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Optimization of resistant starch-rich browntop millet based ready to reconstitute health mix.

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ABSTRACT

Resistant starch is the sum of starch and products of starch hydrolysis that are not absorbed in small intestine. Resistant starch helps in management of diabetes, cardiovascular diseases and plays important role in weight management and anti-inflammatory processes. Resistant starch (g/100 g) content of Indian foods ranges from 1.2 to 1.8 in cereals, 2 to 3.4 in legumes, 0.3 to 1.3 in vegetables. This indicates that Indian diets are low in resistant starch. Thus, attention can be shifted to increasing resistant starch content of foods. Therefore, in the present study browntop millet was subjected to physical and enzymatic debranching method for increasing resistant starch content. The resulting resistant starch rich browntop millet flour was used for the development of ready to reconstitute mix along with other ingredients. It was found that proportion of ingredients in best accepted ready to reconstitute resistant starch rich browntop millet-based health mix (RR-RS-BHM) were RS-BTMF: 60 per cent, roasted bengal gram flour: 15 per cent, milk powder: 12 per cent, soya protein isolate: 6 per cent, beet root powder: 2.4 per cent, gaur gum 0.4 per cent, salt:1.8 per cent, cumin: 0.6 per cent and pepper: 0.6 per cent.

Keywords: *Browntop millet, Resistant starch, Debranching enzyme, Autoclave, Ready-to-use, Reconstitution*

Introduction

From the dietary point of view consumption of high glycaemic foods is one of the major risk factors. Hence, focus has to be shifted to foods that are low in glycaemic index. Quality and quantity of starch are major attributes that dictate the glycaemic index and glycaemic load of foods. Starch is an important plant metabolite, that acts as the primary source of energy. Usually, starch is digested in the human gastrointestinal tract by amylases and is absorbed for metabolic uses. Before the early 1980s, it was considered that the human intestine could fully break down starch. However, after Englyst's identification of starch fraction that couldn't be broken down by human enzyme, focus has been shifted to the concept of starch bioavailability. The term "resistant starch" was coined to describe a portion of starch that cannot be completely broken down in a test tube [1]. The starch fraction that is resistant to enzyme hydrolysis after 180 minutes of ingestion is called as resistant starch. Resistant starch is the sum of starch and products of starch hydrolysis that are not absorbed in the small intestine [2]. Resistant starch helps in the management of diabetes, cardiovascular diseases and plays an important role in weight management and anti-inflammatory processes.

The resistant starch (g/100 g) content of Indian foods ranges from 1.2 to 1.8 in cereals, 2 to 3.4 in legumes, 0.3 to 1.3 in vegetables. This indicates that Indian diets are low in resistant starch. Thus, attention can be shifted to increasing the resistant starch content of foods. The resistant starch content of foods can be increased by physical, enzymatic and chemical methods. Other novel techniques like the application of gamma irradiation, the complexion of amylose with lipids and genetic modification of starches are emerging [3].

Thus, food ingredients rich in resistant starch can be used to develop convenience foods to cater for the health and convenience needs of consumers.

Therefore, in the present study, browntop millet was subjected to physical and enzymatic debranching methods to increase resistant starch content. The resulting resistant starch-rich browntop millet flour was used for the development of a ready-to-reconstitute mix along with other ingredients.

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Materials and methods

Development of resistant starch-rich browntop millet flour: native browntop millet flour was autoclaved then subjected to enzymatic debranching. After enzymatic debranching, it was stored at 4°C for 24 hours, dried and finally milled to flour.

Development of ready-to-reconstitute resistant starch-rich browntop millet-based health mix was carried out in the following steps:

- Standardization of reconstitution ratio: resistant starch-rich browntop millet flour (RS-BTMF) was in reconstituted @ 5,10, 15, 20 grams in 100 ml of hot water. The best accepted reconstitution ratio was (based on sensory scores) used in the next stages of development of ready-to-reconstitute resistant starch-rich health browntop millet-based health mix.

- Standardization of roasting time: RS-BTMF was roasted at 40±5°C for 0, 2, 4, 6, 8 minutes.
- Standardization of roasted Bengal gram proportion: RS-BTMF was replaced with roasted bengal gram @ 0, 6, 9, 12,15, 18 per cent.
- Standardization of milk powder proportion: RS-BTMF was replaced with milk powder @ 0, 6, 9, 12, 15, 18 per cent.
- Standardization of soya protein isolate proportion: RS-BTMF was replaced with soya protein isolate @ 0, 1.2, 2.4, 3.6, 4.8, 6, and 7.2 per cent
- Standardization of beet root powder proportion: RS-BTMF was replaced with beet root powder @ 0, 1.2, 2.4, 3.6 and 4.8 per cent.
- Standardization of gum powder proportion: RS-BTMF was replaced with gum powder @ 0, 0.12, 0.24, 0.36, 0.48 per cent.
- Standardization of salt proportion: RS-BTMF was replaced with salt @ 0, 0.6, 1.2, 1.8, 2.4 per cent.
- Standardization of cumin powder proportion: RS-BTMF was replaced with cumin powder @ 0, 0.15, 0.30, 0.45, 0.60, 0.75 per cent.
- Standardization of pepper powder proportion: RS-BTMF was replaced with gum powder @ @ 0, 0.15, 0.30, 0.45, 0.6, 0.75 per cent.
- Standardization of spice combinations: for the standardisation of spices (salt, cumin, pepper) the impact of each spice on sensory parameters was evaluated individually, then individually standardized spice proportion was used in combination to select the best combination of spices.

In each step of standardization of ready-to-reconstitute resistant starch-rich browntop millet-
based health mix a reconstitution ratio of 10:100 (mix: hot water) was used. Reconstituted drink
was evaluated by 15 semi-trained panellists using the 9-point hedonic scale (appendix XVII) [4].

Results

Sensory scores for optimization of the reconstitution ratio of resistant starch-rich browntop millet flour for the development of ready-to-reconstitute resistant starch-rich browntop millet-based health mix are presented in Table 1.

The sensory scores of all treatments for colour ranged from 5.72 to 5.81, appearance ranged from 5.63 to 5.90, flavor ranged from 5.54 to 6.09, taste ranged from 5.80 to 5.81, after taste ranged from 5.80 to 5.81, consistency ranged from 5.45 to 7.09 and overall acceptability ranged from 5.63 to 7.00. It was found that there was a significant difference among the treatments only with respect to flavour ($p \leq 0.05$), consistency ($p \leq 0.01$) and overall acceptability ($p \leq 0.01$). Further, it was evident that T_2 i.e., 10 g of resistant starch-rich browntop millet flour (RS-BTMF) reconstituted in 100 ml of water, had significantly higher scores for flavour (6.09), consistency (7.09), and overall acceptability (7.00). Though T_1 (5 grams of resistant starch-rich browntop millet flour in 100 ml of water) and T_3 (15 grams of RS-BTMF in 100 ml of water) were on par to T_2 (10 grams of RS rich browntop millet flour in 100 ml of water) with respect to flavor, they had lower scores for consistency and overall acceptability. Thus, T_2(10 grams of RS RS-rich browntop millet flour in 100 ml of water) which had higher scores for three sensory parameters [i.e., flavor (6.09), consistency (7.09) and overall acceptability (7.00) was selected as the best-accepted reconstitution ratio. Further, in the development of ready to -to-reconstitute resistant starch-rich browntop millet-based health mix, a reconstitution ratio of 10 grams of mix in 100 ml of water was used as a standard to clearly study the effect of other added ingredients on sensory attributes.

Sensory scores for optimization of roasting time of resistant starch-rich browntop millet flour for the development of ready to reconstitute resistant starch-rich browntop millet-based health mix are presented in Table 2. For all treatments, the sensory scores of color ranged from 5.27 to 6.09, appearance ranged from 5.81 to 6.09, flavour ranged from 5.09 to 6.72, taste ranged from 5.00 to 6.63, after taste ranged from 5.00 to 7.00, consistency ranged from 5.90 to 6.00, and overall acceptability ranged from 5.00 to 6.81. It was found that roasting times of 0, 2, 4, 6, and 8 minutes had no significant impact on appearance and consistency but had a significant ($p \leq 0.01$) impact on color flavor, taste, after taste and overall acceptability. With respect to flavor, taste, after taste and overall acceptability, as the time increased from 0 to 4 minutes (T_1: no roasting to T_3: 4 minutes roasting) the scores also increased significantly ($p \leq 0.01$) from 5.81 to 6.72 for flavor, from 5.54 to 6.63 for taste, 5.27 to 7.00 for after taste and from 5.9 to 6.81 for overall acceptability. For 6 minutes of roasting time (T_4) though the sensory scores for flavor, taste and after taste were higher than T_1 (no roasting), they were not significant. For T_5 (8 minutes roasting), the sensory scores for flavour, taste, after taste, and consistency were significantly lower than other treatments. With respect to colour, a significantly higher score of 6.09 was seen in T_3 treatment (4 minutes roasting). Though T_5 (8 minutes roasting) and T_1 (no roasting) were on par to T_3 (4 minutes roasting) with respect to color, it was not considered as the best treatment as both the treatments (T_5 and T_1) had significantly lower scores for flavor, taste, after taste and overall acceptability than T_3.

Hence, T_3 i.e., roasting time of 4 minutes with significantly ($p \leq 0.01$) higher scores for colour (6.09), flavor (6.72), taste (6.63), aftertaste (7.00), overall acceptability (6.81 was selected as the best treatment.

Table 1. Optimization of reconstitution ratio of resistant starch rich browntop millet flour for the development of ready to reconstitute resistant starch rich browntop millet-based health mix.

Treatments	Reconstitution ratio (gram/100 ml)	Colour	Appearance	Flavour	Taste	After taste	Consistency	Overall acceptability
T_1	5	5.81 ± 0.40^a	5.90 ± 0.30^a	6.00±0.45^{ab}	5.81±0.40^a	5.81±0.40^a	5.45±0.52^b	5.81±0.40^b
T_2	10	5.72 ± 0.46^a	5.81±0.40^a	6.09±0.30^a	5.81±0.40^a	5.81±0.40^a	7.09±0.53^a	7.00±0.00^a
T_3	15	5.72 ± 0.46^a	5.90 ± 0.30^a	5.90±0.30^{ab}	5.81±0.40^a	5.81±0.40^a	5.72±0.64^b	6.00±0.00^b
T_4	20	5.72 ± 0.46^a	5.63 ± 0.50^a	5.54±0.52^b	5.80±0.40^a	5.80±0.40^a	6.00±0.44^b	5.63±0.50^b
F value		0.11	1.21	3.84	0.00	0.00	19.154	39.058
CD value		NS	NS	0.46*	NS	NS	0.62**	0.36**
S Em		0.11	0.13	0.12	0.12	0.12	0.16	0.09

Note: Values are expressed as mean ± Standard deviation of fifteen replications, Values have different superscripts in a column are significantly different, values having same superscript in a column are not significantly different, CD: Critical Difference, S. Em: Standard Error of Means, ** significant at 1% level, * significant at 5% level, NS: Not significant. T1: 5 grams of RS-BTMF in 100 ml water, T2: 10 grams of RS-BTMF in 100 ml water, T3: 15 grams of RS-BTMF in 100 ml water, T4: 20 of RS-BTMF in 100 ml water.

Table 2 Optimization of roasting time of resistant starch rich browntop millet flour for the development of ready to reconstitute resistant starch rich browntop millet-based health mix.

Treatments	Roasting time (minutes)	Colour	Appearance	Flavour	Taste	After taste	Consistency	Overall acceptability
T_1	0	5.90 ± 0.53^{ab}	6.09 ± 0.83^{a}	5.81 ± 0.60^{b}	5.54 ± 0.52^{bc}	5.27 ± 0.46^{c}	6.00 ± 0.00^{a}	5.90 ± 0.30^{b}
T_2	2	5.36 ± 0.50^{b}	5.90 ± 0.53^{a}	5.81 ± 0.40^{b}	5.54 ± 0.52^{bc}	5.81 ± 0.40^{b}	5.90 ± 0.30^{a}	6.00 ± 0.00^{b}
T_3	4	6.09 ± 0.83^{a}	5.81 ± 0.60^{a}	6.72 ± 0.46^{a}	6.63 ± 0.67^{a}	7.00 ± 0.00^{a}	6.00 ± 0.00^{a}	6.81 ± 0.40^{a}
T_4	6	5.27 ± 0.46^{b}	5.81 ± 0.60^{a}	6.00 ± 0.00^{b}	5.81 ± 0.40^{bc}	5.36 ± 0.50^{c}	6.00 ± 0.00^{a}	5.81 ± 0.40^{b}
T_5	8	5.63 ± 0.50^{ab}	6.09 ± 0.83^{a}	5.09 ± 0.30^{c}	5.00 ± 0.00^{c}	5.00 ± 0.00^{c}	6.00 ± 0.00^{a}	5.00 ± 0.00^{c}
F value		3.9	0.43	22.39	16.87	53.78	1.00	54.89
CD value		0.70**	NS	0.45**	0.54**	0.39**	NS	0.32**
S. Em		0.20	0.17	0.12	0.14	0.10	0.03	0.08

Note: Values are expressed as mean ± Standard deviation of fifteen replications, Values have different superscripts in a column are significantly different, values having same superscript in a column are not significantly different, CD: Critical Difference, SEm: Standard Error of Means, ** significant at 1% level, * significant at 5% level, NS: Not significant. T1: No roasting, T2: 2 minutes roasting, T3: 4 minutes roasting, T4: 6 minutes roasting, T5: 8 minutes roasting

Table 3. Optimization of roasted bengal gram flour for the development of ready to reconstitute resistant starch rich browntop millet-based health mix.

Treatments	RSBTMF+RBF (g)	Color	Appearance	Flavour	Taste	After taste	Consistency	Overall acceptability
T_1	10+0	5.63 ± 0.50^{b}	5.81 ± 0.60^{b}	6.72 ± 0.46^{a}	6.36 ± 0.50^{b}	6.09 ± 0.83^{b}	6.00 ± 0.00^{c}	6.81 ± 0.40^{b}
T_2	10+1	5.81 ± 0.40^{b}	5.72 ± 0.64^{b}	6.63 ± 0.50^{a}	6.36 ± 0.50^{b}	5.81 ± 0.75^{b}	6.00 ± 0.00^{c}	6.81 ± 0.40^{b}
T_3	10+1.5	5.81 ± 0.40^{b}	5.63 ± 0.67^{b}	6.63 ± 0.50^{a}	6.45 ± 0.52^{b}	5.81 ± 0.75^{b}	6.18 ± 0.40^{bc}	6.81 ± 0.40^{b}
T_4	10+2	5.90 ± 0.30^{b}	5.81 ± 0.75^{b}	6.54 ± 0.52^{a}	6.63 ± 0.67^{ab}	6.09 ± 0.70^{b}	6.36 ± 0.50^{bc}	6.81 ± 0.40^{b}
T_5	10+2.5	6.90 ± 0.30^{a}	6.72 ± 0.64^{a}	6.54 ± 0.52^{a}	7.09 ± 0.53^{a}	6.90 ± 0.30^{a}	7.54 ± 0.52^{a}	7.54 ± 0.52^{a}
T_6	10+3	6.81 ± 0.40^{a}	7.00 ± 0.77^{a}	6.45 ± 0.52^{a}	7.00 ± 0.63^{ab}	6.90 ± 0.30^{a}	6.54 ± 0.52^{b}	6.54 ± 0.52^{b}
F Value		22.27	8.02	7.36	3.55	6.83	23.18	4.61
CD Value		0.77**	0.44**	NS	0.64**	0.73**	0.45**	0.51**
SEm Value		0.20	0.11	0.15	0.17	0.19	0.12	0.13

Note: Values are expressed as mean ± Standard deviation of fifteen replications, Values have different superscripts in a column are significantly different, values having same superscript in a column are not significantly different, CD: Critical Difference, SEm: Standard Error of Means, ** significant at 1% level, * significant at 5% level, RS-BTMF: Resistant starch-rich browntop millet flour, RBF: Roasted Bengal gram flour, T1: No roasted bengal gram flour, T2: 1 gram of roasted Bengal gram flour, T3: 1.5 gram of roasted bengal gram flour, T4: 2 grams of roasted bengal gram flour, T5: 2.5 grams of roasted Bengal gram flour, T6: 3 grams of roasted bengal gram flour.

Sensory scores for optimization of roasted Bengal gram flour for the development of ready-to-reconstitute resistant starch-rich browntop millet-based health mix are presented in Table 3.

The range of sensory scores for all the treatments was from 5.63 to 6.90 for colour, from 5.81 to 7.00 for appearance, from 6.45 to 6.72 for flavor, from 6.36 to 7.09 for taste, from 5.81 to 6.90 for after taste, from 6.00 to 7.54 for consistency, from 6.54 to 7.54 for overall acceptability. It was found that the addition of roasted Bengal gram flour had significantly ($p\leq0.01$) influenced all the sensory parameters except flavor. Among all the treatments, T_5 (2.5 g of roasted bengal gram flour) had a significantly higher score for taste (7.09), consistency (7.54) and overall acceptability (7.54). With respect to colour, appearance and after taste T_5 (2.5 g of roasted Bengal gram flour) and T_6 (3 g of roasted Bengal gram flour) were on par to each other and also had significantly higher scores (6.90, 6.72 and 6.90 for colour, appearance and after taste scores of T_5 respectively, 6.81, 7.00 and 6.90 for colour, appearance and after taste scores of T_6 respectively) than other treatments. Though T_6 (3 g of roasted Bengal gram flour) was on par to T_5 (2.5 g of roasted bengal gram flour) with respect to colour, appearance and aftertaste, it had significantly lower scores for consistency and overall acceptability compared to T_5. Hence, T_5 (2.5 g of roasted Bengal gram flour) was found to be the best accepted formulation.

Table 4 depicts sensory scores for optimization of milk powder for the development of ready-to-reconstitute resistant starch rich browntop millet-based health mix.

It is evident from the results that the addition of milk powder showed a significant ($p\leq0.01$) influence on taste, after taste, consistency, and overall acceptability. Sensory scores for colour ranged from 6.63 to 7.18, for appearance ranged from 6.63 to 7.18, for flavour ranged from 6.18 to 6.54, for taste ranged from 6.54 to 7.63, for after taste ranged from 6.54 to 7.27, for consistency ranged from 6.18 to 7.81 and for overall acceptability ranged from 6.45 to 7.90. Scores for taste (7.63), after taste (7.27), consistency (7.81), and overall acceptability (7.90) increased significantly ($p\leq0.01$) in T_4 (2 g of milk powder.

With respect to taste and aftertaste, T_4 (2 g of milk powder), T_5 (2.5 g of milk powder) and T_6 (3 g of milk powder) were on par to each other. Also, T_5(2.5 g of milk powder) and T_6 (3 g of milk powder) were on par to T_1 (without milk powder), T_2 (1g of milk powder), and T_3 (1.5 g of milk powder) treatments which had lower sensory scores. Therefore, T_4 (2 g of milk powder) having the highest sensory scores of 7.18, 7.18, 6.54, 7.63, 7.27, 7.81 and 7.90 for colour, appearance, flavour, taste, aftertaste, consistency and overall acceptance respectively was selected as the best accepted treatment.

Table 4. Optimization of milk powder for the development of ready to reconstitute resistant starch rich browntop millet-based health mix.

Treatments	RSBTMF+ RBF+MP(g)	Color	Appearance	Flavour	Taste	After taste	Consistency	Overall acceptability
T_1	10+2.5+0	6.63±0.50^a	6.63±0.50^a	6.18±0.40^a	6.54±0.52^b	6.54±0.68^b	6.18±0.40^c	6.45±0.52^c
T_2	10+2.5+1	6.72±0.46^a	6.81±0.40^a	6.18±0.40^a	6.54±0.52^b	6.63±0.67^{ab}	6.36±0.50^c	6.63±0.50^{bc}
T_3	10+2.5+1.5	6.81±0.40^a	6.90±0.30^a	6.27±0.46^a	6.72±0.46^b	6.63±0.67^{ab}	6.54±0.52^c	6.81±0.40^{bc}
T_4	10+2.5+2	7.18±0.6^a	7.18±0.87^a	6.54±0.52^a	7.63±0.50^a	7.27±0.40^a	7.81±0.52^a	7.90±0.30^a
T_5	10+2.5+2.5	6.90±0.30^a	6.81±0.60^a	6.54±0.52^a	7.18±0.60^{ab}	7.18±0.46^{ab}	7.05±0.40^b	7.00±0.00^b
T_6	10+2.5+3	6.90±0.30^a	6.81±0.60^a	6.54±0.52^a	7.09±0.53^{ab}	7.18±0.40^{ab}	6.81±0.87^c	7.00±0.00^b
	F value	1.98	1.06	1.66	7.27	3.84	14.51	21.64
	CD value	NS	NS	NS	0.59**	0.64**	0.63**	0.40**
	S. Em value	0.17	0.13	0.14	0.15	0.17	0.16	0.10

Note: Values are expressed as mean ± Standard deviation of fifteen replications, Values have different superscripts in a column are significantly different, values having same superscript in a column are not significantly different, CD: Critical Difference, S Em: Standard Error of Means, ** significant at 1% level, NS: Not significant, RS-BTMF: Resistant starch-rich browntop millet flour, RBF: Roasted Bengal gram flour, MP: Milk powder, T1: No milk powder, T2: 1 gram of milk powder, T3: 1.5 gram of milk powder, T4: 2 grams of milk powder, T5: 2.5 grams of milk powder, T6: 3 grams of milk powder

Table 5 shows sensory scores for optimization of soya protein isolate for the development of ready-to-reconstitute resistant starch-rich browntop millet-based health mix.

It was observed that sensory scores for colour ranged from 6.90 to 7.18, for appearance ranged from 6.81 to 7.18, for flavor ranged from 6.54 to 6.81, for taste ranged from 5.90 to 7.18, for after taste ranged from 6.45 to 7.27, for consistency ranged from 6.27 to 7.81 and for overall acceptability ranged from 6.72 to 7.54 with the addition of soya protein isolate. The addition of soya protein isolate significantly ($p \le 0.01$) influenced taste, after taste, consistency and overall acceptability. Significant ($p \le 0.01$) decrease was seen in taste, after taste, consistency and overall acceptability in T_7 (1.2 g of soya protein isolate), up to T_6 (1 g of soya protein isolate) the decrease in these parameters was non-significant (i.e., T_1, T_2, T_3, T_4, T_5 and T_6 were on par to each other). Therefore, T_6 (1 g of soya protein isolate) having acceptable sensory scores for colour (7.09), appearance (6.18), flavour (6.67), taste (7.18), after taste (7.00), consistency (7.54) and overall acceptability (7.54) was selected as the best accepted treatment.

Table 6 depicts sensory scores for optimization of beet root powder for the development of ready-to-reconstitute resistant starch rich browntop millet-based health mix.

For all the treatments, the sensory scores ranged from 6.54 to 7.63 for colour, 6.81 to 7.45 for appearance, 6.63 to 6.72 for flavour, 6.81 to 7.00 for taste, 6.90 to 7.00 for after taste, 7.09 to 7.54 for consistency and 6.18 to 7.45 for overall acceptability. Addition of beetroot powder significantly influenced colour ($p \le 0.01$), appearance ($p \le 0.05$) and overall acceptability ($p \le 0.01$). T_3 (0.4 g of beetroot powder) was found to have significantly higher scores for colour (7.63) and overall acceptability (7.45). Though appearance scores of T_4 (0.6 g of beet root powder) and T_5 (0.8 g of beetroot powder) i.e., 7.09 and 7.00 respectively were on par to T_3 (0.4 g of beetroot powder) appearance score (7.45), colour (7.00) and overall acceptability scores (7.00) of T_4 and T_5were significantly ($p \le 0.01$) lower than T_3 (0.4 g of beet root powder) colour (7.63) and acceptability (7.45) score. Thus, T_3 (0.4 g of beetroot powder) was chosen as the best treatment since it had significantly higher sensory scores for colour, appearance and overall acceptability.

Table 5. Optimization of soya protein isolate for the development of ready to reconstitute resistant starch rich browntop millet-based health mix.

Treatments	RSBTMF+RBF+ MP+SPI(g)	Color	Appearance	Flavour	Taste	After taste	Consistency	Overall acceptability
T_1	10+2.5+2+0	7.18±0.60^a	7.18±0.87^a	6.54±0.52^a	7.18±0.60^a	7.27±0.46^a	7.81±0.40^a	7.36±0.46^a
T_2	10+2.5+2+0.2	7.09±0.53^a	7.09±0.83^a	6.54±0.52^a	6.72±0.78^a	7.18±0.40^a	7.72±0.46^a	7.36±0.50^a
T_3	10+2.5+2+0.4	6.90±0.53^a	7.00±0.77^a	6.54±0.52^a	6.90±0.70^a	7.09±0.30^a	7.63±0.50^a	7.29±0.50^a
T_4	10+2.5+2+0.6	7.00±0.44^a	6.90±0.70^a	6.63±0.50^a	6.81±0.60^a	7.00±0.44^a	7.54±0.52^a	7.28±0.40^a
T_5	10+2.5+2+0.8	7.00±0.44^a	6.90±0.70^a	6.63±0.50^a	6.81±0.60^a	7.00±0.44^a	7.54±0.52^a	7.29±0.40^a
T_6	10+2.5+2+1	7.09±0.53^a	6.81±0.75^a	6.67±0.64^a	7.18±0.40^a	7.00±0.44^a	7.54±0.52^a	7.54±0.30^a
T_7	10+2.5+2+1.2	7.18±0.40^a	6.81±0.75^a	6.81±0.60^a	5.90±0.30^b	6.45±0.52^b	6.27±0.46^b	6.72±0.46^b
F value		0.43	0.34	0.40	5.76	4.82	12.73	6.91
CD value		NS	NS	NS	0.66**	0.50**	0.55**	0.49**
S. Em value		0.23	0.15	0.16	0.17	0.13	0.14	0.13

Note: Values are expressed as mean ± Standard deviation of fifteen replications, Values have different superscripts in a column are significantly different, values having same superscript in a column are not significantly different, CD: Critical Difference, SEm: Standard Error of Means, ** significant at 1% level, * significant at 5% level, NS: Not significant, RS-BTMF: Resistant starch rich browntop millet flour, RBF: Roasted bengal gram flour, MP: Milk powder, SPI: Soya protein isolate. T1: No soya protein isolate, T2: 0.2 grams of soya protein isolate, T3: 0.4 grams of soya protein isolate, T4: 0.6 grams of soya protein isolate, T5: 0.8 grams of soya protein isolate, T6: 1 gram of soya protein isolate, T7: 1.2 grams of soya protein isolate.

Table 6. Optimization of beet root powder for the development of ready to reconstitute resistant starch rich browntop millet-based health mix.

Treatments	RSBTMF+RBF+ MP+SPI+BP (g)	Color	Appearance	Flavour	Taste	After taste	Consistency	Overall acceptability
T_1	10+2.5+2+1+0	$6.54{\pm}0.52^{b}$	$6.81{\pm}0.75^{b}$	$6.72{\pm}0.64^{a}$	$6.81{\pm}0.60^{a}$	$7.00{\pm}0.44^{a}$	$7.54{\pm}0.52^{a}$	$6.18{\pm}0.40^{c}$
T_2	10+2.5+2+1+0.2	$6.81{\pm}0.40^{b}$	$7.18{\pm}0.40^{ab}$	$6.63{\pm}0.50^{a}$	$6.81{\pm}0.40^{a}$	$6.90{\pm}0.30^{a}$	$7.36{\pm}0.67^{a}$	$7.27{\pm}0.46^{ab}$
T_3	10+2.5+2+1+0.4	$7.63{\pm}0.50^{a}$	$7.45{\pm}0.52^{a}$	$6.72{\pm}0.46^{a}$	$7.00{\pm}0.00^{a}$	$7.00{\pm}0.00^{a}$	$7.45{\pm}0.52^{a}$	$7.45{\pm}0.52^{a}$
T_4	10+2.5+2+1+0.6	$7.00{\pm}0.00^{b}$	$7.09{\pm}0.30^{ab}$	$6.72{\pm}0.46^{a}$	$7.00{\pm}0.00^{a}$	$7.00{\pm}0.00^{a}$	$7.45{\pm}0.52^{a}$	$7.00{\pm}0.00^{b}$
T_5	10+2.5+2+1+0.8	$7.00{\pm}0.00^{b}$	$7.00{\pm}0.00^{ab}$	$6.72{\pm}0.46^{a}$	$7.00{\pm}0.00^{a}$	$7.00{\pm}0.00^{a}$	$7.09{\pm}0.30^{a}$	$7.00{\pm}0.00^{b}$
F value		2.79	12.82	0.68	1.03	0.31	1.23	19.3
CD value		0.53**	0.42*	NS	NS	NS	NS	0.41**
S. Em value		0.14	0.11	0.15	0.09	0.072	0.15	0.10

Note: Values are expressed as mean ± Standard deviation of fifteen replications, Values have different superscripts in a column are significantly different, values having same superscript in a column are not significantly different, CD: Critical Difference, S. Em: Standard Error of Means, ** significant at 1% level, * significant at 5% level, NS: Not significant, RS-BTMF: Resistant starch rich browntop millet flour, RBF: Roasted bengal gram flour T1: No soya protein isolate, MP: Milk powder, SPI: Soya protein isolate, BP: Beet root powder, T1: No beet root powder, T2: 0.2 grams of beet root powder, T3: 0.4 grams of beet root powder, T4: 0.6 grams of beet root powder, T5: 0.8 grams of beet root powder

Table 7 presents sensory scores for optimization of gum for the development of ready-to-reconstitute resistant starch rich browntop millet-based health mix.

For all the treatments, the sensory score for colour ranged from 7.00 to 8.36, appearance ranged from 6.45 to 8.26, flavour ranged from 6.63 to 6.72, taste ranged from 6.81 to 7.00, after taste ranged from 6.90 to 7.00, consistency ranged from 6.18 to 8.36, and overall acceptability ranged from 7.00 to 7.90. color, appearance, consistency and overall acceptability were significantly ($p \leq 0.01$) influenced by the addition of gum. T_3 (0.04 g of gum) was found to have significantly ($p \leq 0.01$) higher colour (8.36), appearance (8.26), consistency (8.36), and overall acceptability (7.90) scores than all other treatments. Therefore, T_3 (0.04 g of gum) was accepted as the best treatment.

Sensory scores for optimization of salt for the development of ready-to-reconstitute resistant starch-rich browntop millet-based health mix are presented in Table 8.

Sensory scores for colour ranged from 8.08 to 8.75, appearance ranged from 8.07 to 8.36, flavour ranged from 6.63 to 6.75, taste ranged from 6.18 to 8.09, after taste ranged from 7.00 to 7.01, consistency ranged from 8.00 to 8.18 and overall acceptability ranged from 7.00 to 8.18. The addition of salt significantly ($p \leq 0.01$) influenced only taste and overall acceptability. T_4 (0.3 g of salt) having significantly higher scores for taste (8.09), overall acceptability (8.18) was observed as the best treatment.

Table 9 presents the sensory scores for optimization of cumin powder for the development of ready to reconstitute resistant starch-rich browntop millet-based health mix.

Sensory scores for colour ranged from 7.91 to 8.36, for appearance ranged from 8.09 to 8.27, for flavour ranged from 6.45 to 7.50, for taste scores ranged from 6.63 to 8.33, for after taste ranged from 6.90 to 7.66, for consistency scores ranged from 7.75 to 7.90 and for overall acceptability ranged from 7.45 to 8.50. The addition of the cumin powder showed a significant ($p \leq 0.01$) impact on colour, flavor, taste, after taste, and overall acceptability. The sensory scores increased up to T_5 (0.1 g of cumin powder) and then decreased in T_6 (0.125 g of cumin powder). T_5 (0.1 g of cumin powder) had significantly ($p \leq 0.01$ highest sensory scores for taste (8.33), after taste (7.66) and overall acceptability (8.50) among all treatments. With respect to T_5 (0.1 g of cumin powder) had a significantly higher score than T_6 (0.125 g of cumin powder) and was on par to T_1 (without cumin powder), T_2 (0.025 g of cumin), T_3 (0.050 g of cumin powder) and T_4 (0.075 g of cumin powder). Though T_1 to T_4 were on par to T_5 they have significantly lower scores for taste, after taste and overall acceptability. Therefore, T_5 (0.1 g of cumin powder) with significantly higher scores for taste, after taste and overall acceptability was considered as the best accepted formulation.

Table 7. Optimization of gum for the development of ready to reconstitute resistant starch rich browntop millet-based health mix.

Treatments	RSBTMF+RBF+ MP+SPI+BP+G (g)	Color	Appearance	Flavour	Taste	After taste	Consistency	Overall acceptability
T_1	10+2.5+2+1+0.4+0	$7.45{\pm}0.52^{b}$	$6.81{\pm}0.75^{bc}$	$6.72{\pm}0.64^{a}$	$6.81{\pm}0.60^{a}$	$7.00{\pm}0.44^{a}$	$6.18{\pm}0.12^{c}$	$7.09{\pm}0.09^{b}$
T_2	10+2.5+2+1+0.4+0.02	$7.54{\pm}0.52^{b}$	$7.36{\pm}0.50^{b}$	$6.63{\pm}0.50^{a}$	$6.81{\pm}0.40^{a}$	$6.90{\pm}0.30^{a}$	$6.45{\pm}0.15^{cb}$	$7.27{\pm}0.14^{b}$
T_3	10+2.5+2+1+0.4+0.04	$8.36{\pm}0.50^{a}$	$8.26{\pm}0.50^{a}$	$6.72{\pm}0.46^{a}$	$7.00{\pm}0.00^{a}$	$7.00{\pm}0.00^{a}$	$8.36{\pm}0.15^{a}$	$7.90{\pm}0.09^{a}$
T_4	10+2.5+2+1+0.4+0.06	$7.00{\pm}0.00^{b}$	$7.00{\pm}0.00^{cb}$	$6.72{\pm}0.46^{a}$	$7.00{\pm}0.00^{a}$	$7.00{\pm}0.00^{a}$	$7.18{\pm}0.12^{b}$	$7.00{\pm}0.00^{b}$
T_5	10+2.5+2+1+0.4+0.08	$7.00{\pm}0.00^{b}$	$6.45{\pm}0.52^{cb}$	$6.72{\pm}0.46^{a}$	$7.00{\pm}0.00^{a}$	$7.00{\pm}0.00^{a}$	$6.81{\pm}0.18^{b}$	$7.00{\pm}0.00^{b}$
F value		21.689	21.420	0.06	1.03	0.31	32.649	20.11
CD value		0.59**	0.45**	NS	NS	NS	0.56**	0.32**
S.Em value		0.15	0.12	0.15	0.09	0.07	0.14	0.08

Note: Values are expressed as mean ± Standard deviation of fifteen replications, Values have different superscripts in a column are significantly different, values having same superscript in a column are not significantly different, CD: Critical Difference, SEm: Standard Error of Means, ** significant at 1% level, * significant at 5% level, NS: Not significant, RS-BTMF: Resistant starch rich browntop millet flour, RBF: Roasted bengal gram flour, MP: Milk powder, SPI: Soya protein isolate, BP: Beet root powder, G: Gum, T1: No gum, T2: 0.02 grams of gum, T3: 0.04 grams of gum, T4: 0.06 grams of gum, T5: 0.08 grams of gum

Table 8. Optimization of salt for the development of ready to reconstitute resistant starch rich browntop millet-based health mix.

Treatments	RSBTMF+RBF+MP+SPI+BP+G+S (g)	Colour	Appearance	Flavour	Taste	After taste	Consistency	Overall acceptability
T_1	10+2.5+2+1+0.4+0.04+0	$8.09±0.30^a$	$8.18±0.39^a$	$6.63±0.50^a$	$6.18±0.40^c$	$7.00±0.00^a$	$8.18±0.40^a$	$7.18±0.40^b$
T_2	10+2.5+2+1+0.4+0.04+0.1	$8.09±0.30^a$	$8.36±0.49^a$	$6.72±0.46^a$	$6.81±0.40^b$	$7.00±0.00^a$	$8.09±0.30^a$	$7.18±0.60^b$
T_3	10+2.5+2+1+0.4+.04+0.2	$8.75±0.30^a$	$8.31±0.47^a$	$6.72±0.46^a$	$6.81±0.40^b$	$7.00±0.00^a$	$8.00±0.44^a$	$7.54±0.52^b$
T_4	10+2.5+2+1+0.4+0.04+0.3	$8.18±0.40^a$	$8.09±0.29^a$	$6.72±0.46^a$	$8.09±0.30^a$	$7.01±0.00^a$	$8.00±0.44^a$	$8.18±0.40^a$
T_5	10+2.5+2+1+0.4+0.04+0.4	$8.08±0.28^a$	$8.07±0.38^a$	$6.75±0.45^a$	$6.83±0.57^b$	$7.00±0.00^a$	$8.08±0.28^a$	$7.00±0.42^b$
F value		1.27	1.55	0.09	19.52	0.00	0.43	10.86
CD		NS	NS	NS	0.59**	NS	NS	0.54**
S.Em value		0.126	0.10	0.14	0.15	0	0.11	0.143

Note: Values are expressed as mean ± Standard deviation of fifteen replications, Values have different superscripts in a column are significantly different, values having same superscript in a column are not significantly different, CD: Critical Difference, SEm: Standard Error of Means, ** significant at 1% level, * significant at 5% level, NS: Not significant, RS-BTMF: Resistant starch rich browntop millet flour, RBF: Roasted bengal gram flour, MP: Milk powder, SPI: Soya protein isolate, BP: Beet root powder, G: Gum, S: Salt, T1: No salt, T2: 0.1 grams of salt, T3: 0.2 grams of salt, T4: 0.3 grams of salt, T5: 0.04 grams of salt

Table 9. Optimization of cumin powder for the development of ready to reconstitute resistant starch rich browntop millet-based health mix.

Treatments	RSBTMF: RBF: MP: SPI: BP: G: C(g)	Color	Appearance	Flavour	Taste	After taste	Consistency	Overall acceptability
T_1	10+2.5+2+1+0.4+0.04+0	$8.09±0.30^{ab}$	$8.09±0.30^a$	$6.63±0.50^b$	$6.63±0.67^c$	$6.90±0.30^b$	$7.90±0.30^a$	$7.63±0.50^b$
T_2	10+2.5+2+1+0.4+0.04+0.025	$8.09±0.40^{ab}$	$8.18±0.40^a$	$6.63±0.50^b$	$6.72±0.64^c$	$6.90±0.30^b$	$7.81±0.40^a$	$7.63±0.50^b$
T_3	10+2.5+2+1+0.4+0.04+0.050	$8.00±0.46^{ab}$	$8.27±0.46^a$	$6.81±0.60^b$	$7.54±0.52^b$	$7.15±0.46^b$	$7.81±0.40^a$	$7.81±0.40^b$
T_4	10+2.5+2+1+0.4+0.04+0.075	$8.00±0.40^{ab}$	$8.18±0.40^a$	$6.90±0.53^a$	$7.63±0.50^b$	$7.16±0.50^b$	$7.81±0.40^a$	$7.81±0.40^b$
T_5	10+2.5+2+1+0.4+0.04+0.1	$8.36±0.30^a$	$8.26±0.38^a$	$7.50±0.52^a$	$8.33±0.49^a$	$7.66±0.77^a$	$7.75±0.45^a$	$8.50±0.52^a$
T_6	10+2.5+2+1+0.4+0.04+0.125	$7.91±0.38^b$	$8.09±0.30^a$	$6.45±0.52^b$	$7.45±0.52^b$	$6.90±0.30^b$	$7.90±0.30^a$	$7.45±0.68^b$
F value		0. 23	0. 34	5.50	14.29	4.95	0.29	5.88
CD value		0.43**	NS	0.60**	0.63**	0.54**	NS	0.58**
S.Em value		0.11	0.14	0.16	0.17	0.14	0.11	0.15

Note: C: Cumin powder, T1: No cumin powder, T2: 0.25 grams of cumin powder, T3: 0.050 grams of cumin powder, T4: 0.075 grams of cumin powder, T5: 0.1 grams of cumin powder, T6: 0.125 grams of cumin powder.

Table 10. Optimization of pepper powder for the development of ready to reconstitute resistant starch rich browntop millet-based health mix

Treatments	RSBTMF+RBF+MP+SPI+BP+G+PP (g)	Color	Appearance	Flavour	Taste	After taste	Consistency	Overall acceptability
T_1	10+2.5+2+1+0.4+0.04+0	$8.36±0.50^a$	$8.00±0.00^a$	$7.63±0.50^a$	$6.81±0.60^b$	$7.00±0.00^{bc}$	$7.72±0.46^a$	$7.27±0.78^b$
T_2	10+2.5+2+1+0.4+0.04+0.025	$8.19±0.94^a$	$8.18±0.40^a$	$7.72±0.64^a$	$7.36±0.50^b$	$7.09±0.53^{bc}$	$7.54±0.52^a$	$7.36±0.50^b$
T_3	10+2.5+2+1+0.4+0.04+ 0.050	$8.54±0.52^a$	$8.27±0.46^a$	$7.81±0.60^a$	$7.36±0.50^b$	$7.27±0.46^b$	$7.54±0.52^a$	$7.45±0.52^b$
T_4	10+2.5+2+1+0.4+0.04+0.075	$8.12±0.44^a$	$8.18±0.40^a$	$7.09±0.53^a$	$7.45±0.52^b$	$7.45±0.52^{ab}$	$7.45±0.68^a$	$7.54±0.52^b$
T_5	10+2.5+2+1+0.4+0.04++ 0.1	$8.16±0.38^a$	$8.08±0.51^a$	$7.41±0.51^a$	$8.08±0.66^a$	$8.00±0.85^a$	$7.58±0.51^a$	$8.58±0.51^a$
T_6	10+2.5+2+1+0.4+0.04+0.125	$8.09±0.70^a$	$8.00±0.00^a$	$6.63±0.50^a$	$7.36±0.50^b$	$6.54±0.52^c$	$7.72±0.46^a$	$7.45±0.52^b$
F value		1.24	0.98	3.60	6.05	8.96	0.45	8.52
CD value		NS	NS	NS	0.62**	0.62**	NS	0.64**
S.Em value		0.11	0.18	0.16	0.16	0.16	0.16	0.17

Note: Values are expressed as mean ± Standard deviation of fifteen replications, Values have different superscripts in a column are significantly different, values having same superscript in a column are not significantly different, CD: Critical Difference, SEm: Standard Error of Means, ** significant at 1% level, * significant at 5% level, NS: Not significant, RS-BTMF: Resistant starch rich browntop millet flour, RBF: Roasted bengal gram flour, MP: Milk powder, SPI: Soya protein isolate, BP: Beet root powder, G: Gum, S: Salt, C: Cumin powder, P: Pepper powder. T1: No pepper, T2: 0.25 grams of pepper powder, T3: 0.050 grams of pepper powder, T4: 0.075 grams of pepper powder, T5: 0.1 grams of pepper powder, T6: 0.125 grams of pepper powder.

Table 11. Sensory scores of ready to reconstitute resistant starch rich browntop millet-based health mix with combination of spices.

Treatments	combination	Color	Appearance	Flavour	Taste	After taste	Consistency	Overall acceptability
T_1	Control	7.90±0.53^{b}	8.09±0.30^{a}	6.60±0.50^{c}	6.72±0.64^{c}	6.90±0.83^{c}	7.63±0.50^{a}	6.57±0.46^{c}
T_2	Salt	8.09±0.53^{ab}	8.00±0.00^{a}	7.27±0.46^{b}	7.54±0.52^{b}	7.63±0.50^{b}	7.45±0.52^{a}	7.36±0.50^{b}
T_3	Salt + Pepper	8.18±0.40^{ab}	8.18±0.40^{a}	7.27±0.64^{b}	7.81±0.40^{b}	7.54±0.52^{b}	7.36±0.50^{a}	7.27±0.64^{b}
T_4	Salt+ Cumin	7.90±0.53^{ab}	8.18±0.40^{a}	7.27±0.78^{b}	7.72±0.46^{b}	7.72±0.46^{b}	7.45±0.52^{a}	7.45±0.68^{b}
T_5	Pepper	8.00±0.44^{ab}	8.27±0.46^{a}	7.36±0.50^{b}	7.45±0.52^{b}	7.52±0.50^{b}	7.45±0.52^{a}	7.45±0.52^{b}
T_6	Pepper +Cumin	7.75±0.45^{b}	8.00±0.00^{a}	7.58±0.51^{b}	7.83±0.57^{b}	7.58±0.51^{b}	7.66±0.49^{a}	7.41±0.51^{b}
T_7	Cumin	7.75±0.86^{b}	8.09±0.30^{a}	7.45±0.68^{b}	7.81±0.87^{b}	7.72±0.46^{b}	7.90±0.30^{a}	7.45±0.52^{b}
T_8	Salt + pepper+ Cumin	8.39±0.53^{a}	8.08±0.28^{a}	8.75±0.45^{a}	9.00±0.00^{a}	8.41±0.51^{a}	7.58±0.51^{a}	8.41±0.66^{a}
F Value		1.00	0.93	12.28**	15.07**	6.68**	1.38	4.80**
CD value		0.35**	NS	0.65**	0.61**	0.61**	NS	0.64**
SEM value		0.09	0.16	0.17	0.16	0.16	0.14	0.17

Note: Values are expressed as mean ± Standard deviation of fifteen replications, Values have different superscripts in a column are significantly different, values having same superscript in a column are not significantly different, CD: Critical Difference, SEm: Standard Error of Means, ** significant at 1% level, * significant at 5% level, NS: Not significant.

Table 10 shows the sensory scores for optimization of pepper powder for the development of ready-to-reconstitute resistant starch-rich browntop millet-based health mix.
Sensory scores of all the treatments for colour ranged from 8.09 to 8.54, for appearance ranged from 8.00 to 8.27, for flavour ranged from 7.41 to 7.81, for taste ranged from 6.81 to 8.08, for after taste ranged from 6.54 to 8.00, for consistency ranged from 7.45 to 7.72 and for overall acceptability ranged from 7.27 to 8.58. Different proportions of pepper powder had a significant (p≤0.01) influence on taste, after taste, and overall acceptability. Taste and overall acceptability increased from T_1 (without pepper powder) to T_5 (0.1 g of pepper powder), with a significant increase in T_5 (0.1 g of pepper), where the scores for taste and overall acceptability were 8.08 and 8.58 respectively. After-taste was significantly higher in T_4 (0.075 g of pepper powder) and T_5 (0.1 g of pepper powder), with scores of 7.45 and 8.00 respectively. The acceptability index also increased from T_1 (without pepper powder) to T_5 (0.1 g of pepper powder) treatments (i.e., from 82.2 to 88.71) and then decreased in T_6 (82.2). Hence, T_5 with the highest significantly higher sensory scores was selected as the best accepted treatment.

Table 11 presents sensory scores of ready-to-reconstitute resistant starch-rich browntop millet-based health mix with combination of spices.
The range of sensory scores for colour was from 7.75 to 8.39, for appearance was from 8.00 to 8.27, for flavour was from 6.60 to 8.75, for taste was from 6.72 to 9.00, for after taste from 6.90 to 8.41, for consistency from 7.45 to 7.90 and for overall acceptability from 6.57 to 8.41. Addition of combination of spices in ready-to-reconstitute resistant starch browntop millet-based health mix significantly (p≤0.01) influenced colour, flavour, taste, after taste and overall acceptability. It is evident that the sensory scores for flavour, taste, after taste and overall acceptability of the treatments T_2 to T_7 were significantly higher than T_1 (control), however T_8 scored significantly higher than T_2 to T_6 with respect to flavour, taste, after taste and overall acceptability. With respect to colour though T_2 (salt), T_3 (salt+pepper), T_4 (salt+cumin) and T_5 (pepper) were on par to T_8, they reported significantly lower scores for other parameters (flavor, taste, after taste and overall acceptability). Therefore, T_7 (salt+pepper+cumin) with found to have significantly higher scores for colour (8.39), flavour (8.75), taste (9.00), after taste (8.41) and overall acceptability (8.41). The acceptability index (92.57 %) was also found to be highest in T_8 (salt+pepper+cumin). Therefore, T_8(combination of salt, pepper and cumin) was selected as the best-accepted combination.

Discussion

In the first step of the development of ready-to-reconstitute resistant starch-rich browntop millet-based health mix (RR-RS-BHM), acceptance of a reconstitution ratio of 10 g of resistant starch-rich browntop millet flour in 100 ml of water can be related to the good water absorption capacity of RS-BTMF. The present study reconstitution ratio was similar to the reconstitution ratio of millet-based instant soup mix [5].
The enhanced sensory qualities of RS-BTMF after roasting (2 minutes) may be the result of a kilning procedure similar to that used to preparing of malted flours [6]. In parallel to this, it was reported that roasted bajra flour had higher scores (overall acceptability of 6.58) compared to un-roasted bajra flour (overall acceptability of 5.58) [7].
Higher sensory scores with the addition of roasted bengal gram flour (15%) during the standardization of RR-RS-BHM can be related to the facts that roasted bengal gram have higher L * (88-83), lower a* (0.41- 2.25) and good water absorption capacity (3.62 g/g) [8]. In a previous study it was reported that the incorporation of chickpea flour enhanced overall acceptability to 8 from 7.12 of rice-based noodles [9].
Addition of milk powder (12%) resulted in increased sensory acceptance, this can be related to the fact that milk powder has high lactose which is sweeter (40-55%), have good flowability indicated by a lower Hauser ratio (1.1 to 1.2) and carr index (15 to 25) [10].
The addition of soya protein isolate revealed that it was accepted up to 6 per cent. Lower sensory scores beyond 6 per cent level of soya protein isolate might be due to the bitter peptides that are formed by proteases during soya protein isolate preparation [11]. Similarly, a reduction in sensory scores was reported beyond 5 per cent level of incorporation of soya protein isolate during custard preparation [12].
In the present study higher colour score (7.63) with the addition of beet root powder (2.4%) could be due to betalains which acts

as natural colouring agents. Similarly, it was found that the incorporation of beet root powder at 1 per cent level improved colour score from 4.37 to 5.80 [13].

The enhanced sensory score for consistency (8.36) with the addition of gum in RR-RS- RRHM can be related to the facts that gaur gum is a hydrocolloid that hydrate easily, possess higher viscosity and produces good mouth feel [14]. The results of the present study are in accordance with results reported [15] where addition of gaur gum improved consistency of Kinnow juice. The presence of gum at 0.24 per cent in the present study was in accordance with food safety and Standards Authority of India (fssai) limits that guar gum should not exceed 0.5 per cent in the final product [16]. It was reported that levels up to 2.5 g/day did not have any toxic effects [17]. Therefore, it can be confirmed that RR-RS-RHM is safe to consume with respect to gum.

RR-RS-BHM sensory acceptance improved with addition of salt, pepper and cumin in the ratio 1.8 per cent, 0.6 per cent and 0.6 per cent respectively. This can be associated to the presence of active compounds cuminol, pinene and myrcene [18]. It was demonstrated that cumin and pepper at 0.5 per cent and 0.25 per cent respectively resulted in cheese and panner with good sensory scores [19]. Therefore, it is conclusive that RR-RS-BHM had best combination of ingredients in appropriate proportions that makes RR-RS-BHM nutritious and safe product.

Conclusion

Therefore, from the present, it can be concluded that modified browntop millet along with other ingredients can be used effectively to develop a convenient health mix with higher sensory acceptance.

Future Scope of Study

ready to reconstitute health mix standardized in the present can be experimented as a supplemental formula at household, community and clinical level.

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References

1. Sharma A, Yadav B S and Ritika, 2008, Resistant Starch: Physiological Roles and Food Applications. *Food Reviews International*, 24(2):193-234.

2. Park O J, Kamg N E, Chnag M J and Kim V K, 2004, Resistant Starch Supplementation Influences Blood Lipid Concentrations and Glucose Control in Overweight Subjects. *Journalof Nutrition Science Vitaminology*, 50: 93-99.

3. Dupuis, John H, Liu, Qiang, Yada and Rickey Y, 2014, Methodologies for Increasing the Resistant Starch Content of Food Starches: A Review. *Comprehensive Reviews in Food Science and Food Safety,* 13(6):1219–1234.

4. Amerine, M.A, Pangborn, R.M and Roseller, E.B. 1965. Principles of sensory evaluation of food. *Academic Press*, London.

5. Srilekha, 2019, Development and evaluation of millet based instant soup mixes, *M.Sc. Thesis* Professor Jayashankar Telangana State Agricultural University, Hyderebad, India.

6. Srilaxmi, Food Science 3rd edition, 2005, New age international limited publishers, New Delhi, India.

7. Mridula, M M R G O W, 2006, Effect of roasting on quality of bajra and sattu. *Journal of Agricultural Eng*ineering, 43(4):65–70.

8. Jogihalli, Praveen Singh, Lochan Kumar, Kshitiz Sharanagat and Vijay Singh, 2017, Physico-functional and antioxidant properties of sand-roasted chickpe*a (Cicer arietinum). Food Chemistry,* 237: 1124–1132*.*

9. Sofi S A, Singh J, Chhikara N and Panghal A, 2020, Effect of incorporation of germinated flour and protein isolate from chickpea on different quality characteristics of rice-based noodle. *Cereal Chemistry*, *97*(1):85–94.

10. Pugliese A, Cabassi G, Chiavaro E, Paciulli M, Carini E and Mucchetti G 2017, Physical characterization of whole and skim dried milk powders. *Journal of Food Science and Technology*, 54(11):3433–3442

11. Akinwale T E, Shittu T A, Razaq A, Adebowale A, Adewuyi S and Abass A B, 2017, Effect of soy protein isolate on the functional, pasting, and sensory acceptability of cassava starch-based custard. *Food Science Nutrition*, 5:1163–1169

12. Geisenhoff H, 2009, Bitterness of soy protein hydrolysates according to molecular weight of peptides.p. 107.

13. Baycar A, Konar N, Goktas H, Sagdic O and Polat D G, 2022, The effects of beetroot powder as a colorant on the color stability and product quality of white compound chocolate and chocolate spread. *Food Science and Technology (Brazil)*, *42*.

14. Theocharidou A, Mourtzinos L and Ritzoulis, 2022, The role of guar gum on sensory perception, on food function, and on the development of dysphagia supplements – A review. *Food Hydrocolloids for Health*, 2 :100053

15. Aggarwal P, Kumar V, Yaqoob M, Kaur S and Babbar N, 2020. Effect of different levels of hydrocolloids on viscosity and cloud stability of kinnow juice and beverages. *Journal of Food Processing and Preservation*, *44*(10): 14802-14810.

16. Anonymous, 2017, *List of Food Additives Use of Food Additives in Food Products*

17. Mudgil D, Barak S and Khatkar B S, 2014, Guar gum: Processing, properties and food applications - A Review. *Journal of Food Science and Technology*, 51(3): 409–418.

18. Getahun D, Tolera H and Serka S, 2019, Evaluation of Sensorial and Antimicrobial Effects of Cumin on Cottage Cheese. *Journal of Food Processing and Technology*, *10*(9): 8–11.

19. Badola R, Danish M, Kumar S, Fahad M, Kanade P P, Upadhayay S, Kohli D and Rautela I, 2018, Effect of Incorporation of Black Pepper and Cardamom on Quality Characteristics of Paneer. *International Journal of Applied Science and Engineering*, *6*(2):121–127.

