increase in iron content, respectively. Zinc is another important micronutrient having public health significance. It plays a major role in cellular function and immunity. Mango beverage showed increased zinc content up to 42% with foxtail and little millet incorporation, whereas in Pomegranate beverage about 66 and 44% increase was observed in foxtail and little millet flour incorporation, respectively. Further studies on interaction of millet flour with fruit components and other ingredients such as FOS and sucralose needs to be carried out to understand the changes in bioactive compounds.

3.5 Sensory evaluation of RTS beverages

Sensory evaluation of any food product is an important quality parameter critical for the consumer acceptance. For any new product to be established in a market, it should appeal the consumers with all the sensory parameters such as appearance, colour, flavour, taste and mouth feel. In the present study, the beverages were evaluated using 9-point hedonic scale. The sensory panelists were informed about the addition of germinated millet flours and the health benefit of millet flours. The sensory score of mango beverage is represented in Figure 2. Even though control samples scored high for all the parameters, the sensory score for MFT1 was also found at par with control. As the concentration of millet flour incorporation increased, sensory score of the samples decreased as high flour concentration decreased the mango flavour and altered the taste. However, MFT2, MFT4 and MFT6 scored less since the sucralose was used in these treatments. The sweetness of sucralose was not found acceptable by the panelists. In case of mango beverage with little millet flour, the colour of the beverage scored less since the little millets were dark brown in colour which imparted change in colour. In all the treatments with little millet flour, score for colour was less compared to foxtail millet incorporated beverage. Butt *et al*. (2000) [35] replaced sucrose with aspartame and cyclamate in mango drink at different concentrations. Authors have found that the drink with 75% sucrose and 25% cyclamate was found more acceptable. However, when sucrose was replaced with 100% sweeteners, the mango drink was not liked by the sensory panelists. Previous study by Mansoor *et al*. (2017) [36] has showed that the score for pineapple RTS was 7.8 and 7.9 for aspartame and sucralose, respectively compared to sucrose (8.9). However, when sucrose was replaced with 50% aspartame and 50% sucralose, the RTS was acceptable. It was concluded that pineapple beverage with low calories can be prepared by replacing 50% of sucrose. The pomegranate beverage had very bright colour due to its anthocyanin content. In this study, pomegranate RTS was prepared without adding cane sugar and 100 percent fruit juice was used as control. The TSS and acidity of treatments were adjusted with sugar and FOS except in sucralose treatments. The sensory acceptance of the beverage was found high for sucralose added treatments (Figure 3). This might be because 100% juice was used in the beverage preparation and sweetness imparted by the sucralose might have made the consumers for scoring high. Regarding consumers' perception for orange and pomegranate juice prepared by adding sweeteners was evaluated by Reis *et al*. (2017) [18]. The study concludes that consumers' sensory perception did not differ between juices prepared with stevia and sucralose.

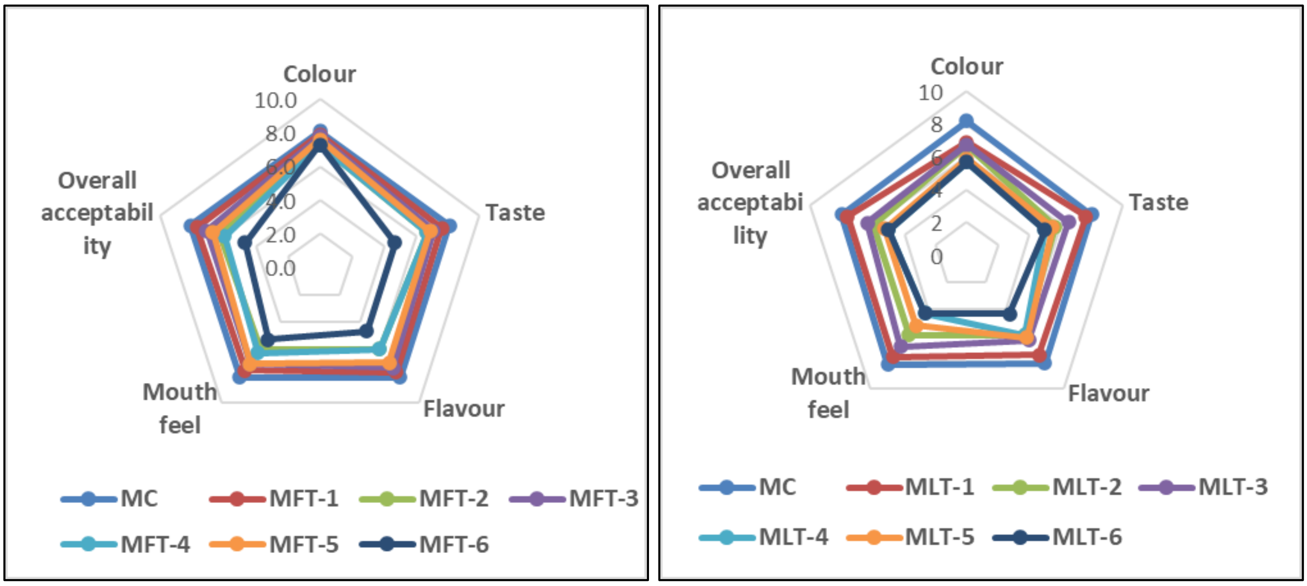

Fig 2: Mean score of germinated foxtail and little millet flour incorporated mango RTS beverage for sensory attributes

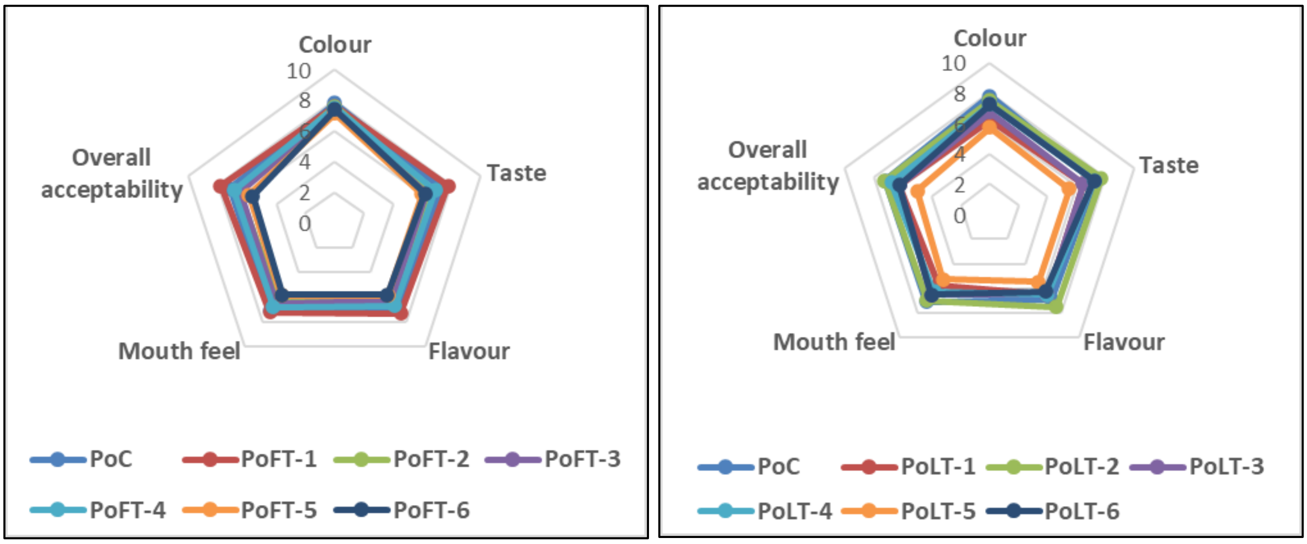

Fig 3: Mean score of germinated foxtail and little millet flour incorporated pomegranate RTS beverage for sensory attributes

4. Conclusion

Studies have shown that consumption of millets and fruits are inversely associated with development of many non-communicable diseases. The bioactive compounds present in these will benefit human health. Thus, in the present study, incorporation of germinated foxtail and little millet flours into mango and pomegranate RTS beverages enhanced total polyphenols, increased antioxidant activity, and micronutrients. Substitution of sucrose with FOS did not alter the sensory parameters and addition of sucralose into pomegranate beverage scored high compared to sucrose added beverage. The present study thus can provide consumers a bioactive compound rich mango and pomegranate beverage with reduced sucrose content.

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