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Effect of Germination on Nutritional Composition of Common Buckwheat (*Fagopyrum esculentum Moench*)

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Authors' contributions

This work was carried out in collaboration among all authors. Author KS performed work, statistical analysis and wrote the first the first draft of the manuscript. Authors SSD, WJS and BNP designed study, managed literature and approved final manuscript. All authors read and approved the final manuscript.

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ABSTRACT

There is a growth trend in buckwheat consumption, as it has high nutritional value. Buckwheat is the main form consumed, although the consumption of buckwheat sprouts is increasingly popular in the world. Buckwheat grains were germinated at 30°C for 48 hours with 12 hours of soaking in BOD incubator followed by drying at 60°C. Germination process has increased moisture, protein and crude fiber (11.03% - 12.77%, 10.22% - 12.14% and 0.92% - 1.44%). Minerals such as sodium and potassium were also increased. Total and reducing sugars were increased and starch content has decreased with the germination process. Germinated buckwheat flour can be used in the formulations of nutraceutical foods.

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1. INTRODUCTION

Pseudocereals are the seeds resembling cereals in function and composition. Amaranth, quinoa and buckwheat are the commonly used pseudocereals. Among the main nine species of buckwheat, common buckwheat and tartary buckwheat are widely grown species [1]. Government of India declared two pseudocereals, amaranth and buckwheat as "Nutri Cereals" due to their high nutritive value for production and consumption to combat hidden hunger of burgeoning population. Buckwheat grains contain a variety of nutrients like proteins, polysaccharides, lipids, dietary fiber, rutin, polyphenols along with micro elements. It has a well-balanced amino acid profile with a good amount of lysine, which is limiting amino acid in wheat and barley [2]. Minerals such as zinc, copper, and potassium from buckwheat is especially high which play an essential role in the prevention of hypertension and anemia [3].

There are many traditional food processing methods to eliminate nutritional impediments which also contribute to alleviation of existing micronutrient deficiencies. Germination is the one of the widely accepted technique in cereal grains that helps in breakdown and leaching of anti-nutrients like phytate and protease inhibitors and activating enzyme systems that catalyzes the hydrolysis of reserved compounds such as proteins, starch and mineral solubility for improved bio-availability of nutritional value [4,5,6] in sorghum millet. Increased nutritional compounds were observed by [7] in foxtail, [8] in ragi, [9] *C. album* and [10] in brown rice. There were many reports on improved sensory, functional and nutritional properties along with clinical benefits [11-14]. The objective of this study is to investigate the effect of germination of buckwheat in its proximate, starch content, total and reducing sugars along with minerals.

2. MATERIALS AND METHODS

2.1 Preparation of Raw Material

Common buckwheat (*Fagopyrum esculentum* Moench) was procured from Assam Agricultural University, Jorhat, India. Buckwheat was graded to eliminate seeds that were damaged and deformed. The cleaned grains were soaked in distilled water for 12 hours, drained, shifted to sterilized petri plates for germination and placed in BOD incubator at 30ºC for 48 hours by frequent moistening of grains. The germinated buckwheat was dried at 65°C in a tray drier for 5-6 hours to moisture content below 12.0%. The dried sprouts were grounded to flour and stored in plastic bags till analysis. Whole buckwheat flour was used as the control.

2.2 Nutritional Analysis

The analysis was carried out as per the standard AOAC procedures. Moisture, ash and protein [15,16], fat, carbohydrate and energy [17], crude fiber [18], sodium and potassium [19] were used to estimate germinated and ungerminated buckwheat flours.

3. RESULTS AND DISCUSSION

3.1 Proximate Composition

Effect of germination in buckwheat on proximate composition was presented in Table 1. Percent changes in nutrients compared with control were presented in Fig. 1.

3.2 Moisture

The moisture content of ungerminated and germinated buckwheat varied between 11.03 to 12.77%. The moisture has increased by 15.78% after germination (Fig. 1). There was significant increase of moisture in soya beans after germination from 6.71 to 63.72% as reported by [20]. As germination proceeds grains take up water from surrounding water in order to commence metabolic process. Water uptake into the grain is increased as the time increases to a certain point due to increasing in number of cells within grain becoming hydrated [6, 20].

3.3 Protein

The protein content of germinated buckwheat was 12.14%, whereas in ungerminated one was 10.22%. The increased percentage of protein after germination was 18.79% compared to ungerminated buckwheat flour (Fig.1). Similar results in germinated buckwheat were reported by [3]. The protein content of germinated quinoa grains from 11.18 to 12.32% [21]. The protein content in extrudes of brown rice before and after germination increased from 7.8 to 8.2% [22].

The higher sprouting temperature and longer sprouting time can result in greater loss of dry weight and increase in crude protein content. The reawakening of protein synthesis upon imbibition of water before germination can lead to increased protein content in sprouted seeds [23]. The increase may be due to an enzymatic synthesis or other components losses [20].

3.4 Fat

Fat content of buckwheat decreased from 3.13±0.10 g/100 g to 2.05±0.15 g/100 g after germination. The percent change after germination was 34.50% (Fig.1). Sesame seeds were germinated at 35ºC for 4 days decreased the fat content in sesame seeds was 23% [24]. Decrease in fat content may be due to depletion of the fat stored that contributed to the catabolic activities of the seeds during sprouting [25]. Fatty acids were oxidized to CO_2 and H_2O to generate energy for sprouting and there was synthesis of certain structural constituents in seedlings [26].

3.5 Ash

The results showed that ash content in buckwheat decreased after processing by 25.36% (Fig. 1). Ash content of the buckwheat was 2.05% and it decreased to 1.53% after germination (Table 1.). Ash content of the amaranth seeds has decreased from 2.9 to 0.5% after germination [27]. The ash content of the sorghum has varied between 2.9 to 2.65% after germination in sorghum [28]. Similar results in white sesame [29]. This fact could be explained for the mineral loss during the germination process, formation of rootlet and soaking before the germination begins [15].

3.6 Crude Fiber

The results indicated that crude fiber content of germinated buckwheat flour was higher than the ungerminated buckwheat flour by 56.52% (Fig. 1). The crude fiber content of buckwheat was 0.92% and it has risen to 1.44% after germination as shown in Table 1. The increment in crude fiber content may be attributed to the breakdown of starch. The fiber content of ungerminated millet grain flour varied between 3.5 to 3.7% whereas that of germinated grains varied from 4.7 to 6.3% [30]. The crude fiber content of chickpea increased from 5.65 to 8.96% after germination processing [31].

3.7 Carbohydrate

The carbohydrate content of the buckwheat after germination decreased from 72.63 to 69.49% (Table 1.). The percentage decreased after germination was 4.32% (Fig. 1). There was 5.6% decrease of carbohydrate in germinated cowpea after 24 hours germination [32]. Similarly, 2.34% decrease in carbohydrate content after germination in cowpea was observed [33]. During sprouting, carbohydrates are used as source of energy for embryonic growth which explains the changes in carbohydrate content after sprouting [34].

3.8 Energy

The energy content of ungerminated buckwheat was higher than the germinated buckwheat. Energy content of buckwheat was 360 Kcal decreased to 345 Kcal (Table 1.). The percent decrease in germinated buckwheat was 4.05%. Germination of buckwheat has decreased the total carbohydrate, energy, ash, fat and increased the moisture, protein and fiber content of buckwheat.

3.9 Mineral Content

The germination has increased the mineral content of buckwheat flour as mean scores presented in Table 2. The percentage change in mineral content was shown in Fig. 2.

The results indicated that sodium content increased by 65.48% with germination. Sodium content in ungerminated buckwheat was 3.1 ppm which increased to 5.13 ppm due to germination. The potassium content of buckwheat increased from 427.6 to 517.0 ppm after germination with the increased percentage of 20.90% in germinated ones. This might be due to breakdown of internal structures. Potassium and sodium have increased from 445 ppm and 6.5 ppm before germination to 472.0 ppm and 8.4 ppm after germination respectively in sesame seeds [28]. The sodium content of mung bean, pea and lentils increased from 11.00 to 11.62, 12.00 to 12.71 and 11.00 to 11.66 ppm respectively. In as similar fashion, potassium content of mung bean, pea and lentils increased from 340.0 to 410.0, 360.0 to 415.0 and 240.0 to 300.0 ppm with germination [35].

3.10 Starch, Total and Reducing Sugars

The mean scores of starch, total and reducing sugars were presented in the Table 3. The starch content of the buckwheat decreased with the effect of germination by 8.35% (Fig. 3.). The starch content of buckwheat lowered from 42.83±0.35% to 39.25±0.78%. The total sugars and reducing sugar content of buckwheat was increased by 76.08 and 46.77% after germination (Fig 3.). The ungerminated buckwheat content of total and reducing sugars were 1.84±0.19 and 0.62±0.03% increased to 3.24±0.25 and 0.91±0.08% with the processing effect such as germination. The content of the total and reducing sugars were increased from 0 to 1.08 and 3.7 to 8.0% by germination in amaranth grain [31].

The effect of physico-chemical change in germinated buckwheat (*Fagopyrum esculentum* Dur) was observed in starch content which decreased from 55.8 to 51.56% whereas total and reducing sugar content have increased from 2.40 to 4.85 and 0.80 to 0.97% [3]. This might be due to increased activity of α-amylase and β-amylase enzyme that hastened the germination process resulting in breakdown of starch molecules.

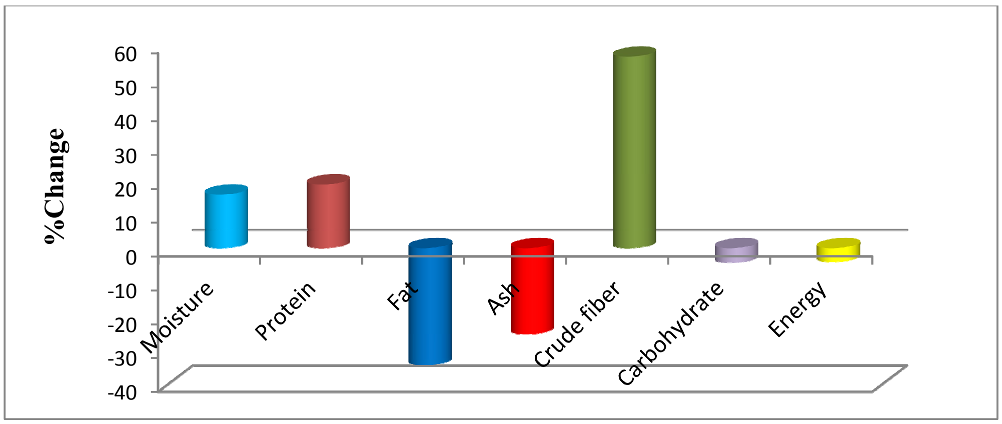

Fig 1. Percentage change in proximate composition of germinated buckwheat

Table 1. Proximate composition of germinated buckwheat

Samples	Moisture (g/100g)	Protein (g/100g)	Fat (g/100g)	Ash (g/100g)	Crude fiber (g/100g)	Carbohydrate (g/100g)	Energy (Kcal)
BW	11.03±0.17	10.22±0.32	3.13±0.10	2.05±0.17	0.92±0.12	72.63±0.41	359.64±1.98
GBW	12.77±0.17	12.14±0.25	2.05±0.15	1.53±0.15	1.44±0.08	69.49±0.60	345.06±3.42
Mean	11.90	11.18	2.59	1.79	1.18	71.11	352.35
CD	0.17	0.29	0.03	0.17	0.10	0.20	1.74
SE of mean	0.05	0.14	0.01	0.05	0.01	0.07	4.94
CV%	0.43	1.26	0.06	2.88	1.60	0.09	1.40

Note: Values are expressed for the three determinants as mean ± standard deviation
BW – Buckwheat GBW – Germinated buckwheat

Table 2. Mineral content in selected GBW

S. no	Sample	Sodium (mg/100g)	Potassium (mg/100g)
1	BW	3.1±0.1	427.6±1.52
2	GBW	5.13±0.20	517±2.64
3	Mean	4.11	473.5
4	CD value	0.13	2.09
5	SE of mean	0.03	7.16
6	CV%	0.77	1.51

Note: Values are expressed as mean ± standard deviation for the three determinants BW – Buckwheat GBW – Germinated buckwheat

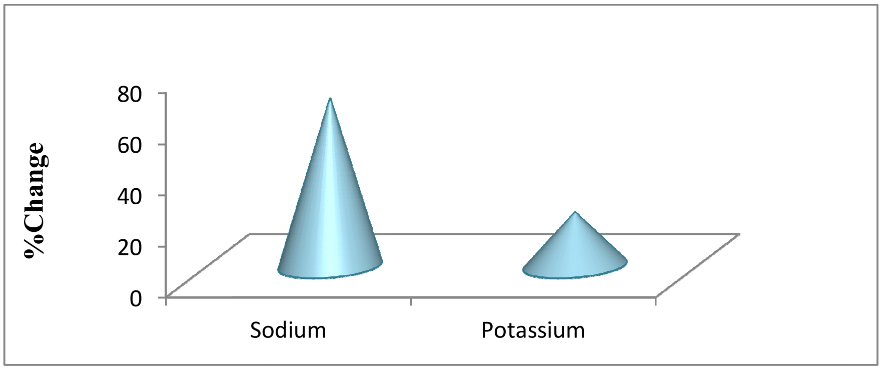

Fig. 2. Percentage change in mineral content of selected GBW

Table 3. Total and reducing sugars content in selected GBW

S. No	Sample	Starch	Total sugars	Reducing sugars
1	BW	42.83±0.35	1.84±0.19	0.62±0.03
2	GBW	39.25±0.78	3.24±0.25	0.91±0.08
3	Mean	41.04	2.54	0.76
4	CD value	0.23	0.07	0.02
5	SE of mean	0.09	0.008	0.001
6	CV%	0.22	0.34	0.13

Note: Values are expressed as mean ± standard deviation for the three determinants
BW – Buckwheat GBW – Germinated buckwheat

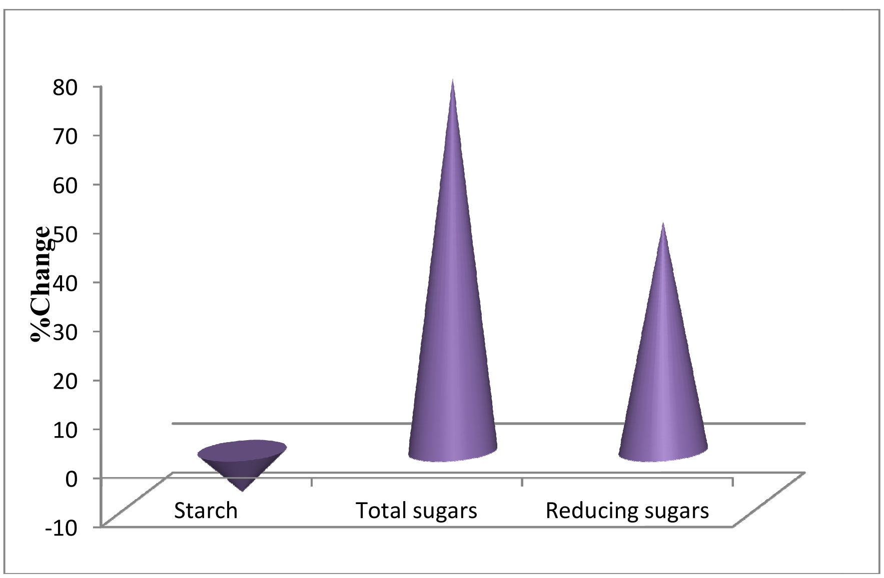

Fig. 3. Percentage change in starch, total and reducing sugar content of selected GBW

4. CONCLUSION

It can be concluded that even though there is increased protein, crude fiber, minerals, total and reducing sugars content whereas decrease in starch, total carbohydrates as well as energy due to germination. In view of this, germinated buckwheat can be incorporated in low calorie foods for diabetes, hypertensive and celiac patients as it is gluten free grain. Germination along with fermentation can increase nutritional composition and can be used in designing traditional foods to improved nutrient bioavailability. Analyzing functional, pasting, cooking and rheological properties of germinated buckwheat flour and development of functional products from it are suggestible.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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