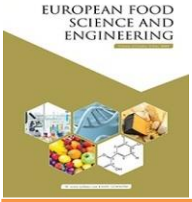

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Physical and sensory characteristics of cookies from rice and amaranth flour blends

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ABSTRACT

In the present study, cookies containing amaranth flour (AF) at various substitution levels, viz. 5, 10, 15 and 20% with rice flour (RF) were studied in terms of physical and sensory characteristics. AF had significant higher protein and crude fiber content than RF. DPPH radical scavenging activity of AF was found to be 85.47%, which was higher than RF (4.57%). Increasing in the substitution levels of AF in the blend increased the cookies thickness and diameter, and decreased the hardness of cookies from 142.23 N to 128.45 N. Analysis of color characteristics of the cookies showed that increase in substitution levels of AF decreased the L^* value, increased the a^* value and decreased the b^* value of the cookies. Overall acceptability of the cookies observed by principal component analysis, was positively correlated to flavor (r=0.991) and mouth feel (r=0.975). Both the sensory evaluation and principal component analysis results indicated that the 10% amaranth flour substituted cookies had better sensory properties in comparison to the other four cookie samples.

1. Introduction

Amaranthus, commonly known as amaranth, is a pseudocereal grown as ornamental, leafy vegetable, grain or forage crop (Bensch, Horak, & Peterson, 2003). It has small, edible starchy seeds yellow or light brown in color with a high protein content and is gluten-free, which is an advantage over cereals with gluten. These seeds are ground or milled to produce flour, flaked, puffed or popped for consumption and are recommended in gluten free vegan diets.

Celiac disease triggers an immune reaction to consuming gluten, a protein found in grains like wheat, barley and rye. It is a digestive disorder, which results in inflammation in the lining of small intestine and prevents the absorption of nutrients. So, a suitable replacement for wheat flour is desired where it is necessary to maintain a diet free of gluten. Because amaranth is gluten-free, it is usually blended with wheat flour to make chapattis in India, tortillas in Latin America, biscuits, pancakes, extruded products, etc. (Singh & Singh, 2011). Chillo, Laverse, Falcone, & Del Nobile (2007) reported successfully making gluten-free pasta from amaranth flour. Gluten-free cookies were produced from raw and germinated amaranth flour with increased antioxidant activity, fiber and protein contents (Chauhan, Saxena & Singh, 2015). Utilization of processed amaranth into bread making were also reported by Lorenz (1981) and de la Barca, Rojas-Martínez, Islas-Rubio, & Cabrera-Chávez (2010), using wheat flour supplementation ranging from 10-25%. Modified amaranth in the form of sourdough (Jekle, Houben, Mitzscherling & Becker, 2010) and refined amaranth flour (Marcilío, Amaya-Farfan, Silva, & Spehar, 2005) were utilized to test mixing properties in bread and cookie making, and gluten-free biscuits respectively. Studies on the shelf life of amaranth containing gluten-free biscuits were carried out by Tosi, Ciappini, & Masciarelli (1996). Several researchers have reported the antioxidant activity of amaranth flour, such as the presence of polyphenols, phenolic acids, amino acids and water-soluble peptides (Gorinstein et al., 2007; de la Rosa et al., 2009; Tiengo, Faria, & Netto, 2009; Tironi & Anon, 2010).

Rice, the seed of the grass species of *Oryza sativa* (Asian) *or Oryza glaberrima* (African), is one of the major staple foods consumed globally, particularly for the population in Asia. Rice flour or rice powder is a type of flour made from milled rice or broken rice. It could be obtained from broken rice grains from milling and is gluten free too (Dias, Müller, Larotonda, & Laurindo, 2010). From a nutritional perspective, rice flour is one of the most valuable flours albeit its limited use in unfermented baked products (Gujral & Rosell, 2004).

Kim, Lee, Kang, & Kim (2002) studied the physicochemical and sensory characteristics of cookies with substitution of functional rice flour at levels of 10-30%. Lee & Oh (2006b) described successful incorporations of brown rice flour in cookie making. Cookies made from brown rice flour was reported to have greater variety of functional components than those made from wheat flour alone; substitution was acceptable even at levels of 30%. Another investigation on replacement of wheat flour by black rice flour had increased cookie sensory qualities at 30% substitution (Lee & Oh, 2006a).

Gujral, Mehta, Samra, & Goyal (2003) documented the effect of separately replacing wheat flour with wheat bran, coarse wheat flour and rice flour on the quality of cookies. They found acceptable sensory results for cookies made with rice flour and coarse wheat flour. A study by Torbica, Hadnađev, & Hadnađev (2012) reportedly developed formulations of gluten free cookies based in rice and buckwheat flour in ratios of 90:10, 80:20 and 70:30. Very few literatures exists citing works on incorporation of rice flour to create a formulation for gluten free cookies. There is no available literature reported on addition of amaranth flour to rice flour for a gluten free cookie formulation. The potential use of broken rice flour and underutilization of functional and nutritional attributes of amaranth flour, present market growth trends, and the increasing demands of the younger generations for gluten-free foods prompted the proposal of this study.

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2. Materials and methods

2.1. Materials

White rice flour (RF) and amaranth grains were procured from the local market of Alaknanda, New Delhi, India. The procured amaranth grains were cleaned and stored in airtight containers under refrigeration at 4 °C until further use. RF was kept in dry in an air tight container at room temperature (RT). Other ingredients for use in baking such as shortening, sugar, skimmed milk powder for cookie preparations were also purchased from the local Alaknanda market, New Delhi, India. All the chemicals and reagents used were of analytical grade.

2.2. Preparation of amaranth flour

Amaranth seeds were dried in a convective oven to a moisture content of about 10% (dry basis). Uniformly dried amaranth seeds were milled using a mixer grinder (Philips HL7756/00 Mixer Grinder, 750W, India). To get super fine particle, the obtained flour was further pulverized using mortar and pestle, and passed through 72 BSS mesh size sieve. The collected amaranth flour (AF) was packed in an airtight container and stored at RT for further analysis.

2.3. Formulation of flour blends

100% RF was taken as control and various blends of the flours were prepared in the following combinations as formulations: 95% RF + 5% AF; 90% RF + 10% AF; 85% RF + 15% AF and 80% RF + 20% AF. All formulations were stored in airtight containers at RT for production of cookies.

2.4. Production of cookies

Cookies were produced from the control sample and flour formulations. For every 100 g of flour formulation, the formula for the ingredients used was 1g salt, 1g sodium bicarbonate, 40 g sugar, 30 g butter, 20 g cream cheese, 20 g skimmed milk powder (SMP) and 25 mL distilled water. Butter, cream cheese, SMP and sugar were taken in a container and whipped to a foamy texture. This was termed Mix1. RF, baking powder and salt were sieved together to get Mix2. AF was then blended uniformly in a laboratory mixer with Mix2 to obtain Mix3.Mix3 was added sparingly to Mix1, kneaded with water until all ingredients were consumed and produced clean dough. The prepared dough was rested for 20 min under refrigeration and then flattened into a sheet of 0.5 cm thickness. A circular disc cutter of 4.5 cm diameter was used to cut the sheeted dough into unbaked cookie shapes, which were transferred to a greasy baking tray. The cookies were baked at 190 °C for 15 min, cooled and kept in an airtight container at RT.

2.5. Proximate compositions

Proximate analysis of the RF and AF were carried out for moisture (AACC Method 44-01.01), ash (AACC Method 08-01.01), protein (Nx6.5) (AACC Method 46-11.02), fat (AACC Method 30-10.01) and crude fiber (AACC Method 32-10.01) content following standard method of analysis (AACC, 2010). Carbohydrate content was calculated by difference.

2.6. Functional properties

Various functional properties of RF and AF were estimated. Water and oil holding capacities (WHC and OHC) were measured by the method given by Rodríguez-Ambriz, Islas-Hernández, Agama-Acevedo, Tovar, & Bello-Pérez (2008); bulk density of the flours by the method of Kaur & Singh (2005); swelling power and solubility of the flours by the method described by Leach (1959), while pH was determined using the method given by Suntharalingam & Ravindran (1993).

2.7. Antioxidant activity

DPPH radical scavenging capabilities of the flours were estimated using a modified method of Brand-Williams, Cuvelier, & Berset (1995). 100 mg sample was extracted with 2 mL methanol on a shaker for 2 hrs and centrifuged at 3000 g for 10 min. 100 µL supernatant was transferred into a test tube and reacted with 3.9 mL of 6×10^{-5} mol/L of DPPH solution. The mixture was shaken and allowed to stand for 30 min in the dark, following which absorbance was measured at 515 nm using methanol as blank. The DPPH radical scavenging activity of the sample was calculated as follows:

$$\text{DPPH radical scavenging activity (\% inhibition)} = (1-\frac{A_s}{A_c})\times100$$

where, A_s = absorbance of the sample; A_c = absorbance of the control

2.8. Physical properties of the cookies

Thickness, diameter, spread ratio and hardness of the cookies were determined by the methods reported by Chauhan et al. (2015).

2.9. Color characteristics of the cookies

A spectrocolorimeter, Lovibond LC 100 (The Tintometer Ltd., Amesbury, UK) was used to determine the color profile of the cookie samples on the basis of $L*$, $a*$ and $b*$ values. The colorimeter was first calibrated by positioning the reference slide over the optics and the 'Measure' button was pressed. When the calibration was done, the reference slide was positioned back to storage location. After calibration, the instrument optics was placed over the cookie sample and the 'Measure' button was lightly pressed and held to take the measurements.

2.10. Sensory evaluation of the cookies

Sensory evaluations on the basis of appearance, flavor, mouth feel, body texture, stickiness and overall acceptability were carried out for baked cookies from control and formulated flours. A team of trained sensory panelists (age 21-40 years) were selected after a sensory blind test to exclude the sensory blind panelists. The panelists were then briefed about the rating method, on a 9-point hedonic scale, where 1 = extreme dislike and 9 = extreme like.

2.11. Statistical analysis

The data reported in the tables are average of three replicates ± standard deviation except sensory evaluation data (n = 10). Microsoft Excel was used for the two sample *t* test statistical analysis of the data reported in Table 1 and Table 2. Principal component analysis (PCA) was carried out using Minitab software (Minitab Inc., State College, PA, USA) to investigate the variation among the physical properties of cookies and sensory evaluation scores of the cookies. Data reported in Table 3 and Table 4 was also subjected to one way ANOVA using the Minitab software.

3. Results and Discussion

3.1. Proximate composition of flours

Proximate compositions for rice flour (RF) and amaranth flour (AF) are shown in Table 1. Moisture content of flour is very important parameter regarding its shelf life, lower the flour moisture, the better its storage stability. At lower moisture content, the deterioration of baking quality will be less which can be credited to retarded respiration and activity of microorganisms (Staudt & Zeigler, 1973). Moisture content of RF and AF were found to be 10.05% and 8.24%, respectively. The ash content of RF and AF was 0.88% and 2.8%, respectively, which is in close agreement with reported values of 0.26–0.97% in rice flour (Park, Kim, & Kim, 2001; Zhu et al., 2011) and 2.37-5.1% in amaranth flour (Brennan et al., 2012; Chauhan et al., 2015; Choi, Kim, & Shin, 2004). Ashes are crucial for normal metabolic functions and are required constituent in a balanced diet (Luccarini et al., 1999). Moreover, it has been reported that ash content may vary due to differences in mineral status of the soil, the species, and the part of the plant as well as the stage of harvest (Gidamis et al., 2003). Fat content of 1.32% and 5.9% was estimated for RF and AF, respectively. The fat content obtained are in agreement with reported value of 0.11–2.88% in rice flour (Park et al., 2001; Deepa, Singh, & Naidu, 2008) and 5.9–8.16% in amaranth flour (Brennan et al., 2012; Chauhan et al., 2015; Mariotti, 2009). The amount of fat is important for cookie spread (Abboud, Rubenthaler, & Hoseney, 1985). Protein content of RF and AF was found to be 10.02% and 14.2%, respectively. These experimental values are in agreement with the earlier reported values of 5.92–10.66% in rice flour (Deepa et al., 2008; Ding, Ainsworth, Tucker, & Marson, 2005; Park et al., 2001; Sivaramakrishnan, Senge, & Chattopadhyay, 2004) and 13.58–15.78% in amaranth flour (Brennan et al., 2012; Chauhan et al., 2015). Nutritional composition of baking products can be enhanced by various factors; one such practice is by supplementing flour with protein rich non-wheat flours (Chavan, Kadam, & Reddy, 1993). Thus, amaranth flour addition can add nutritional value to foods. Crude fiber content of RF and AF was observed to be 0.63% and 8.4%, respectively, which correlates well with the previously reported values of 0.7% in rice flour (Ding et al., 2005) and 8 – 9.3% in amaranth flour (Mariotti, 2009; Brennan et al., 2012). The higher fiber content of amaranth flour could increase the water absorption capacity of the flours (Ayo, 2001). Amaranth flour had a higher value of ash, fat, protein and crude fiber content than the rice flour. The nutritional composition of the amaranth grain, like amino acid composition, protein content, vitamin and mineral composition was found to be proportionate or even better than that of common cereal grains (Becker, 1981). Thus, the amaranth grain, because of its high nutritional qualities can be used for various baking applications (Lorenz, 1981).

Table 1. Proximate compositions of the sample rice flour and amaranth flour.

Constituents	Rice flour	Amaranth flour
Moisture (%)	10.05±0.01^a	8.24 ± 0.02^b
Ash (%)	0.88±0.06^b	2.80 ± 0.41^a
Fat (%)	1.32±0.13^b	5.90 ± 0.07^a
Protein (%)	10.02±0.21^b	14.20 ± 0.28^a
Crude fiber (%)	0.63±0.10^b	8.40 ± 0.18^a
Total Carbohydrate (%)	77.74±0.16^a	68.86 ± 0.69^b

Data are presented as means ± standard deviation; Means followed by similar superscript in a row do not differ significantly (P<0.5).

3.2. Functional properties of flours

The experimental data regarding the functional properties of the RF and AF are reported in Table 2. WHC and OHC values of RF and AF were found to be 1.34 g/g and 0.70 g/g, and 1.04 g/g and 0.92 g/g, respectively. WHC and OHC values of RF and AF noted in the current investigation is in close agreement with the reported values of 1.19–2.24 g/g and 0.56–0.78 g/g for rice flour (de la Hera, Gomez, & Rosell, 2013), and 1.02 g/g and 0.91 g/g for amaranth flour (Singhal & Kulkarni, 1991), respectively. WHC and OHC are two important properties that can significantly affect the appearance (e.g. color, gloss, shape and others), texture (crispness), and product moistness (Joshi, Liu, & Sathe, 2015). Bulk density of RF and AF was found to be 0.67 g/ml and 0.63 g/ml, respectively. Chauhan et al. (2015) reported similar result in raw amaranth flour. Falade & Christopher (2015) observed the bulk density of six rice cultivars in the range between 0.46 – 0.79 g/ml.

3.3. Antioxidant activity of flours

The antioxidant activity of AF as determined by DPPH radical was significantly higher (85.47%) in comparison to RF (4.57%). The free radical scavenging activity of amaranth flour using DPPH was observed to be in the range of 84.67–93.35 % (Kunyanga, Imungi, Okoth, Biesalski, & Vadivel, 2012; Akin-Idowu, Ademoyegun, Olagunju, Aduloju, & Adebo, 2017). The total antioxidant activity of rice varieties ranged from 3.08-49% (Thanuja & Parimalavalli, 2020; Sripum et al., 2017).

Table 2. Functional properties and antioxidant activity of the sample rice flour and amaranth flour.

Properties	Rice flour	Amaranth flour
WHC (g water/g dry powder)	1.34±0.11^a	1.04±0.07^b
OHC (g oil/g dry powder)	0.70±0.02^b	0.92±0.04^a
Bulk density (g/ ml)	0.67±0.04^{ns}	0.63±0.3^{ns}
Swelling power (%)	8.86±0.06^a	6.55±0.07^b
Solubility (%)	4.95±0.09^a	1.55±0.10^b
pH	6.80±0.10^b	7.30±0.20^a
DPPH radical scavenging activity (% inhibition)	4.57±0.12^b	85.47±0.15^a

Data are presented as means ± standard deviation; Means followed by similar superscript in a row do not differ significantly (P<0.5); ns – not significant. WHC: Water holding capacity; OHC: Oil holding capacity; DPPH: 2,2-diphenyl-1-picrylhydrazyl.

3.4. Physical characteristics of cookies

Data on physical characteristics of cookies prepared from blend of RF and AF are presented in Table 3. Blends with increasing level of AF produced cookies with increased spread ratio (P>0.5) and decreased hardness force (significant at P<0.5) required to compress. A similar result was reported by Kaur, Singh, and Kaur (2017), where the spread ratio of cookies increased with the increase of flaxseed flour in the blends of wheat flour and flaxseed flour. In general, the spread ratio of the AF substituted cookies was less than that of control (RF) cookies. Fuhr (1962) reported that spread ratio is affected by the competition of constituents for the available water; flour or any other constituent which absorbs water during dough mixing will decrease it. Increase in the quantity of AF in the blend, decreased the hardness. Similar decrease in hardness along with substitution levels was reported by Adeola and Ohizua (2018). Hardness of the AF substituted cookies was found to be lower than that of control (RF) cookies. Increasing the proportion of AF, in the blend, increased the cookies thickness and diameter. A similar finding for thickness and diameter was reported by Kaur et al. (2017), for cookies produced from blends of wheat flour and flaxseed flour, and Ikuomola, Otutu, & Oluniran (2017), for cookies from blends of wheat flour and malted barley.

3.5. Color characteristics of cookies

The data regarding color characteristics of the cookies from blends of RF and AF are given in Table 3. It was observed that as the quantity of AF in the blend increased, the cookies became darker in color as evident from lower L^* value of the blends in comparison to control cookies. A similar result was reported by Suriya, Rajput, Reddy, Haripriya, & Bashir (2017), where an increase in the fortification levels of yam flour decreased the L^* value. This may be due to the Maillard reaction between the amino acids and reducing sugars during the baking process of cookies. The lowest value (49.61) of L^* was for AF cookies and the highest value (62.19) was for control cookies. The value of a^* of AF incorporated cookies were higher than the control cookies and the value of b^* of AF incorporated cookies were lower than control cookies at different level of substitution. Analysis of the color characteristics of cookies showed that increase in the proportion of AF in the blends increased the redness (a^*) and decreased the yellowness (b^*).

Table 3. Physical and color characteristics of cookies prepared from blend of rice and amaranth flour.

Sample	Thickness (T, cm)	Diameter (W, cm)	Spread ratio (W/T)	Hardness (N)	Color attributes		
					*L**	*a**	*b**
Control	0.73±0.11 ns	5.08±0.20b	7.04±0.80ns	148.51±1.39a	62.19±3.00a	8.73±1.51c	27.14±1.08a
A1	0.85±0.10 ns	5.24±0.10ab	6.19±0.63 ns	142.23±1.01b	59.79±4.40a	9.75±2.00bc	26.92±1.04a
A2	0.84±0.12 ns	5.28±0.12ab	6.33±0.75 ns	139.86 ±1.48bc	57.12±5.23a	11.2±2.05bc	26.57 ±1.35ab
A3	0.86±0.11 ns	5.50±0.13ab	6.46±0.73 ns	137.38±0.82c	56.93±3.69a	10.19±1.60ab	26.13±0.80ab
A4	0.86±0.10 ns	5.63±0.21a	6.56±0.53 ns	128.45±1.13d	49.61±4.63b	13.05±0.86a	25.04±1.89b

Control- 100% RF; A1- 95% RF + 5% AF; A2- 90% RF + 10% AF; A3- 85% RF + 15% AF; A4- 80% RF + 20% AF; RF- rice flour; AF- amaranth flour; Data are presented as means ± standard deviation; Means followed by similar superscript in a row do not differ significantly (P<0.5); ns – not significant.

Table 4. Sensory evaluation of the cookies.

Sample	Sensory attributes					
	Appearance	Flavor	Mouth feel	Body texture	Stickiness	Overall acceptability
Control	7.1±0.57a	7.4±0.52ab	7.6±0.52a	6.9±1.10bc	7.4±0.52a	8.1±0.57ab
A1	6.2±1.03ab	6.8±0.63b	7.5±0.53a	7.5±0.53b	7.2±0.42a	7.4±0.52b
A2	6.8±0.79a	7.6±0.52a	7.9±0.74a	8.5±0.53a	6.8±0.63ab	8.6±0.52a
A3	5.4±0.70b	5.1±0.57c	6.0±0.82b	6.3±0.67cd	6.2±0.42bc	6.1±0.74c
A4	5.3±0.48b	4.8±0.79c	5.4±0.52b	5.8±0.79d	5.9±0.57c	5.6±0.70c

Control- 100% RF; A1- 95% RF + 5% AF; A2- 90% RF + 10% AF; A3- 85% RF + 15% AF; A4- 80% RF + 20% AF; RF- rice flour; AF- amaranth flour. Data are presented as means ± standard deviation of 15 observations; Means followed by similar superscript in a row do not differ significantly (P<0.5).

3.6. Sensory evaluation of cookies

The results of sensory evaluation of the cookies are presented in Table 4. The A2 (90% RF + 10% AF) cookies had the significant (P<0.5) highest rating in terms of body texture and similar rating in terms of appearance, flavor, mouth feel, stickiness and overall acceptability in comparison to control cookies. The addition of AF above 10% in the cookie formulations resulted decrease in the sensory attributes of the cookies and thereby affecting its acceptability. This was due to the evident dark appearance of the amaranth substituted (AF>10%) cookies and a bitter after taste (as reported by the sensory panelists). A3 and A4 cookies were of inferior quality when compared with control, A1 and A2 cookies in terms of the rated sensory attributes. The results of this sensory evaluation study was contradicting with the results reported by Sindhuja, Sudha, Rahim (2005), where the cookies with substitution of 25% amaranth flour had a high acceptance among the sensory panelists.

3.7. Principal component analysis

The results of the principal component analysis of the various physical properties and sensory evaluation scores of the cookies prepared from rice flour and amaranth flour blends are shown in Figure 1 and 2. The first and the second principal component accounted for 91.8% (eigenvalue = 9.8329) of the total variation, 75.6 % (eigenvalue = 9.8329) of which were explained by the first component (PC1) and 16.1 % (eigenvalue = 2.0991) of which were explained by the second component (PC2). Loading plot (Figure 1) of PC1 and PC2 investigated the correlations between the measured physical properties and sensory properties. A negative correlation (significant at P<0.05) of cookie diameter with stickiness (r =-0.983), hardness (r =-0.964), b* (r =-0.952), L* (r =-0.919), appearance (r =-0.932), flavor (r =-0.913), and mouth feel (r =-0.910) was observed. A significant (P<0.05) positive correlation between hardness, L*, b*, appearance and stickiness was observed. Overall acceptability was positively correlated to flavor (r =0.991) and mouth feel (r =0.975). Stickiness was positively correlated with hardness (r =0.937, P<0.5), and flavor was positively correlated with appearance (r =0.968, P<0.5), mouth feel (r =0.985, P<0.5) and overall acceptability (r =0.991, P<0.5).

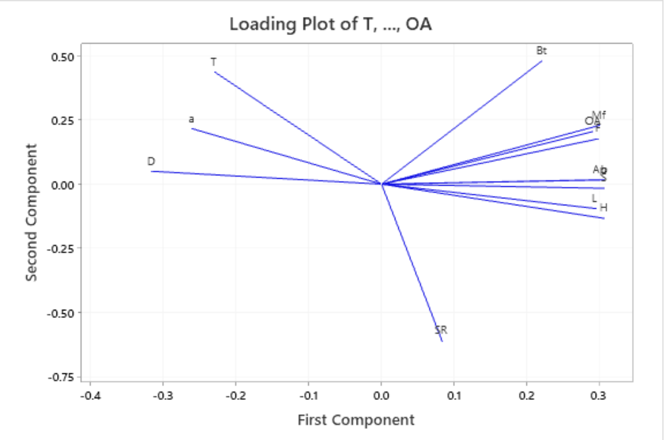

Figure 1. Principal component analysis: loading plot of first principal component (PC1) and second component (PC2) describing variation among the physical properties and sensory scores of the cookies. T- Thickness; D- Diameter; SR- Spread ratio; L- *L**; a- *a**; b- *b**; Bt- Body texture; Mf- Mouth feel; OA- Overall acceptability; F- Flavor; S- Stickiness; and Ap-Appearance.

Correlation between the sample cookies (control, A1, A2, A3 & A4) tested by PCA can be visualized when one compares the score plot (Figure 2) between PC1 and PC2. The sample dimensions that are close to each other in a PCA score plot have similar characteristics and the samples that are far from each other are different. The score plot showed that cookies substituted with 5% and 10% AF were located at right side of the score plot with a positive score in PC1 and PC2. The cookies substituted with 15% and 20% AF were located at left side of the score plot with a negative score in PC1. The results of the PCA score plot resulted in the effective classification of cookies into three groups (A2, A4 and control). Cookies with 5% AF (A1) and 15% AF (A3) could not be classified into separate groups because none of the properties could be correlated to these samples. A1 and A3 cookies are located at a shorter distance from the origin of PC1 and PC2 in the score plot due to which they possessed an average of the measured properties of all cookie samples without much variation. Therefore, the results of PCA reported a reasonable clarification for the variation among the cookie samples and the A2 cookies as the most acceptable cookies in terms of the measured properties.

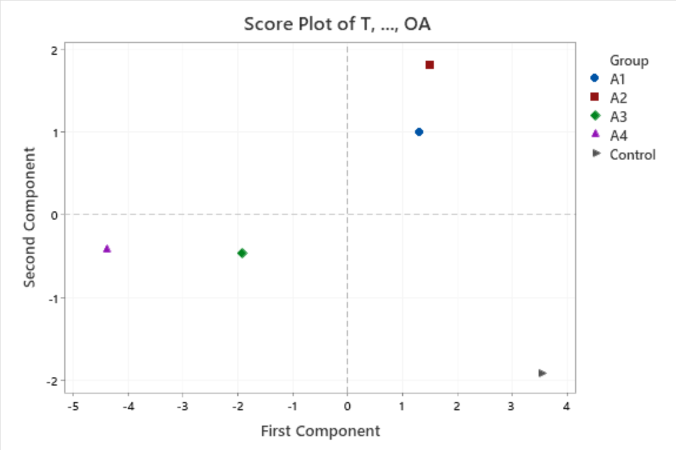

Figure 2. Principal component analysis: Score plot of PC1 and PC2 describing the variation among the cookies based on physical characteristics and sensory scores. Control- 100% RF; A1- 95% RF + 5% AF; A2- 90% RF + 10% AF; A3- 85% RF + 15% AF; A4- 80% RF + 20% AF; RF- rice flour; AF- amaranth flour.

4. Conclusions

The emerging research that is attracting worldwide attention for the preparation of different types of gluten-free foods encourages the total or partial replacement of basic constituents with value-enhanced raw materials to fit the desired nutritional ameliorations. Consequently, in an effort to formulate gluten-free food products with enhanced nutritional quality, cookies were formulated by replacing common rice flour with increasing levels of amaranth flour. The physical properties, color attributes and sensory scores were measured, where significant differences in diameter, color attributes and sensory scores were reported comparing amaranth-substituted cookies to the control. Interestingly, despite the fact that the referred sensory attributes were impaired by the addition of amaranth flour above 10% in the formulations, the sensory evaluation revealed that cookies prepared by incorporating amaranth flour (5% and 10 %) were acceptable in terms of sensory scores (>7). From the foregoing results, it can be concluded that amaranth substituted cookies might represent a good compromise between health benefits, technological quality and sensory attributes. Future works, exploring the role of amaranth as a novel alternative ingredient in developing various functional foods, are recommended.

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