International Journal of Food Science and Nutrition
www.foodsciencejournal.com
ISSN: 2455-4898
Received: 02-08-2025, Accepted: 02-09-2025, Published: 17-09-2025
Volume 10, Issue 5, 2025, Page No. 4-8

Evaluation of Physico-chemical properties and nutritional composition of buckwheat enriched cookies

S Mounika[1], Uma N Kulakarni[1], P Jayamma[2], AD Srikanth Tangirala[3]
[1] Department of Food Science and Nutrition, College of Community Science, UAS, Dharwad, Karnataka, India
[2] Department of Food Safety and Quality Assurance, College of Food Science and Technology, Angrau, Pulivendula, Andhra Pradesh, India
[3] Department of Food Process Engineering, College of Food Science and Technology, Angrau, Pulivendula, Andhra Pradesh, India

Abstract
Buckwheat is a pesudo cereal and nutraceutical crop which has gained importance due to its unique nutritional profile, health benefits, short growing period and rich source of rutin. It is a dicotyledonous crop that belongs to the family Polygonaceae and genus *Fagopyrum* sp. The current study was undertaken to analyse physico-chemical properties of buckwheat enriched cookies. Physical parameters include diameter (4.84 cm), thickness (1.58 cm), spread ratio (3.05), hardness (1800.5 g force) and weight (12.61 g) of buckwheat enriched cookies. The color components of buckwheat enriched cookies in terms of L*, a* and b* values were 63.59, 9.59 and 23.66 respectively. Proximate principles of buckwheat enriched cookies had 2.65 g of moisture, 4.25 g of protein, 1.50 g of ash, 22.23 g of fat, 0.38 g of crude fiber, 69.36 g of total carbohydrate and 68.98 g of available carbohydrate with 495 Kcal per 100g. Minerals include 35.68 mg of calcium, 0.24 mg of copper, 1.85 mg of iron, 1.42 mg of zinc and 1.25 mg of manganese per 100g.

Keywords: Pseudocereal, polygonaceae, fagopyrum, buckwheat, cookies

Introduction

Buckwheat is a pseudocereal and belongs to polygonaceae family. Pseudocereals are not true cereals. There are over 1200 species of plants that make up the family Polygonaceae. This family includes buckwheat, which is almost universally distributed but primarily grows in the northern hemisphere. Russia and China are the main producers of buckwheat in the world. One of the many ancient Asian crops still grown today is buckwheat and mostly grown in India, China, Nepal, Canada, North Korea, Bhutan, eastern Russia, Mongolia and Japan. In India, the hilly regions of Jammu and Kashmir, Uttarakhand, Himachal Pradesh, Chattisgarh, Uttar Pradesh, West Bengal, Upper Assam region, Sikkim, Meghalaya, Manipur, Arunachal Pradesh, Nilgiris and Palani hills in Tamil Nadu and Kerala are the most buckwheat cultivated areas. Due to shifting patterns of land usage in India, buckwheat production and cultivation have decreased. In India, there are twenty species of buckwheat cultivated across various hilly regions, out of these only nine species have desirable nutritional value and two are commonly grown. Common buckwheat (*Fagopyrum esculentum Moench*) and Tartary buckwheat (*Fagopyrum tataricum*) are the two species that are most frequently cultivated and consumed (Nalinkumar, *et al.*, 2020) [17].

Buckwheat is highly nutritious because of its numerous nutraceutical compounds, vitamins especially B-group vitamins (Li and Zhang, 2001), macro minerals, trace minerals like iron, copper, magnesium, zinc and manganese (Ikeda and Yamashita, 1994) [7], starch and dietary fiber (Skrabanja *et al*., 2004) [21]. It is a good source of protein with a balanced amino acid profile, primarily lysine, histidine, valine and leucine (Bonafaccia *et al.*, 2003) [3]. Buckwheat contains rutin, orientin, vitexin, quercetin, isovitexin, kaempferol-3-rutinoside, isoorientin and catechins, among other phenolic chemicals (Dietrych-Szostak and Oleszek, 1999) [5]. Buckwheat has more antioxidant activity than other popular cereals because of its high rutin content, which helps to prevent lipid peroxidation (Kreft *et al.*, 2006) [11]. Buckwheat possesses healthy effects due to its high levels of phenol compounds. These functional components of buckwheat reduce high blood pressure, regulate blood sugar, lower blood cholesterol, prevent fat accumulation, constipation, (Kayashita *et al*., 1996) [10], mammary and colon carcinogenesis (Liu *et al*., 2001) [14] and inhibit gallstone formation and plasma cholesterol (Tomotake *et al*., 2000) [23].

Buckwheat seeds are the main form of consumption of this pseudocereal. Dehulled seeds (raw groats) are principally used for human consumption as breakfast cereals or as processed flour for making different bakery products (bread, cookies, snacks, and noodles) enriched with buckwheat flour and buckwheat enhanced non-bakery products (tea, honey, tarhana and sprouts). These foods can be included in gluten-free diets for those with gluten intolerance because buckwheat is a gluten-free pseudoceral (Nalinkumar, *et al.*, 2020) [17]. As utility depends on nutritional and health componentsof buckwheat the present study was undertaken with an objective to analyse physico-chemical properties of buckwheat enriched cookies.

Materials and methods

The experiment was conducted at the Department of Food Science and Nutrition, College of Community Science, University of Agricultural Sciences, Dharwad during the year 2020-2021. Buckwheat of Neelageri variety was procured from AICRP on Wheat and Barley, University of Agricultural Sciences, Dharwad. Dehulled buckwheat was

subjected for milling to yield flour using electrical blender. All other materials including sugar, butter, vanilla essence, soda and baking powder were purchased from local market.

Control cookies were prepared by standard recipe. Preliminary trials were conducted to optimize buckwheat enriched cookies. Different formulations of refined wheat flour and buck wheat flour in the ratio of 100:0, 50:50, 25:75 and 0:100 were used to develop cookies manually and baked in a commercial baking oven at 150 -170˚C for 10-15 min.

The cookies were evaluated for sensory quality using nine-point hedonic scale by semi trained panel of 15 judges comprising of staff and students of Department of Food Science and Nutrition, College of Community Science, University of Agricultural Sciences, Dharwad, Karnataka. The cookies were evaluated for appearance, color, flavor, taste, texture and overall acceptability on a nine-point hedonic scale.

Physical properties of cookies like diameter and thickness was measured by using slide caliper, weight was recorded using electronic weighing balance with sensitivity of 0.01mg, spread ratio was calculated by dividing the average value of diameter by average value of thickness, color was assessed in spectrophotometer model Konica Minolta, CM-2600/2500d and was measured in chromatic components of 'L' (black - 0 to white - 100), 'a' represents redness (+a values) to greenness (- a values) and 'b' represents yellowness (+b values) to blueness (-b values) and texture was determined by using Instron universal testing machine of TAXT.

Proximate principles such as moisture, protein, fat, crude fibre, ash, **t**otal carbohydrate, available carbohydrate and energy value**,** mineral contents such as calcium, iron, zinc, copper and manganese were assessed by standard AOAC methods (Anon., 2019).

Results and discussion

Descriptive characteristics of buckwheat enriched cookies are given in table 1. The results of sensory evaluation of buckwheat enriched cookies prepared with different formulations were assessed using nine-point hedonic scale are shown in table 2. All the formulations differed significantly ($p < 0.05$) among all the sensory parameters. The sensory profile of 100 per cent buckwheat enriched cookies revealed scores of 7.5 for appearance, 7.62 for color,7.5 for flavor, 7.5 for taste, 7.25 for texture and over all acceptability of 7.41 with acceptability index of 82.92 per cent (Fig 1).

Table 1: Preliminary trials for standardization of buckwheat enriched cookies

Trials	WF: BWF	Descriptive characteristics	
		Dough	Cookies
I	100:0	Mixing and development of dough was little difficult, colour of dough was creamish white, ball formation was simple.	Creamish, evenly baked, attractive, well spread, crunchy and chewy, pleasant aroma and flavor, smooth in mouth feel, highly acceptable.
II	50:50	Mixing and development of dough was little difficult, colour of dough was creamish and little bit grey, ball formation was simple.	Dull creamish, evenly baked, attractive, less spread, chewy but not crunchy, slightly compact, pleasant aroma and flavor, coarse in mouth feel, acceptable.
III	25:75	Mixing and development of dough was easy, colour of dough was dull grey and ball formation was simple.	Dull creamish, evenly baked, attractive, less spread, chewy but not crunchy, slightly compact, pleasant aroma and flavor, coarse in mouth feel, acceptable.
IV	0:100	Mixing and development of dough was easy, colour of dough was light grey, ball formation was simple.	Creamish brown, evenly baked, light and crisp, attractive, less spread, pleasant aroma and flavour, slightly coarse mouth feels, acceptable.

Note: WF- Wheat flour; BWF- Buckwheat flour; The other ingredients sugar, butter, curd, baking powder, baking soda and vanilla essence were kept constant.

Table 2: Sensory profile of buckwheat enriched cookies

Trials	Proportions WF: BWF	Sensory scores					
		Appearance	Color	Flavor	Taste	Texture	Overall acceptability
I	100:0	8.08 ± 0.28^{a}	8.16 ± 0.38^{a}	8.25 ± 0.45^{a}	8.16 ± 0.38^{a}	8.00 ± 0.00^{a}	8.00 ± 0.00^{a}
II	50:50	7.83 ± 0.57^{ab}	7.58 ± 0.51^{b}	7.83 ± 0.57^{ab}	7.58 ± 0.51^{b}	7.83 ± 0.38^{a}	7.75 ± 0.45^{ab}
III	25:75	7.58 ± 0.51^{b}	7.66 ± 0.61^{b}	7.70 ± 0.54^{b}	7.66 ± 0.44^{b}	7.33 ± 0.49^{b}	7.50 ± 0.52^{b}
IV	0:100	7.50 ± 0.52^{b}	7.62 ± 0.56^{b}	7.50 ± 0.52^{b}	7.50 ± 0.47^{b}	7.25 ± 0.45^{b}	7.41 ± 0.51^{b}
S. Em		0.141	0.152	0.151	0.132	0.111	0.354
CD		0.402*	0.435*	0.432**	0.377**	0.318**	0.354**
F value		3.492	3.195	4.346	5.120	10.907	4.490

Note: WF- Wheat flour; BWF- Buckwheat flour; Values with the same superscripts - a, b and c in the same column are not significantly different; S. Em- Standard error of mean; C.D. - Critical difference; NS- Non-significant; * Significant @ 5%; ** Significant @ 1%

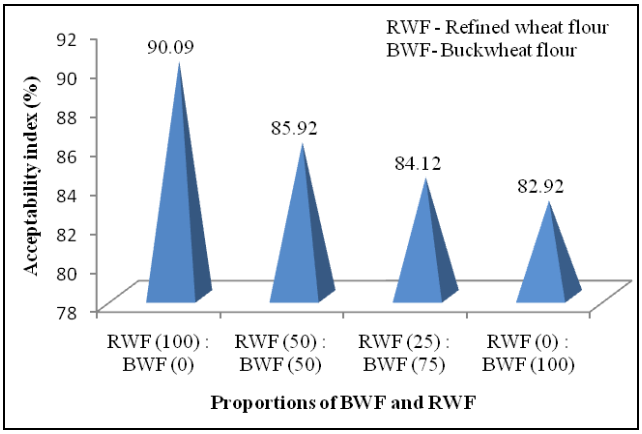

Fig 1: Acceptability index of buckwheat enriched cookies

With increase in the level of buckwheat flour in the formulation, the sensory scores for appearance, color, flavor and texture of cookies decreased (table 2). The colour of buckwheat cookies was better than control sample. The appearance and color scores were decreased with the addition of buckwheat flour because the buckwheat flour had lower lightness and higher yellowness and redness value than control sample (Duarte *et al.*, 1996). The score of appearance and color reduced to 7.50 and 7.62 with 100 per cent concentration of buckwheat flour. This may be due to formation of cracks with the addition of gluten free buckwheat flour. The use of non glutenous composite flours in cookie preparation reduces the textural strength of cookies where such strength is dependent upon approximate levels of gluten development. This is because in contrast to bread, the gluten network in cookies is to be only slightly cohesive without being too elastic (Schober *et al.*, 2003). The score of taste and flavor lowered significantly ($p < 0.05$) to 7.50 at higher concentrations, possibly due to presence of flavonoid compound- rutin imparting bitter taste in buckwheat flour. But this was not evident in present cookies because of dry sandy mouth feel of gluten free products thus reducing sensory scores. The cookies formed with addition of 50, 75 and 100 per cent buckwheat flour got overall acceptability scores of 7.75, 7.50 and 7.41 respectively. Jan *et al.* (2015) [8] developed cookies by refined wheat flour replacement with buckwheat flour at different levels i.e., 0, 20, 40, 60, 80, and 100 per cent. The overall acceptability of cookies was highest at 40 per cent level of blending. Chopra *et al.* (2014) [4] developed buckwheat cookies with 50, 75 and 100 per cent buckwheat flour. 75 per cent incorporation got highest overall acceptability. Baljeet *et al.* (2010) [2] developed biscuits by incorporating buckwheat flour at 10, 20, 30 and 40 per cent concentration with refined wheat flour. The biscuits with20 per cent incorporation of buckwheat flour got high overall acceptability. Sakac *et al.* (2015) [19] developed gluten free cookies at levels of 10, 20 and 30 per cent substitution of buckwheat flour with rice flour. The cookies with 20 per cent incorporation of buckwheat flour got high overall acceptability score. Filipcev *et al.* (2011) developed ginger nut biscuits using buckwheat flour with refined wheat flour at three different levels (30, 40 and 50%). Hussain *et al.* (2017) [6] developed buckwheat cookies by incorporating buckwheat flour at 10, 20, 30, 40 and 50 per cent with refined wheat flour.

The physical properties of refined wheat flour and buckwheat supplemented cookies are presented in table 3. The control (refined wheat flour) cookies had mean weight of 11.58 g, thickness - 1.69 cm, diameter - 4.68 cm, hardness - 3025.3 g force and spread ratio of 2.76. The color components of control cookies indicated that L*, a* and b* were 65.19, 8.84 and 24.41 respectively. Buckwheat enriched cookies had higher diameter (4.84 cm) and decreased in thickness (1.58 cm), hardness (1800.5 g force) and weight (12.61 g). The color components L*, a* and b* of buckwheat enriched cookies were 63.59, 9.59 and 23.66 respectively.

Table 3: Physical properties of cookies

Parameters		Refined wheat flour (Control) cookies	Buckwheat enriched cookies
Diameter		4.68±0.01	4.84±0.01
Thickness		1.69±0.06	1.58±0.03
Spread ratio		2.76±0.09	2.05±0.07
Weight		11.58±0.02	12.61±0.06
Hardness		3025.3	1800.5
Colour	L*	65.19±0.18	63.59±0.40
	a*	8.84±0.25	9.59±0.40
	b*	24.41±0.25	23.66±0.36

All values are expressed as mean ± SD of 3 replications.

Increase in thickness may be due to decrease in diameter. The changes in diameter and thickness were reflected in spread ratio of cookies (McWatters, 1978) [15]. The weight of buckwheat enriched cookies was high compared to control cookies. The increase in cookies weight may be due to the ability of buckwheat flour to retain oil during baking process (Rufeng *et al.*, 1995) [18]. The cookies made from 100 per cent buckwheat flour had least hardness and was most fragile. The hardness of cookies decreased with the incorporation of buckwheat flour. This may be due to dilution of gluten content in the flour blends which decreased with addition of buckwheat flour, thus lowering elasticity leading to softer cookies. The surface color of the cookie decreased for lightness (L*), yellowness (b*) and increased for a* (redness) with increase in buckwheat flour content in the cookies. This may be due to the browning reactions caused during baking. Maillard browning and caramelization of sugar are considered to produce brown pigments during baking (Laguna *et al.*, 2011) [12]. These browning reactions are influenced by many factors such as water activity, pH, temperature, sugars, type and ratio of amino compounds (Sharma and Gujral, 2013 [20]; Stojceska *et al.*, 2009). Similar results were reported by Baljeet *et al.* (2010) [2]; Chopra *et al.* (2014) [4] and Jan *et al.* (2015) [8].

The proximate principles of cookies made from refined wheat flour (RF) i.e., control cookies and buckwheat flour (BWF) blend is shown in Table 4. The moisture content ranged from 2.65 per cent to 4.16 percent in 100 per cent buckwheat flour-based cookies and control cookies respectively. The decrease in moisture content may be due to decrease in protein percent. The protein content of cookies ranged from 4.25 to 7.33 per cent. The cookies showed decrease in protein content when buckwheat flour concentration was increased. Mustafa *et al.* (1986) [16] reported an increase in moisture content of bakery products with increase in protein content. The fat content of control and buckwheat flour cookies were found to be 20.34 per cent and 22.23 per cent respectively. This may be due to the oil retention ability of buckwheat flour during baking

process. No definite trend in increase or decrease in crude fiber contents was observed. The ash content of cookies increased with the addition of buckwheat flour. The increase in ash content may be due to the high mineral content in the buckwheat flour i.e., iron, copper and magnesium (Kaur *et al.,* 2015 [9]; Baljeet *et al.,* 2010) [2].

Table 4: Proximate principles of cookies

Parameters	Refined wheat flour (Control) cookies	Buckwheat enriched cookies
Moisture (g %)	4.16±0.14	2.65±0.32
Protein (g %)	7.33±0.20	4.25±0.20
Ash (g %)	0.54±0.12	1.50±0.15
Fat (g %)	20.34±0.02	22.23±0.01
Crude fiber (g %)	0.18±0.08	0.38±0.14
Total Carbohydrate (g %)	67.62±0.13	69.36±0.30
Available Carbohydrate (g %)	67.44±0.08	68.98±0.42
Energy (K. Cal)	483	495

All values are expressed as mean ± SD of 3 replications.

The mineral composition of cookies made from refined wheat flour (RF) i.e., control cookies and buckwheat flour (BWF) blend is shown in Table 5. Minerals including calcium, copper, iron, zinc and manganese were assessed for the cookies. The calcium (35.68 mg/100g), copper (0.24 mg/100g), iron (1.85 mg/100g), zinc (1.42 mg/100g) and manganese (1.25 mg/100g) contents were high in buckwheat enriched cookies compared to control cookies. This may be because buckwheat flour is rich in minerals especially Zn, Fe, K, Ca, Mg, Mn and Cu. Similar results were reported by Hussain *et al.* (2017) [6]; Sakac *et al.* (2015) [19].

Table 5: Mineral composition of cookies

Parameters	Refined wheat flour (Control) cookies	Buckwheat enriched cookies
Calcium (mg/100g)	24.68±0.20	35.68±0.20
Copper (mg/100g)	0.09±0.02	0.24±0.03
Iron (mg/100g)	0.93±0.07	1.85±0.06
Zinc (mg/100g)	0.30±0.20	1.42±0.03
Manganese (mg/100g)	0.37±0.07	1.25±0.04

All values are expressed as mean ± SD of 3 replications.

Conclusion

The physico-chemical composition *viz.*, diameter, thickness, weight, fat, ash, crude fibre, total carbohydrate, available carbohydrate and energy, calcium, copper, iron, zinc and manganese were higher in buckwheat enriched cookies compared to control cookies.

Reference

1. Anonymous. Official methods of analysis. Association of Official Chemists, 21st Ed. Washington, DC, USA, 2019.
2. Baljeet SY, Ritika BY, Roshan LY. Studies on functional properties and incorporation of buckwheat flour for biscuit making. International Food Research Journal,2010:17:1067–1076.
3. Bonafaccia G, Marocchini M, Kreft I. Composition and technological properties of the flour and bran from common and tartary buckwheat. Food Chemistry,2003:80(1):9–15.
4. Chopra N, Dhillon B, Puri S. Formulation of buckwheat cookies and their nutritional, physical, sensory and microbiological analysis. International Journal of Advanced Biotechnology and Research,2014:5(3):381–387.
5. Dietrych-Szostak D, Oleszek W. Effect of processing on the flavonoid content in buckwheat (*Fagopyrum esculentum* Moench) grain. Journal of Agricultural and Food Chemistry,1999:47:4383–4387.
6. Hussain N, Ali M, Hussain S, Mehmood K, Nasir M. Development of buckwheat cookies supplemented with wheat flour. International Journal of Food Science and Nutrition,2017:2(1):144–147.
7. Ikeda S, Yamashita Y. Buckwheat as a dietary source of zinc, copper and manganese. Fagopyrum,1994:14:29–34.
8. Jan U, Gani A, Ahmad M, Shah U, Baba WN, Masoodi FA, Maqsood S, *et al*. Characterization of cookies made from wheat flour blended with buckwheat flour and effect on antioxidant properties. Journal of Food Science and Technology,2015:52(10):6334–6344.
9. Kaur M, Singh KS, Arora AP, Sharma A. Gluten free biscuits prepared from buckwheat flour by incorporation of various gums: physicochemical and sensory properties. LWT Food Science and Technology,2015:62(1):628–632.
10. Kayashita J, Shimaoka I, Nakajoh M, Kato N. Feeding of buckwheat protein extract reduces hepatic triglyceride concentration, adipose tissue weight and hepatic lipogenesis in rats. Journal of Nutritional Biochemistry,1996:7:555–559.
11. Kreft I, Fabjan N, Yasumoto K. Rutin content in buckwheat (*Fagopyrum esculentum* Moench) food materials and products. Food Chemistry,2006:98(3):508–512.
12. Laguna L, Salvador A, Sanz T, Fiszman SM. Performance of a resistant starch rich ingredient in the baking and eating quality of short dough biscuits. LWT Food Science and Technology,2011:44(3):737–746.
13. Li S, Zhang QH. Advances in the development of functional foods from buckwheat. Critical Reviews in Food Science and Nutrition,2001:41:451–464.
14. Liu Z, Ishikawa W, Huang X, Tomotake H, Kayashita J, Watanabe H. A buckwheat protein product suppresses 1,2-dimethyl hydrazine induced colon carcinogenesis in rats by reducing cell proliferation. The Journal of Nutrition,2001:131:1850–1853.
15. McWatters KM. Cookie baking properties of defatted peanut, soybean and field pea flours in baking powder biscuits. Cereal Chemistry,1978:55:853–863.
16. Mustafa AI, Alwessali MS, Busha OM, Amia RH. Utilization of cowpea flour and protein isolate in bakery products. Cereals Food World,1986:31:756–759.
17. Nalinkumar A, Singh P. An overview of buckwheat (*Fagopyrum* spp.) an underutilized crop in India – nutritional value and health benefits. International Journal of Medical Research and Health Sciences,2020:9(7):39–44.
18. Rufeng N, Enqi L, Chuangji C, Jiangping Z. A study of the production of healthy biscuit made with tartary buckwheat grown in North China. Current Advances in Buckwheat Research,1995:861–865.
19. Sakac MA, Mladenka P, Aleksandra M, Natasa N, Dubravka J, Pavle J, Vojislav B, *et al*. Antioxidant capacity, mineral content and sensory properties of

gluten-free rice and buckwheat cookies. Food Technology and Biotechnology,2015:53(1):38–47.
20. Sharma P, Gujral HS. Extrusion of hulled barley affecting β-glucan and properties of extrudates. Food and Bioprocess Technology,2013:6(6):1374–1389.
21. Skrabanja V, Kreft I, Golob T, Modic M, Ikeda S, Ikeda K. Nutrient content in buckwheat milling fractions. Cereal Chemistry,2004:81(2):172–176.
22. Stojceska V, Ainsworth P, Plunkett A, Ibanoglu S. The effect of extrusion cooking using different water feed rates on the quality of ready-to-eat snacks made from food by products. Food Chemistry,2009:114(1):226–232.
23. Tomotake H, Shimaoka I, Kayashita J, Yokoyama F, Nakajoh M, Kato N. A buckwheat protein product suppresses gallstone formation and plasma cholesterol more strongly than soy protein isolate in hamsters. The Journal of Nutrition,2000:130(7):1670–1674.