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Physical, proximate and nutritional composition of cookies incorporated with germinated brown rice

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Abstract
Enrichment of food products with functional components has been commonly used in order to enhance their pro-health properties. The cookies prepared with 10% incorporation of Germinated brown rice were found to be best. The diameter of GBR incorporated cookies was lower than control cookies. Thickness of the cookies varied from 12.11mm to 12.14mm and the spread factor of cookies varied from 4.32 to 4.30 with incorporation of GBR. The nutritional analysis of cookies showed that the moisture content was lower in control sample (2.23%) when compared with the GBR incorporated cookies (2.32%). Similarly the ash and protein contents were higher in GBR incorporated cookies than control cookies. The fat content was 27.19% in GBR incorporated cookies and 27.28% in control cookies. The energy content was higher in control than GBR incorporated cookies. Control cookies had higher energy value due to higher amount of carbohydrate than the GBR incorporated cookies. The crude fiber content of cookies with 10% level of incorporation of GBR was 0.75 g/100g. The total dietary fiber of cookies was 0.84%. The percentage inhibition values of cookies was 30.02 mg/ml.

Keywords: Cookies, Brown rice, Germination, Incorporation, Nutrition quality, *in vitro* carbohydrate digestibility

Introduction
Rice is the most important staple food for a large part of the world's human population. It provides more than one fifth of the calories consumed worldwide by the human. It is grown in at least 114 countries with global production of 645 million tons and Asian farmers contributing about 90% of the total produce (Sharif *et al.*, 2014) [18]. Roy *et al.* (2011) [17] stated that as brown rice, germinated brown rice and partially milled rice contain health beneficial food components compared to well mill rice. The concentration of crude protein, total free amino acids, α-tocopherol, γ-oryzanol, thiamine, niacin and pyridoxine, in the germinated rough rice and the germinated rice extracted powder, were significantly higher, than those of the germinated brown rice and the ungerminated rice, while there was no significant difference in the levels of crude fat, carbohydrate and ash (Anuchita and Nattawat, 2010) [3]. Enrichment of food products with functional components has been commonly used in order to enhance their pro-health properties. (Akhtar *et al*., 2011) [2]. GBR is used to make many products such as rice-balls, soup, bread, doughnuts, cookies, rice burger, etc. (Patil and Khan, 2011) [15].

Material and methods
Germination process: Paddy (*Oryza sativa*) variety RNR 15048 was procured from Rice section, ARI Rajendranagar, Hyderabad. Paddy was dehusked by a rubber roll huller at 14% moisture content. The mixture comprising brown rice and paddy was separated by a paddy separator. The brown rice was obtained from the paddy separator.

Preparation of GBR flour: The brown rice was germinated by soaking it in warm water of 35–40 °C for about 10–12hr, after that water drained out and kept in moist condition for 48-52hr and during soaking period, changing the water every 3–4hr to prevent fermentation (which usually produces undesirable odour) and to maintain consistent water temperature.

Standardization and development of cookies: Refined wheat flour and GBR flour are used in the preparation of cookies. The incorporated level of GBR is 10%, 20% and 30%.

Control samples were prepared with refined wheat flour. The experimental samples were made with GBR in different proportions i.e. 10%, 20% and 30%. The ingredients, processing conditions, process parameters were taken from the bakery laboratory manual.

Selection of best accepted incorporation level

The cookies prepared with 10% incorporation of cookies were found to be most accepted product. Sensory evaluation was conducted to the product as per the procedure followed by 9 point hedonic scale given by Meilgaard *et al.* (1999) [14]. Physical characteristics like diameter, thickness and spread factor were determined according to the (AACC 2000) [1] method. Nutritional analysis were carried to cookies as per the procedures followed by standard AOAC methods. Moisture, ash and protein (AOAC, 2005) [7-9], fat (AOAC, 1997) [6], carbohydrate and energy (AOAC, 1980) [4], crude fiber (AOAC, 1990) [5] and total dietary fiber (AOAC 2000) were used.

Results and discussion

Physical quality characteristics of cookies

Diameter: The diameter of cookies prepared with 10% incorporation of GBR had lower value (52.26mm) compared with control cookies (52.32mm). Percent decrease in diameter of 10% GBR cookies was 0.11% when compared with control (Figure 1).

Thickness: The result showed that 10% GBR incorporated cookies (12.14mm) had higher thickness compared with control 12.26mm. The percent increase in Thickness of 10% GBR cookies was 0.25% when compared with control (Figure 1).

Spread ratio: The spread ratio was affected by the competition for the available water. The result showed that control had the higher spread factor 4.32 than sample (4.30). The percent decrease in spread ratio of 10% GBR cookies was 0.46% when compared with control. The spread factor is highly dependent on the dough viscosity. Chung *et al*. (2014) [10] reported that the cookies containing GBR showed lower spread factors than those prepared with brown rice flour. The degradation of macromolecules usually increases hydrophilic nature of the cookies as found in the results of moisture content.

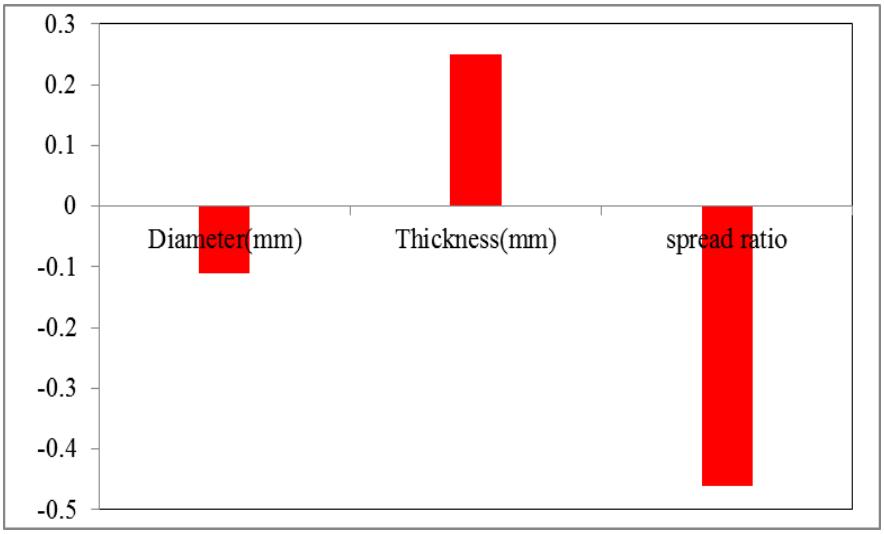

Fig 1: Percent change in the physical quality characteristics of GBR incorporated cookies in comparison with control.

Proximate composition of cookies

Moisture content: The results indicated that the moisture content was lower in control sample than the value added products. The moisture content of 10% GBR (C_1) sample was higher than the control sample(C 2.32). There was a significant difference (p<0.05) in the moisture content of cookies. Kumar *et al.* (2011) observed that moisture content varied from 4.03 to 4.79% with an average moisture content of 4.41% in cookies.

Ash content: The results of cookies indicate that ash content showed significant difference (p<0.05) amongst the cookies. The ash content varied from 0.96 to 1.12%. The ash content of GBR incorporated cookies is higher than control cookies

Protein content: Statistically there was no significant difference between the control and GBR incorporated cookies (p<.005). High protein content was seen for 10% GBR cookies (7.95%) than in control cookies (7.88%).

Similar results reported by Kulthe *et al.* (2014) [12] in development of high protein and low calorie cookies prepared by substituting maida with defatted soy flour (DSF) at 0, 10, 15, 20 and 25% levels and sugar with stevia leaves powder (SLP) at 0, 15, 20, 25 and 30% levels. The protein content was increased from 6.1 to 10.0% on substitution of maida with 20% DSF and to 12.8% on substitution of maida with 20% DSF and substitution of sugar with 20% SLP.

Fat content: The results obtained showed that the fat content in control cookies was 27.28 and it was 27.19 % in C_1. The lower fat content was observed in 10% GBR than control. Statistically significant difference was observed in fat content of control and experimental samples.

Table 1: proximate composition of cookies

samples	Moisture (%)	Ash (%)	Protein (%)	Fat (%)	Carbohydrate (%)	Energy(kcal/100g)
C	2.23^{b}±0.05	0.96^{b}±0.07	7.88^{a}±0.03	27.28^{a}±0.03	60.98^{a}±0.12	521^{a}±0.06
C_1	2.32^{a}±0.03	1.12^{a}±0.04	7.95^{a}±0.03	27.19^{b}±0.04	60.66^{b}±0.08	520^{b}±0.57
Mean	2.36	1.15	8.04	27.15	60.51	518.56
CD	0.04	0.10	0.07	0.01	0.19	0.64

Note: Values are expressed as mean ± standard deviation of three determinations.
Means within the same column followed by a common letter do not significantly
Differ at $p < 0.05$.
C - Control sample
C_1 - 10% GBR incorporated cookies

Carbohydrate content: The carbohydrate content of control was 60.98% and 60.66% was observed in experimental samples. The Germinated brown rice incorporated cookies showed lower score for carbohydrate than control.

Energy content: The higher energy content was seen in control cookies (521 kcal) than 10% GBR cookies (520 kcal). The incorporation of GBR lowered the total carbohydrate and energy content and improved the ash and protein content when compared with control. Statistically significant difference was observed in energy content between control and GBR incorporated cookies.

Nutritional composition of cookies: Nutritional composition of cookies was given in table 2.

Crude and total dietary fiber: Crude fiber is the residual part remaining after treatment with acid, alkali and alcohol. Dietary fiber is the portion that is resistant by digestion to enzymes secreted in human body consisting of hemi cellulose, cellulose, lignins, oligosaccharides, pectin, gums and waxes. Crude fiber is a part of dietary fiber (Dhingra *et al.*, 2012) [11]. The consumption of diets with high dietary fiber lower the risk of cardiovascular diseases by reducing the plasma and LDL cholesterol levels but do not alter the concentration of HDL cholesterol or triglycerides (Schneeman, 1999) [19]. The result showed that crude fiber content in cookies with 10% level of incorporation of GBR was 0.75 g/100g. The total dietary fiber of cookies was 0.84%.

***In vitro* carbohydrate digestibility**: α-Amylase is one of the main enzymes in human body that is responsible for the breakdown of starch to more simple sugars. α-Amylases hydrolyze complex polysaccharides to produce oligosaccharides and disaccharides which are then hydrolyzed by α-glycosidase to monosaccharide which are absorbed through the small intestines into the hepatic portal vein and increase postprandial glucose levels (Ranilla *et al*., 2010) [16]. The percentage inhibition values of cookies calculated for was 30.02 mg/ml. There was not much change in the inhibition percentage in the developed cookies

Table 2: Nutritional composition of cookies

S.NO	Parameters	Mean values
1.	Crude fiber (g/100g)	0.75±0.03
2.	Total dietary fiber (g/100g)	0.84±0.02
3.	*In vitro* carbohydrate digestibility(mg/ml)	30.02±0.03

Note: Values are expressed as mean ± standard deviation of three determinations.
Units: g/100gm

Conclusion: Control cookies had significantly higher content of fat, carbohydrate and energy than GBR incorporated cookies. Cookies incorporated with germinated brown rice were having higher content of moisture, ash and protein in comparison with control cookies. The crude fiber content of cookies with 10% level of incorporation of GBR was 0.75 g/100g. The total dietary fiber of cookies was 0.84%. The percentage inhibition values of cookies calculated for was 30.02 mg/ml. More studies should be conducted to investigate the possibility of using GBR as an ingredient in other food products in order to increase applications of such value added food ingredient. Consumer acceptability studies and commercialization on developed baked products can be carried out to popularise the product.

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