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Physical, functional and sensory profile of buckwheat-based health mix

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Abstract
Buckwheat (*Fagopyrum esculentum*), an annual crop belonging to the *Polygonaceae* family, stands out as a pseudo-cereal with unique properties. Its gluten-free nature and distinct amino acid composition grant it special biological attributes. Notably, when comparing the roasted buckwheat-based health mix with the control, significant differences (p<0.01) were observed in various aspects, including volume and colour values such as L* and b*. These values ranged from 12.17 to 13.33 and 41.87 to 59.33 and 14.58 to 16.47, respectively. Additionally, the volume of the roasted buckwheat-based health mix surpassed that of the control, registering at 13.33 compared to 12.17. Bulk density measurements (in g/ml) including tapped and loose, were slightly lower (0.91 and 0.81) in comparison to the control (0.93 and 0.82). Furthermore, noteworthy distinctions were noted between the control and RBWBHM (Roasted Buckwheat-Based Health Mix) in parameters such as Water Absorption Capacity (WAC), final gelation temperature and gelation time, which ranged from 2.14 to 3.37 (g/g), 94.03 to 95.03 °C and 723.37 to 750.44 seconds respectively. The overall acceptability score favoured the control (8.87) over the roasted buckwheat-based health mix, which received a score of 7.13.

Keywords: Buckwheat, gelation temperature, health mix, oil absorption capacity, overall acceptability, water absorption capacity

Introduction
Buckwheat is often mistaken for a cereal grain, is a unique and versatile pseudo-cereal with a distinct set of characteristics. Buckwheat, scientifically known as *Fagopyrum esculentum* gets its name from the combination of the Anglo-Saxon words "boc" (meaning beech) and "whoet" (meaning wheat) due to its resemblance to beech nuts (Ahmed *et al.*, 2014) [2]. Buckwheat is grown in Japan, Korea, China, Belarus, Moldova, Poland, Yugoslavia, Croatia, Slovenia, Austria, Italy, France, USA, Brazil and some other countries (Ikeda, 2002) [7]. As per the findings of Farooq *et al.* (2016) [5], buckwheat cultivation is observed in the following Indian states: Jammu and Kashmir, Uttarakhand, West Bengal, Meghalaya, Arunachal Pradesh and Manipur. Buckwheat has a powerful ecological adaptability that allows the plant to grow in almost all kinds of extreme environments (Ahmed *et al.*, 2014) [2]. Buckwheat can flourish in practically any type of harsh climate due to its remarkable ecological adaptation (Li & Zhang, 2001) [8].

Buckwheat's distinctive earthy, nutty flavor sets it apart from conventional grains like wheat and rice. Its versatility shines through as it can be milled into flour, prepared as whole groats or used in the form of noodles (known as soba in Japanese cuisine) or pancakes (such as blinis in Russian cuisine). Sindhu and Khatkar (2016) [11] at Hisar analysed the physical and functional properties of tartary buckwheat grain flour. The results revealed that the flour had swelling power of 6.54 g per g, solubility of 15.52 percent, water absorption capacity of 119 percent, oil absorption capacity of 126.66 percent and bulk density of 0.68 g per ml. Baljeet *et al.* (2010) [10] at Haryana assessed the functional properties of buckwheat flour and observed that the water absorption capacity (133.67 %) and swelling capacity (15.77 ml) of buckwheat flour was lower than that of refined wheat flour (151.00 % and 16.37 ml) respectively. But the oil absorption capacity (181.37 %) and bulk density (0.81 g/ml) of buckwheat flour were significantly higher than that of refined wheat flour (16.37 % and 0.73 g/ml) respectively. The present research was conducted to study the physical, functional and sensory attributes of roasted buckwheat-based health mix.

Materials and Methods

Buckwheat was procured from Main Agricultural Research Station, AICRP on wheat and barley, Dharwad during Kharif 2022. Other ingredients like green gram, flaked rice, milk powder, sugar and cardamom powder were obtained from local market of Dharwad, Karnataka. The preparation of roasted buckwheat-based health mix is shown in fig 1. Physical, functional and sensory characteristics were analyzed by following methods described here under.

Physical properties of roasted buck wheat-based health mix: The physical parameters such as weight and volume were determined by using methods of (Amerine *et al.*, 2013) [3], bulk density such as tapped bulk density (TBD) and loose bulk density (LBD) was determined by following formula of (Goula *et al.*, 2008) [6], colour was assessed in spectrophotometer (Konica Minolta spectrophotometer of model CM 2600/2500d) and viscosity was measured by using method illustrated by Abdalla *et al.* (2009) [1].

Functional properties of buckwheat-based health mixes: Functional properties like water absorption capacity was determined by the method of Quin and Paton (1983), oil absorption capacity was assessed by using Sosulski *et al.* (1976) [12] method, swelling power and solubility were estimated as per Schoch (1964a) [9] and gelation temperature was analyzed using the method illustrated by Abdalla *et al.* (2009) [1].

Sensory profile of roasted buckwheat-based health mix: The sensory evaluation of roasted buck wheat-based health mix was carried out using method of (Amerine *et al.*, 2013) [3].

Statistical analysis: The data was computed for mean, standard deviation and ANOVA. The experimental results were carried out by using SPSS statistical package (version 23).

Results and Discussion

As displayed in Table 1. no significant difference was observed among control and RBWBHM in physical parameters such as weight, tapped bulk density, loose bulk density, viscosity (hot paste and cold paste) and a* value ranging from 10.00-10.00 g, 0.91-0.93 g/ml, 0.81-0.82 g/ml, 6.93-6.94(cP); 8.58-8.62 and 2.33-2.44 respectively. Significant (p<0.01) difference was found in volume and colour values such as L* and b* ranging from 12.17-13.33, 41.87-59.33 and 14.58-16.47 respectively. volume was more in case of roasted buckwheat-based health mix (13.33) than control (12.17) and bulk density (g/ml) such as tapped and loose was less (0.91 and 0.81) in comparison to control (0.93 and 0.82). The pre-treatment process of roasting induces moisture removal and concurrently triggers dextrinization reactions, culminating in a reduction of volume (Srilakshmi, 2006) [13] but the porosity of buckwheat is more than wheat which resulted more increase in volume in case of roasted buckwheat-based health mix in comparison to control. Swaminathan *et al.* (2018) [14] reported that the instant rice beverage mix contained a bulk density of 0.56 g per cm^3 and bulk density depends upon the particle size of the samples. Sharma *et al.* (2020) [10] reported that the novel Sattu beverage enriched with beetroot juice had the color values such as lightness L* (-6.3), redness a* (3.2) and greenness b* (0.8), the value elucidated by them had low L and b values compared to the results obtained in the present study which may be due to the different ingredients and different processing methods used.

The results pertaining to functional parameters are shown in Table 2. Significant difference was observed among control and RBWBHM in parameters such as WAC (p<0.05) and final gelation temperature and time at (p<0.01) ranging from 2.14-3.37 (g/g), 94.03-95.03 °C and 723.37-750.44 seconds respectively. The WAC and OAC was found highest in control followed by RBWBHM. Baljeet *et al.* (2010) [10] at Haryana assessed the functional properties of buckwheat flour and observed that the water absorption capacity (133.67 %) of buckwheat flour was lower than that of refined wheat flour (151.00 %) respectively.

Organoleptic evaluation of roasted buckwheat-based health mix and control [wheat: green gram: rice flakes: milk powder: sugar powder: cardamom powder] was done to know the acceptability of roasted buckwheat-based health mix w.r.t control. The results are shown in Table 3.

The sensory scores obtained viz., appearance, colour, flavour, taste, consistency and overall acceptability of control were (8.8, 8.6, 8.87, 8.73, 8.93, and 8.87) and scores for RBWBHM were (7.2, 7.2, 7.2, 7.4, 7.67 and 7.13) respectively. All the values were statistically significant at (p<0.01).

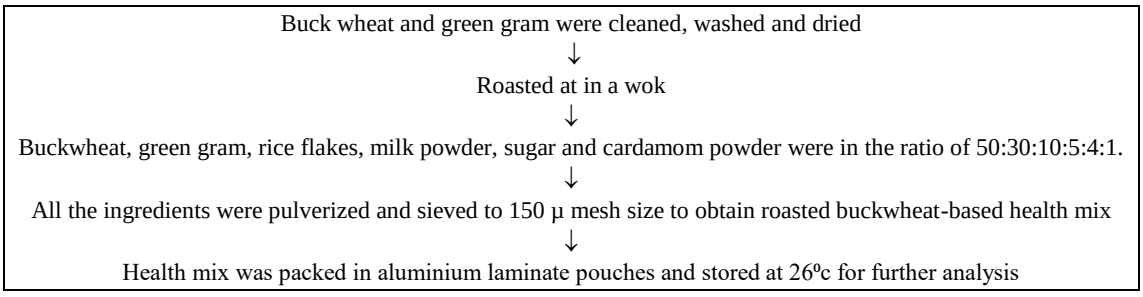

Fig 1: Preparation roasted buckwheat-based health mix

Table 1: Physical properties of roasted buckwheat-based health mix

BWBHM	Weight (g)	Volume (ml)	Bulk density (g/ml)		Viscosity (cP)		Color values		
			Tapped bulk density	Loose bulk density	Hot paste	Cold paste	L* (lightness)	a* (redness)	b* (yellowness)
Control	10.00±0.001	12.17±0.15	0.93±0.02	0.82±0.01	6.93±0.05	8.62±0.07	59.33±0.67	2.33±0.05	16.47±0.27
RBWBHM	10.00±0.002	13.33±0.15	0.91±0.02	0.81±0.04	6.94±0.02	8.58±0.02	41.87±0.62	2.44±0.20	14.58±0.31
't' value									
Control × RBWBHM	0.632^{NS}	9.354**	1.309^{NS}	0.559^{NS}	0.210^{NS}	1.114^{NS}	33.066**	0.856^{NS}	7.992**

Note: Values are the mean of three replications ± SD. *-Significant at 5 percent level, **-Significant at 1 percent level, NS-non significant. RBWBHM-roasted buckwheat-based health mix, BWBHM-buckwheat-based health mix, Control-(wheat: green gram: rice flakes: milk powder: sugar powder: cardamom powder)

Table 2: Functional properties of roasted buckwheat-based health mix

BWBHM	Water Absorption Capacity (g/g)	Oil Absorption Capacity (g/g)	Swelling power (g/g)	Solubility (%)	Gelation temperature		
					Initial gelation temp (°C)	Final gelation temp (°C)	Time in sec
Control	3.37±0.22	1.83±0.02	5.26±0.21	12.44±0.02	90.92±0.61	95.03±0.04	750.44±0.24
RBWBHM	2.14±0.09	1.82±0.002	5.71±0.42	14.65±0.01	90.26±0.02	94.03±0.04	723.37±0.15
't' value							
Control × RBWBHM	8.831*	1.000^{NS}	1.643^{NS}	1.721^{NS}	1.878^{NS}	33.968**	166.179**

Note: Values are the mean of three replications ± SD. *-Significant at 5 percent level, **-Significant at 1 percent level, NS-non significant. RBWBHM-roasted buckwheat-based health mix, BWBHM-buckwheat-based health mix, Control-(wheat: green gram: rice flakes: milk powder: sugar powder: cardamom powder)

Table 3: Organoleptic evaluation of buckwheat-based health mix beverage

BWBHM	Appearance	Color	Flavor	Taste	Consistency	Overall acceptability	Acceptability index (%)
Control	8.80±0.41^{a}	8.60±0.51^{a}	8.87±0.35^{a}	8.73±0.46^{a}	8.93±0.26^{a}	8.87±0.35^{a}	97.78±1.21^{a}
RBWBHM	7.20±0.41^{b}	7.20±0.68^{b}	7.20±0.56^{b}	7.40±0.51^{b}	7.67±0.49^{b}	7.13±0.35^{b}	81.11±4.03^{b}
F-Values	54.25	26.11	41.292	31.727	40.574	77.660	112.583
S. Em	0.116	0.145	0.137	0.128	0.107	0.106	0.840
CD	0.332**	0.415**	0.392**	0.364**	0.305**	0.302**	2.398**

Note: Sensory evaluation done by nine-point hedonic scale, Values are the mean of 15 replications ± SD. S. Em-Standard error mean, CD-Critical difference, **-highly Significant at 1 percent, *-Significant at 5 percent level and NS-non significant. Values with a different superscript in the same column are significantly different ($p \leq 0.05$). RBWBHM-roasted buckwheat-based health mix, BWBHM-buckwheat-based health mix, Control-(wheat: green gram: rice flakes: milk powder: sugar powder: cardamom powder)

Conclusion

The outcomes of this current study have unveiled that the roasted buckwheat-based health mix exhibited no noteworthy distinctions in various physical and functional attributes, indicating its potential as a substitute for wheat. Consequently, our findings endorse buckwheat as an excellent candidate for inclusion in dietary formulations. Furthermore, the sensory evaluation confirmed that the developed roasted buckwheat-based health mix performed comparably to the control, affirming its palatability and suitability for broader consumption. This underscores the promising versatility and nutritional value of buckwheat-based products.

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