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SENSORY, PHYSICAL AND NUTRITIONAL QUALITIES OF COOKIES AND PINNIS PREPARED FROM BROWN RICE AND WHEAT FLOUR

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Abstract

Rice is the food which is most predominantly used across all over the world. Rice contains all the major and the minor nutrients required for the growth of the human body. It contains a sufficient amount of carbohydrates, proteins, fat, vitamins and minerals which provide energy to the body. Brown rice is obtained after shelling of paddy, which on further milling provided milled rice. Brown rice has higher amount of vitamins, minerals and antioxidants as compared to the milled rice. The present study was undertaken to utilize the optimum level of brown rice flour for cookies and pinnies preparation. Cookies and pinnis enriched with brown rice flour were prepared and their physical, proximate, colour and texture parameters were analyzed.

Key words : Vitamins, nutritional qualities, brown rice, antioxidances.

Introduction

Rice (*Oryza sativa* L.) is one of the most important staple food consumed by half of the world population. The nutritional quality of rice has received greater attention in developing countries, where only rice consumption may lead to nutritional deficiencies of minerals and vitamins (Bouis *et al*., 2003). According to FAO STAT, 2008, after China, India accounts second in the production of rice with a total production of 141 million tons and 187 million tons respectively.

In general structure of rice, consists of the outer protective covering, the hull and the caryopsis or fruit. Rice bran is the most abundant and underutilized co-product during the milling process (Laokuldilok *et al*., 2011). As the bran is rich in lipid bodies mainly in the embryo, alarm layer and subaleurone layers, its energy level is higher than the brown rice followed by milled rice. It has shown that rice bran contains a unique complex of naturally occurring antioxidant compounds. Natural antioxidants present in rice bran include tocopherols, tocotrienols and γ-oryzanols. Safety concerns of synthetic antioxidants such as butylated hydroxyanisole (BHA) and butylated hydroxyl toluene (BHT) have increased interest in finding effective natural antioxidants to replace synthetic antioxidants.

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Brown rice consists of the outer layers of the pericarp, seed coat and the nucleus; the germ or embryo; and the endosperm. All nonstarch components in the brown rice are concentrated in the bran fraction of rice, whereas milled rice mainly consists of endosperm (starch). Brown rice contains a higher amount of crude fat, crude ash, crude fiber and total dietary fiber than the milled rice. The nutritional components in brown rice mainly exist in the germ and bran layers, which are mostly removed by polishing as a consequence; milled rice has a lower nutritional quality than brown rice (Monks *et al*., 2013). Brown rice is a good source of functional components which provide a health benefit beyond basic nutrition (Ito *et al*., 2005). Human and animal studies have shown that consumption of brown rice reduces the risk of type-2 diabetes, cardiovascular disease, cancer and these protective health effects have been linked to the presence of bioactive compounds such as antioxidants, polyphenols, minerals, vitamins and dietary fiber in the bran layer of rice grain (Kim *et al*., 2012; Mir *et al*., 2016). White rice (milled rice) has been the major form of consuming rice while the remaining part of the whole rice grain has been used as animal feed.

Snacks, in the food market, increases with the demand for convenient food and with the change in lifestyle pattern. Snack foods are popular products that

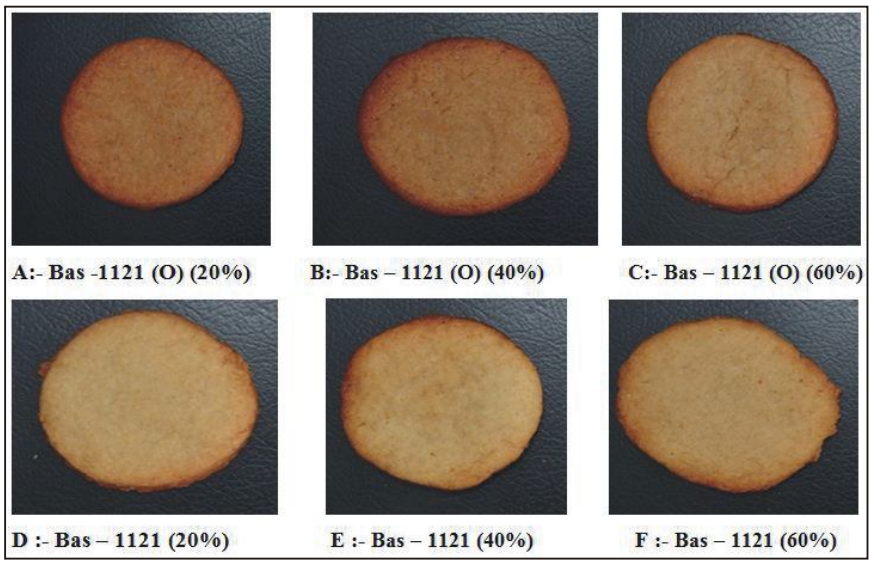

Fig. 1: Brown Rice Flour Cookies incorporated with different levels of the wheat flour mix.

are highly appreciated and consumed throughout the world (Hossain and Shin, 2013). In the market, various types of snacks are available which are designed to be semi perishable and more tempting. Snacks of the new generation fall into several categories such as low fat, high fat, baked, fried, etc. (Mazumder *et al*., 2007; Shittu and Olaitan, 2014). Nowadays, cereal-based snacks have gained importance due to their nutritional value and sensory attributes (Mir *et al*., 2017). Mostly cookies are used as snacks and are prepared from the refined wheat flour, which is deficient in essential nutrients and can thus be used as the matrix for food fortification.

The objectives of the present study were to optimize the formulation of a healthy snack from brown rice flour and wheat flour. Therefore, the brown rice flour which contains a high amount of bioactive compounds and minerals was incorporated into wheat flour in the preparation of cookies and pinnis to increase its nutritional value.

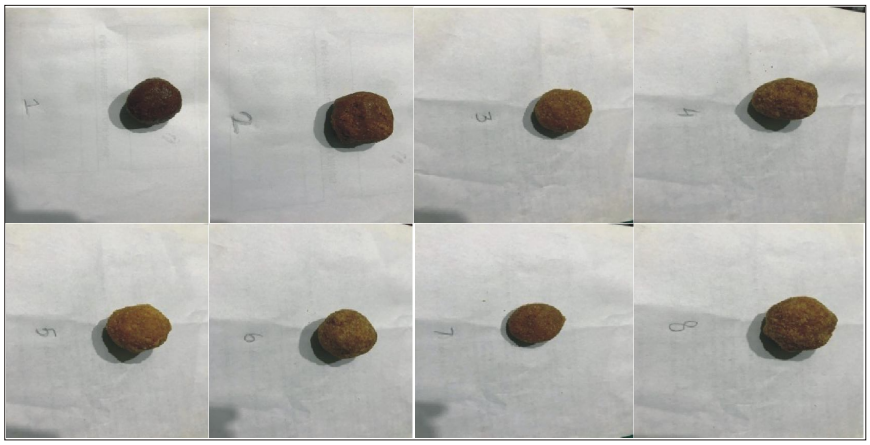

Fig. 2: Brown Rice Flour Pinnis incorporated with different levels of the wheat flour mix.

Materials and Materials

Production of brown rice flour and wheat flour cookies

Two types of flour, brown rice flour and wheat flour were used for this study. The brown rice of BAS-1121 and BAS-386 of both organic and conventional varieties was used. To produce rice flour, the brown rice grains were milled in a laboratory super mill (Super Mill-1500, Newport Scientific Pvt. Ltd, Warriewood, Australia). The brown rice flour was then sieved using a 200 μm sieve to obtain a cookie making flour according to Benkadri (2010). Wheat flour was bought from the local market.

Preparation of composite flours

The brown rice and wheat flours were blended to form composite flours. The substitution level was determined according to Górecka *et al*., (2010). Three substitution levels of brown rice flour with the wheat flour at 20%, 40% and 60% were studied for cookies preparation and 100% and 50% for pinnis preparation. No replacements were done at the control level.

Production of brown rice cookies

The brown rice flour and wheat flour cookies were produced according to a basic recipe developed by AACC, (1990). This recipe comprised of the following raw materials and ingredients: Wheat flour (225.0 g), Sugar (130.0g), Vegetable fat (64.0g), Sodium bicarbonate (2.5 g), Salt (2.1g), Dextrose solution (33.0 mL) and Distilled water (16.0 mL).

Production of brown rice pinnis

Jaggery solution was prepared by adding powdered jaggery (1kg) boiled with 250 mL of distilled water. 50gm of various proportions of brown rice flour and wheat flour were roasted in a vessel on an induction heater set at 80°C and 400 W. When color just changed to brownish, 7.5g of Desi ghee (milk fat) and 12.5mL of jaggery solution was added. Roasting was done at a slow rate of heating with the constant movement of all mass to avoid burning with heat for about 40 min. The vessel was removed from induction heater and small balls of the mixture were formed which was named as pinnis.

Table 1: Proximate composition of Wheat Flour and Brown Rice Flour Cookies.

Samples		Wheat:Rice	Protein (%)	Moisture (%)	Fat (%)	Fiber (%)	Ash (%)	Carbohydrate (%)
Control		100	10.11±0.25^{c}	7.31±0.21^{b}	10.12±1.07^{a}	1.25±1.02^{a}	1.74±0.23^{a}	69.47±0.22^{b}
1121(O)	20%	80:20	8.41±1.05^{b}	7.24±1.03^{a}	15.34±0.56^{b}	1.13±0.64^{a}	1.68±1.07^{a}	66.2±0.43^{a}
	40%	60:40	8.26±0.32^{b}	7.18±0.47^{a}	16.21±2.41^{c}	1.26±0.74^{a}	1.46±0.63^{a}	65.63±0.54^{a}
	60%	40:60	7.01±0.47^{a}	6.56±0.36^{a}	17.31±0.47^{d}	1.21±0.21^{a}	1.70±0.24^{a}	66.21±1.68^{a}
386 (O)	20%	80:20	8.86±2.51^{b}	6.78±0.87^{b}	16.34±0.74^{b}	1.18±1.02^{a}	1.65±0.47^{a}	56.33±1.07^{c}
	40%	60:40	7.89±0.95^{a}	7.86±0.74^{d}	16.97±0.21^{b}	1.43±0.94^{a}	1.34±0.37^{a}	64.51±0.27^{a}
	60%	40:60	7.18±0.23^{a}	6.56±0.25^{a}	18.37±0.3^{c}	1.20±0.19^{a}	1.68±0.54^{a}	65.01±0.58^{b}
1121	20%	80:20	8.72±0.47^{b}	6.98±1.02^{a}	17.24±0.4^{b}	1.23±0.44^{a}	1.75±0.74^{a}	64.08±0.65^{a}
	40%	60:40	7.56±1.02^{a}	7.36±0.63^{a}	17.32±0.78^{b}	1.48±0.74^{a}	1.73±1.05^{a}	64.55±0.21^{a}
	60%	40:60	7.24±0.65^{a}	6.74±0.74^{a}	18.52±0.96^{c}	1.22±1.05^{a}	1.70±0.54^{a}	64.58±0.47^{a}
386	20%	80:20	7.63±0.47^{a}	7.93±0.41^{c}	16.24±0.98^{b}	1.21±1.07^{a}	1.74±0.24^{a}	65.25±0.98^{a}
	40%	60:40	7.94±1.08^{a}	7.63±0.85^{c}	17.38±0.41^{c}	1.34±1.64^{a}	1.69±0.67^{a}	65.24±0.41^{a}
	60%	40:60	7.09±0.25^{a}	6.48±2.03^{a}	18.36±3.01^{d}	1.15±0.41^{a}	1.46±0.42^{a}	65.46±0.47^{a}

Chemical composition of cookies

Brown rice flour cookies from both the modes of farming were tested for their moisture, ash, fat and protein content by employing the standard methods of analysis (AOAC, 1990).

Physical analysis of cookies

Diameter, thickness, spread ratio and spread ratio of cookies were calculated by the standard method of AACC, (1969).

Hunter color characteristics of cookies and pinnis

The visual color was measured using a Hunter colorimeter (Ultra Scan, VIS-1084; Hunter Associates Laboratory, Reston, VA, USA). The colorimeter was standardized with a standard tile. The sample cup was filled with cookies and pinnis, kept in a sample platform and its color was recorded in terms of L^*, a^* and b^* values. The L^* values indicate whiteness to darkness. The chromatic portion is defined by a^* (+) redness and a^* (-) greenness, b^* (+) yellowness and b^* (-) blueness (Sharma and Gujral, 2011).

Texture analysis of cookies and pinnis

The texture of cookies and pinnis were determined by measuring their hardness using the TX-XT2I Texture Analyzer (Texture Technology Crop., Scarsdale, New York, USA) according to Inglett *et al.*, (2015). Hardness was measured by penetrating the cookies and pinnis with a flat probe of 5 mm diameter using a TX-XT2i Texture Analyzer equipped with 5 kg load cell in compression mode. The hardness of the cookies and pinnis was tested using a pre-test speed of 2.00 mms^{-1}, test speed of 3mms^{-1}, post-test speed of 10.0 mms^{-1} and a distance of 20 mm.

Sensory evaluation of cookies and pinnis

The sensory attributes of the rice cookies and pinnis were determined by panelists comprising of students and staff of the Khalsa College Amritsar. The cookies and pinnis were evaluated for appearance, color, aroma, taste, texture and overall acceptance using a 9-point hedonic scale ranging from 9 (like extremely) to 1 (dislike extremely).

Table 2: Physical analysis of wheat & brown rice flour cookies.

Samples		Wheat : Rice	Weight + Gram	Thickness (mm)	Diameter (mm)	Spread ratio
Control		100	13.09±1.05^{a}	7.0±0.1^{c}	47.0±1.36^{a}	6.71±0.74^{a}
1121(O)	20%	80:20	20.75±2.03^{c}	5.2±0.85^{a}	60.0±0.58^{b}	11.53±0.89^{b}
	40%	60:40	17.84±3.25^{b}	5.0±0.74^{a}	63.0±0.47^{b}	12.6±0.32^{c}
	60%	40:60	20.55±1.05^{c}	5.9±0.26^{b}	63.8±0.25^{b}	10.81±0.96^{b}
386 (O)	20%	80:20	17.24±2.34^{b}	5.8±0.47^{b}	58.0±0.14^{a}	10.0±0.32^{b}
	40%	60:40	20.58±0.59^{c}	6.0±0.02^{b}	62.0±0.01^{b}	10.33±0.87^{b}
	60%	40:60	17.35±0.23^{b}	6.0±1.36^{b}	76.0±0.7^{c}	12.66±0.22^{c}
1121	20%	80:20	16.59±0.11^{b}	5.0±0.95^{a}	62.0±0.41^{b}	12.4±0.17^{c}
	40%	60:40	10.00±0.95^{a}	5.8±0.04^{b}	65.0±0.74^{b}	11.20±0.14^{b}
	60%	40:60	10.32±0.12^{a}	5.5±0.33^{a}	67.0±1.05^{b}	12.18±0.96^{c}
386	20%	80:20	8.32±1.02^{a}	6.0±0.21^{b}	64.0±0.74^{b}	10.66±0.5^{b}
	40%	60:40	13.56±0.47^{b}	10.9±1.04^{c}	68.0±0.12^{b}	6.23±2.04^{a}
	60%	40:60	8.03±0.67^{a}	4.00±0.85^{a}	74.0±0.23^{c}	18.50±1.08^{c}

Values expressed are an average of n = 3 (± standard deviation). Averages in a row with different superscript are significantly different ($P \leq 0.05$).

Results and Discussions

Proximate composition of cookies

The proximate composition of cookies produced was shown in (Table 1). Cookies made with BAS-1121 organic brown rice flour 60% had the lowest protein content (7.01%) while the control cookies made with 100 %

Table 3: Color Characteristic and texture analysis of wheat & brown rice flour cookies.

Samples		Wheat:Rice	L* Value	a* Value	b* Value	E*	Hardness (N)
Control		100	52.28±0.85^{c}	3.07±0.43^{a}	12.21±0.65^{d}	53.77±2.08^{d}	107.86±0.72^{b}
1121(O)	20%	80:20	48.02±0.47^{b}	4.78±0.94^{c}	11.23±1.57^{c}	49.55±1.05^{c}	230.42±0.28^{d}
	40%	60:40	43.63±0.98^{a}	3.08±0.14^{a}	8.18±1.38^{b}	44.50±0.68^{b}	164.18±1.67^{c}
	60%	40:60	41.07±0.44^{a}	3.37±1.05^{b}	7.39±0.29^{a}	31.86±0.58^{a}	179.77±1.08^{c}
386 (O)	20%	80:20	40.78±1.08^{a}	3.88±0.36^{b}	8.09±0.28^{b}	41.76±0.47^{b}	74.59±0.52^{a}
	40%	60:40	50.74±0.54^{b}	3.34±1.08^{b}	12.49±0.69^{d}	52.36±0.28^{d}	221.32±0.61^{d}
	60%	40:60	39.50±2.07^{a}	1.26±0.22^{a}	5.85±0.27^{a}	39.96±0.34^{a}	113.16±0.96^{b}
1121	20%	80:20	53.58±1.05^{c}	3.35±0.46^{b}	14.45±0.53^{d}	55.60±0.96^{d}	104.13±0.87^{b}
	40%	60:40	49.80±0.87^{b}	2.11±0.75^{a}	11.91±0.82^{c}	51.25±0.98^{d}	102.64±1.05^{b}
	60%	40:60	45.76±0.47^{a}	1.63±0.94^{a}	8.87±0.73^{b}	46.64±0.24^{c}	272.57±0.64^{d}
386	20%	80:20	47.93±0.65^{b}	2.46±1.07^{a}	10.38±0.58^{b}	49.19±0.21^{c}	196.48±0.87^{c}
	40%	60:40	39.81±1.05^{a}	0.84±0.44^{a}	6.36±0.11^{a}	40.32±0.74^{b}	69.00±0.65^{a}
	60%	40:60	61.45±2.01^{d}	3.37±1.09^{b}	5.45±1.24^{a}	40.42±1.02^{b}	117.34±0.21^{b}

Values expressed are an average of n = 3 (± standard deviation). Averages in a row with different superscript are significantly different ($P \leq 0.05$).

wheat flour had highest protein value (10.11%). It was observed that as the level of brown rice flour increases in the blends, the level of protein reduced in the cookies. This could be due to the high level of fat present in brown rice flour as the bran layer in brown rice is rich in lipid bodies. Values for fiber ranged between 1.13% and 1.48%. The highest fat content was obtained from cookies made with BAS-1121 conventional brown rice flour 60% and wheat flour 40% (18.52%), while the control had the least value of 10.12% (Table 1). Moisture contents of the cookies were all below 10%, which suggests reduced chances of spoilage by microorganisms and consequently increased shelf life (Kure *et al*., 1998). The biscuits produced with plantain and chickpea flour blends had protein contents ranged from between 7.1% and 9.2% (Yadav *et al*., 2011). High levels of fat are undesirable in food products because they could lead to rancidity in foods, leading to the development of unpleasant and odorous compounds (Ihekoronye *et al*., 1985). Ash content of food materials is an indication of the minerals present in the food. It was observed that BAS-1121 organic 40% brown rice flour 1.46% had the least ash content while cookies made with BAS-1121 conventional 20% brown rice flour and 80% wheat flour had the highest value of 1.75% (Table 1).

Table 4: Sensory score of wheat & brown rice flour cookies.

Samples		Wheat:Rice	Taste	Texture	Crispness	Appearance	Overall acceptability
Control		100	8.1±1.05^{c}	7.5±0.71^{c}	7.3±0.25^{c}	7.2±0.24^{c}	8.0±0.12^{d}
1121(O)	20%	80:20	6.9±0.32^{b}	6.7±0.52^{b}	6.5±0.41^{b}	6.8±0.63^{b}	6.9±0.85^{b}
	40%	60:40	7.9±0.47^{c}	7.4±0.12^{b}	7.2±0.36^{c}	7.9±0.25^{d}	7.9±0.64^{c}
	60%	40:60	5.8±0.365^{a}	4.9±0.54^{a}	5.3±0.25^{a}	5.8±0.94^{a}	5.6±0.36^{a}
386 (O)	20%	80:20	5.6±1.02^{b}	6.3±0.52^{b}	7.4±0.89^{c}	7.1±0.91^{c}	7.1±0.9^{c}
	40%	60:40	5.4±0.64^{a}	6.2±1.08^{b}	6.2±0.74^{b}	6.8±0.39^{b}	6.3±1.05^{b}
	60%	40:60	5.8±0.87^{b}	5.6±2.04^{a}	6.0±1.05^{a}	5.2±0.58^{a}	5.8±1.36^{a}
1121	20%	80:20	6.2±1.05^{b}	5.6±2.56^{b}	6.2±1.59^{b}	5.3±1.56^{a}	5.7±2.58^{a}
	40%	60:40	5.4±0.365^{a}	5.3±1.08^{a}	4.1±1.58^{a}	4.9±2.08^{a}	5.3±0.47^{a}
	60%	40:60	5.7±1.58^{b}	5.2±2.36^{a}	4.8±1.36^{a}	4.7±1.05^{a}	5.3±0.56^{a}
386	20%	80:20	6.7±0.7^{b}	5.4±1.05^{a}	6.0±0.23^{b}	5.2±0.42^{a}	6.5±0.47^{b}
	40%	60:40	5.6±1.69^{a}	5.2±0.65^{a}	5.6±0.78^{a}	5.5±0.85^{a}	5.8±0.63^{a}
	60%	40:60	6.1±0.47^{b}	5.0±0.79^{a}	5.9±0.01^{a}	4.6±0.21^{a}	5.4±0.41^{a}

Values expressed are an average of n = 3 (± standard deviation). Averages in a row with different superscript are significantly different ($P \leq 0.05$).

Physical properties of cookies

• Spread Ratio of Cookies:

The cookies spread ratio increased with the addition of brown rice flour to wheat flour. The spread ratio of the control cookies (wheat flour) was 6.71 which increased to 18.50 with the replacement of BAS-386 conventional brown rice flour 60% (Table 2). The brown rice flour incorporated cookies produced the greatest spread ratio and the widest cookies. It was observed that the spread factor increased when wheat flour was substituted by white rice flour (Chung *et al*., 2014). In

Table 5: Testure analysis of wheat flour & brown rice flour pinnis..

Samples	Wheat:Rice	Adhesiveness	Harness	Ratio Cohesiveness	Springiness	Gumminess	Chewiness
1121 (O) Control	100:0	2.303±0.23	40.95±0.14	0.15±0.04	1.28±0.19	6.09±0.11	7.77±0.10
1121 (O) (50%)	50:50	1.56±0.83	49.31±0.29	0.12±1.02	1.04±0.31	5.93±1.05	6.15±0.55
386 (O) Control	100:0	0.207±1.29	30.58±0.86	0.05±0.12	0.79±0.07	1.64±0.67	1.38±0.08
386 (O) (50%)	50:50	0.308±3.10	30.06±0.12	0.02±1.07	1.17±0.04	0.66±0.01	0.77±0.03
1121 Control	100:0	0.062±0.04[a]	102.27±0.09	0.01±0.58	0.71±0.08	1.09±0.04	0.78±0.09
1121 (50%)	50:50	0.129±0.08	29.39±0.75	0.06±0.29	1.13±0.19	1.88±0.26	2.13±0.13
386 Control	100:0	0.333±2.46	95.63±0.26	0.06±0.99	1.21±0.32	5.31±0.27	6.44±0.28
386 (50%)	50:50	0.69±0.11	89.66±0.86	0.01±1.07	1.31±0.83	0.92±0.47	1.21±1.03

Values expressed are an average of n = 3 (± standard deviation). Averages in a row with different superscript are significantly different ($P \leq 0.05$).

contrast, there were no significant differences in spread factor between the other gluten-free cookies, though all had a lower spread and diameter than wheat cookies. This would agree with the findings published by (Kaur *et al*., 2014), who observed a reduced spread ratio of gluten-free biscuits made from wheat flour with substituted buckwheat flour. Among the gluten-free cookies with no significant differences in spread, cookies made from buckwheat and teff flours, with a higher proportion of protein in their composition, were among the widest in this group. It might be considered that this is due to gluten content, as (Chung *et al*., 2014) reported that the spread factor of cookies increased as non-wheat protein content increased.

Color Characteristics and Texture Analysis of Cookies and Pinnis

• Color Characteristics

Cookies and pinnis made from BAS-386 organic rice flour 60% and wheat flour 40% had lowest Lm value (40.78) whereas BAS-386 conventional rice flour 60% and wheat flour 40% showed the highest Lm value (61.45) (Table 3). The color of the cookies is related not only to the colour of the flour used, but also to Millard and caramelization reactions, which take place during baking (Aremu *et al*., 2007). Cookies made from BAS-1121 organic rice flour 20% and wheat flour 80% had highest a mvalue (4.78) whereas BAS-386 conventional rice flour 40% and wheat flour 60% had lowest amvalue (0.84). BAS-1121 conventional rice flour 20% and wheat flour 80% had the highest bm value (14.45) while BAS-386 conventional rice flour 60% and wheat flour 40% had lowest bm value (Table 3). Cookies made from coarse-grained rice flours showed lower brightness (darker) and b* values and higher a* values (more brown) than cookies made from fine-grained rice flours. This effect could have been caused by the greater spread of these cookies and the oil released during the baking process, which could produce a higher concentration of sugars, leading to a more intense caramelization phenomenon, with the production of brown polymers, which contribute to the surface coloration of the cookies (Manley, D., 1998).

Pinnis prepared from BAS- 1121 organic brown rice flour had lowest Lm value (40.69) (Table 6). Pinnis made from BAS-1121 organic brown rice flour 50% and wheat flour 50% had highest a mvalue (6.11). BAS-1121 organic brown rice flour had lowest bm value (5.4). Pinnis made from coarse-grained rice flours showed lower brightness (darker) b* values and higher a* values (more brown) than pinnis made from fine-grained rice flours.

Table 6: Colour characteristics of wheat flour & brown rice flour pinnis.

Samples	Wheat : Rice	L* Value	a*	b*	E*
1121 (O) Control	100:0	40.69±0.32	3.89±0.08	5.4±0.07	41.23±0.45
1121 (O) (50%)	50:50	45.29±0.93	6.11±1.06	9.67±1.02	46.71±1.06
386 (O) Control	100:0	48.21±0.64	5.20±1.05	12.29±0.02	50.02±0.28
386 (O) (50%)	50:50	44.31±0.44	4.02±0.09	9.01±0.01	45.75±2.39
1121 Control	100:0	50.31±0.32	5.76±0.11	14.79±0.36	52.75±1.25
1121 (50%)	0:50	47.12±0.28	4.64±0.05	10.00±0.78	48.39±0.08
386 Control	100:0	43.69±0.58	4.61±0.07	10.16±0.77	45.8±0.04
386 (50%)	50:50	45.45±1.16	4.76±0.58	9.62±0.53	46.70±0.11

Values expressed are an average of n = 3 (± standard deviation). Averages in a row with different superscript are significantly different ($P \leq 0.05$).

• Texture Analysis of Cookies and Pinnis

Cookies prepared from BAS-1121 conventional rice flour 60% and wheat flour 40% showed the maximum hardness value (272.57 N) while BAS-386 conventional rice flour 40% and wheat flour 60% had minimum hardness value (69.00 N) (Table 3). Textural properties are one of the major factors contributing to the eating quality of cookies. Hardness, which is one of the most important textural characteristics for cookies, is measured as the peak force to snap the cookie.

Table 7: Sensory score of wheat flour & brown rice flour pinnis.

Samples	Wheat:Rice	Taste	Texture	Crispness	Appearance	Overall acceptability
1121 (O) Control	100:0	7.5±0.11	7.5±0.33	7±0.01	7±0.54	7±0.08
1121 (O) (50%)	50:50	7±0.02	7±0.21	6±0.07	6±0.43	7±0.09
386 (O) Control	100:0	6.5±0.03	6±0.04	5±0.08	6±0.12	6±0.11
386 (O) (50%)	50:50	7±0.07	6.5±0.04	6.5±0.03	6±0.01	6.5±0.01
1121 Control	100:0	4±0.08	.5±0.11	4±0.02	5±0.05	4±0.03
1121 (50%)	50:50	7±0.05	7.5±0.07	7±0.06	6±0.01	7±0.02
386 Control	100:0	6±0.04	5.5±0.05	5.5±0.01	6±0.02	6±0.01
386 (50%)	50:50	8±0.12	8±0.04	8±0.05	8.5±0.08	8.5±0.07

Values expressed are an average of n = 3 (± standard deviation). Averages in a row with different superscript are significantly different ($P \leq 0.05$).

Pinnis prepared from BAS-1121 conventional brown rice flour showed the maximum hardness value (102.27 N) while BAS-386 conventional white rice flour 50% and wheat flour 50% had minimum hardness value (12.16 N). Textural properties are one of the major factors contributing to the eating quality of Pinnis. Hardness, which is one of the most important textural characteristics for cookies, is measured as the peak force to snap the Pinnis. BAS-1121 organic brown rice flour prepared pinnis showed maximum gumminess and cohesiveness values (0.09 and 0.15) respectively. The chewiness is an important texture parameter which is recorded to measure the energy required to chew a solid food until it is ready for swallowing whereas gumminess is the energy required to disintegrate a semisolid food before swallowing.

Sensory evaluation of cookies and pinnis

The sensory attributes of cookies produced from brown rice flour and wheat flour are presented in table 4. The results showed that cookies prepared from wheat flour were rated almost similar to cookies from BAS-1121 organic brown rice flour 40 % and wheat flour 60% composite in all sensory characteristics evaluated acceptability. The texture of BAS-1121 organic brown rice flour 40 % and wheat flour 60% cookies were rated slightly lower (7.40) than that (7.50) of 100% wheat flour cookies (Table 4). This could be because the panelists prefer the hard texture of both types of cookies. In terms of taste and overall acceptability, 100% wheat flour cookies were rated significantly the same as BAS-1121 organic brown rice flour 40 % and wheat flour 60% cookies (Table 4). This indicates that substitution of brown rice flour with wheat flour positively influenced the sensory attributes of the cookies.

The sensory attributes of pinnis prepared from brown rice and wheat flour are presented in (Table 5). The overall acceptability of BAS-1121 brown rice flour pinnis was rated the lowest range (4.0). This could be because the panelists prefer the semi-hard texture of pinnis. In terms of taste and crispiness BAS-1121, white rice flour and BAS-1121 white rice flour 50% and wheat flour 50% pinnis were rated significantly same as BAS-386 conventional white rice flour 50 % and wheat flour 50% pinnis. This indicates that substitution of brown rice and white rice flour with wheat flour positively influenced the sensory attributes of the cookies.

Conclusion

The incorporation of different blends of brown rice flour with wheat enhanced the nutritional value of cookies and pinnis. The cookies incorporated with 40% and 60% brown rice flour showed higher fat and protein values than the controlled sample (100% wheat flour). Spread ratio was greater for cookies incorporated with 60% brown rice flour and 40% wheat flour. Cookies prepared with 60% brown rice flour and 40% wheat flour was darker with less L* value than all others blend. Overall, the study summarizes that the brown rice flours can be successfully used to prepare cookies with enhanced nutritional properties and their characteristics comparable to those made from only wheat flour. In future we can prepare healthy snacks like cookies by incorporating brown rice flour with wheat flour to increase its nutritional value. For celiac disease patients both brown, as well as white rice flour pinnis, can be prepared as a healthy snack with high nutritional value.

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