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Effects of Processing Methods on the Nutrient Composition and Sensory Attributes of Cookies Produced from Wheat and Sesame Seed Flour Blends

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Abstract

The study was aimed at evaluating the effect of fermentation, boiling, roasting and germination of sesame seed on the proximate composition and acceptability of cookies produced from wheat flour in composite with sesame seed flour. Processed sesame seed was substituted in wheat flour at 4 levels (5%, 10%, 15%, 20%) with other ingredients to produce cookies. Moisture, Ash, Fat, Protein, fibre and carbohydrate content ranged from 7.00 – 16.85%, 1.40 – 3.59%, 11.95 – 24.69%, 7.06 – 13.09%, 0.31 – 3.75% and 51.18 – 64.71%, respectively. The ash content of all the blended samples were significantly (P<0.05) higher than that of the control (100% wheat flour cookies).Cookies produced from roasted and fermented sesame seed flour at substitution level of 20% with 80% wheat flour gave significantly higher crude protein of 13.41% and 13.09%, respectively. The crude fibre contents of sample E (90/5% wheat/boiled sesame seed flour cookies) and that of the control were significantly higher at 13.41% and 13.09%, respectively. Carbohydrate was shown to reduce with increase substitution of processed sesame seed flour. The energy values of cookies produced from wheat flour blended with boiled and germinated sesame seed flour were significantly (P<0.05) higher than those produced from wheat flour blended with fermented and roasted sesame seed flour and also that of the control (sample Q).The overall acceptability of the wheat/processed sesame seed flour cookies were not statistically different (P>0.05) from that of the control (100% wheat flour cookies). Germination, fermentation and roasting at 80:20 blend, ratio increased the protein content of the cookies obtained from them.

Keywords: Nutrient, Sensory, Fermented, Boiled, Roasted, Germinated, Sesame Seed, Cookies

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Introduction

Cookies are nutritive snacks obtained from single or composite dough which has been transformed into digestible and more appetizing products through the action of heat in the oven (Singh et al., 2000). They are regarded as confection-food with low moisture content (Albert, 1999). Cookies are classified based on the ingredient composition and processing techniques (Albert, 1999).Due to increased demand for functional products, attempts are being made to improve the nutritive value and functionality of cookies by modifying their nutritive composition. This involves the use of non-wheat flour with attempt to increase the protein content and quality of the cookies and overcome the problems of high cost of wheat flour due to its importation in Nigeria and other countries whose climates are unfavourable for wheat cultivation. These limitations have prompted the search for available or underutilized crops with functional attributes to be incorporated as composite flours for the production of baked products (Chinma et al., 2011). Sesame seeds (Sesamum indicum) are tiny, flat oval seeds with a nutty taste. It is an important oil seed believed to have originated from tropical Africa with the greatest diversity (RMRDC, 2004). Sesame seed is a staple food among many ethnic groups in Nigeria and it is cultivated in most areas of the middle belt and some northern states of Nigeria (Olanyanju et al. 2006). Sesame is an important source of oil (44-52.5%), protein (18-23.5%), carbohydrate (13%) (Kahyaoglu and Kaya 2006, Bamigboye et al 2010).The seeds are rich in mono-unsaturated fatty acid (oleic acid) and equally rich sources of many minerals such as calcium, phosphorus, manganese, zinc, magnesium and potassium which play vital roles in the body (Makinde and Akinoso, 2013). The seeds are consumed fresh, dried or blended with sugar. It is also used as a paste in some local soups. The meal is notable for its high protein concentration which is rich in methionine and tryptophan. Since these amino acids are missing from a number of other sources of vegetable protein, such as soya, sesame meal or flour can be added to recipes to give a better nutritional balance (Chemonics 2002). Sesame is an important oilseed crop being cultivated in the tropics and the temperate zone of the world. Myanmar is a major producer of sesame followed by India, China, Ethiopia and Nigeria (Nidhi et al., 2018). Sesame seeds are rich in protein, oil, crude fibre and carbohydrates (Obiajunwa et al., 2005).Sesameseedcontains50%oilwhich is highly resistant to oxidation and 25 % protein which has unique balance of essential amino acids and minerals (Johnson et al., 1979). It is also consumed for its medicinal qualities. Among all the oil seed proteins, sesame protein is the most nutritious as it is a rich source of methionine (sulphur containing amino acid) (NarsingaRao, 1985) and tryptophan (Manikantan et al., 2015). Because of its greater and varied utility, it is considered as the "Queen of oilseeds". Processed sesame seeds are used in baked products; cake, hamburger, buns, cookies, confectionery purposes and many snack foods (Nagaraj 2009). The nutritional value of foods depends on their nutrient content and the bioavailability of these nutrients. The nutritional quality of sesame seed and its products can be enhanced by roasting, boiling and defatting prior to consumption. Sesame is commercialized in a number of forms. Sesame seeds can also be consumed directly as a highly nutritious foodstuff (Naturland, 2002). Various processing technologies have helped in transforming food ingredients into healthier products with maximum nutritional value to ensure nutrient security of the population in developing countries (Kumar et al., 2010). Such techniques include Fermentation, boiling, roasting and germination. The most common domestic processing methods include ordinary cooking (boiling) and roasting (Hassan, 2011). The widespread and long-standing tribute to sesame lies in its high oil content, nutritious protein, and savoury roasted flavour (Namiki, 1995). Cooking have been reported to improve the nutritional and functional properties of plant seeds (Jirapa et al., 2001; Yagoub and Abdalla, 2007). Boiling and Roasting can also reduce malnutrition by making micronutrients available for easy absorption; hence, increasing the utilization of sesame seeds. Although exist numerous studies about the nutritional characteristics of sesame seeds, there is little information on nutrient composition in value added products formulated with fermented, boiled, roasted and germinated sesame seed flour. Industrial processing and utilization of sesame have not been fully developed in Nigeria as its utilization is restricted to producing regions; for the most part, the surplus crop is commercialized, bulked and exported. Therefore, the objective of this study was to produce cookies from blends of fermented, boiled, roasted and germinated sesame seed flour in composite with wheat and to access the nutrient composition and acceptability of the cookies.

Materials and Methods

Sesame seeds where purchased from an open market in Anyigba Kogi State. Wheat flour was purchased from confectionery store in Port Harcourt, Rivers State, Nigeria and transported in air tight high density polyethylene bag. Cookies with 100% wheat flour was produced and used as control.

Fermentation

The sesame seeds were dehulled and fermented using the method described by Akindahunsi, (2004). The seeds were boiled in water for 6 h and cooled. The cooked seeds were placed in a plastic container with a tight lid and sealed. The samples were allowed to ferment at 35 ± 2°C for 7 days and oven dried at 105°C for 12 h to bring an end to fermentation, milled (Sieved with No 30 mesh) to obtain fermented sesame flour and stored in a glass container.

Boiling

Boiling was done using the method described by Makinde, and Akinoso, (2013). The whole sesame seeds were cooked at 100°C for 30 min in the seed to water ratio of 1:10 (w/v). Consequently, the seeds were dried by hot air oven at 40°C for 24 h prior to milling and stored.

Roasting

The whole seeds of sesame seeds were roasted in an oven at 120°C for 1 hr according to the method described by Mohamed et al. (2007). The samples were milled in a Braun (KMM 30, Bico, Chicago) mill to pass through a 0.5 mm sieve and stored in a sealed high density polyethylene bags until required for further analysis.

Germination

Sesame seeds were germinated as described by Okoli and Adeyemi, (1989). The seeds were sorted to remove stones and other extraneous materials. It was thereafter soaked for 2 h to achieve hydration then rinsed, drained and spread thinly on jute sack for germination to take place. The germination process was closely monitored to prevent discontinuity of germination and mould growth which was achieved by constant wetting and intermittent uniform spreading of the germinating seedlings. Germination was carried out for three days. The germinated seedlings were thoroughly rinsed with water, drained, derooted, dried in a hot air oven (model QUB 305010G, Gallenkamp, UK) at 60°C for 6 h and then milled using a laboratory blender to pass through a 0.5 mm sieve and stored in plastic bags until required for further analysis.

Production of Cookies from treated Sesame flour and Wheat Flour

Cookies were produced as described by Aliyu and Sani (2009). The raw materials used include flour (wheat and treated sesame flour) (100g), sugar (10g), margarine (30g), salt (2g), sodium bicarbonate (1g), water (50g), milk (10g), vanilla flavour (2g) as shown in table 1. These were weighed appropriately and all the ingredients except flours were mixed thoroughly in a Kenwood mixer (a 3-speed hand mixer), it was then transferred to a bowl. The flours and sodium bicarbonate were added with continuous mixing for 15min until smooth dough was obtained. A piece of this dough was cut, placed on a clean platform then rolled out using rolling pin until the desired uniform texture and thickness was obtained. Cookies cutter was used to cut the sheet of the dough into required shapes and sizes. These were transferred on to a greased (with margarine) baking tray. The baking was done at 200°C and baked for 15 – 20 minutes. After baking, the hot cookies were removed from the pan and

placed on a clean tray to cool down. The cookies were then packed after cooling in polyethylene sachets of appropriate thickness and permeability using an impulse sealing machine prior to further analysis and sensory evaluation

Table 1: Production Blends for Wheat/Processed Sesame Seed Flour Cookies

Ingredient (g)	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
WF	95	90	85	80	95	90	85	80	95	90	85	80	95	90	85	80	100
FSSF	5	10	15	20	0	0	0	0	0	0	0	0	0	0	0	0	0
BSSF	0	0	0	0	5	10	15	20	0	0	0	0	0	0	0	0	0
RSSF	0	0	0	0	0	0	0	0	5	10	15	20	0	0	0	0	0
GSSF	0	0	0	0	0	0	0	0	0	0	0	0	5	10	15	20	0
Sugar	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
Margarine	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
Water	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50
Milk	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
NaHCO3	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Salt	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Flavour	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2

KEY: WF= wheat flour, FSSF= fermented sesame seed flour, BSSF= Boiled sesame seed flour, RSSF= Roasted sesame seed flour, GSSF = germinated sesame seed flour.

A= WF/FSSF cookies (95/5%), B=WF/FSSF cookies (90/10%), C= WF/FSSF cookies (85/15%), D=WF/FSSF cookies (80/20%), E= WF/BSSF cookies (95/5%), F=WF/BSSF cookies (90/10%), G= WF/BSSF cookies (85/15%), H= WF/BSSF cookies (80/20%). I=WF/RSSF cookies (95/5%), J= WF/RSSF cookies (90/10%), K=WF/RSSF cookies (85/15%), L= WF/RSSF cookies (80/20%), M= WF/GSSF cookies (95/5%), N= WF/GSSF cookies (90/10%), O= WF/GSSF cookies (85/15%), P=WF/GSSF cookies (80/20%), Q= control (100% wheat flour cookies).

Nutrient Composition

The determination of the nutrient composition of the cookie samples viz; moisture content, ash, protein, fat and crude fibre were determined by using AOAC method (AOAC, 2012), while carbohydrate was determined using the Clegg anthrone method as described by Osborne and Voogt (1978) and energy was calculated using the Atwater factors (Kiin-Kabari and Giami, 2015).

Sensory Evaluation

Sensory evaluation of the cookies was carried out after baking using the method described by Giami and Barber (2004) for fluted pumpkin cookies. The sensory attribute included appearance, aroma, crispiness, taste and general acceptability were evaluated using a 9 – point hedonic scale with 1 representing the least score (dislike extremely) and 9, the highest score (like extremely) as described by Iwe (2010).

Statistical Analysis

All the analyses were carried out in replicates. Data obtained were subjected to Analysis of variance (ANOVA), differences between means were evaluated using Tukey's multiple comparison test, and significance accepted at $P \leq 0.05$ level. The statistical package in Minitab 16 computer program was used.

Results and Discussion

Nutrient Composition of Cookies Produced from Wheat/ Processed Sesame Seed Flour Blends

Result for nutrient composition of cookies Produced from Wheat/ Processed Sesame Seed Flour blends is shown in Table 2. Moisture, Ash, Fat, Protein, fibre and carbohydrate content ranged from 7.00 – 16.85%, 1.40 – 3.59%, 11.95 – 24.69%, 7.06 – 13.09%, 0.31 – 3.75% and 51.18 – 64.71%, respectively. Cookies produced with90% wheat and 10% roasted sesame seed flour blends (sample J) gave significantly higher moisture content of 16.85%, while the control (100% wheat cookies) gave the least moisture content of 7.00%. Moisture content of sample H were closest to that of the control. High moisture content has been associated with short shelf life of baked products, as they encourage microbial proliferation that lead to spoilage (Ezeama, 2007; Akhtar et al., 2008; Elleuch et al., 2011). Samples G (85/15% wheat/ boiled sesame seed flour cookies) and F (90/10% wheat/sesame seed flour cookies) had high ash content of 3.59 and 3.46%, respectively. The ash content of all the blended samples were significantly ($P<0.05$) higher than that of the control. The fat content of sample D (80/20% wheat/fermented sesame seed flour cookies) and that of the control were not significantly different ($P<0.05$). Samples H, E and O showed significantly higher fat content than the control and other blends. The high oil content of the cookies will affect the shelf stability. Fat is essential component of tissues and a veritable source for fat soluble vitamins (A, D, E and K). It is able to supply thrice the amount of energy required by the body (Wardlaw, 2004). As shown in Table 2, the protein content in all the cookies samples increased significantly ($P<0.05$) with increase in percentage substitution of processed sesame seed flour. The protein contents of samples M, J and F were not significantly different ($P>0.05$) from that of the control (100% wheat flour cookies). Cookies produced from roasted and fermented sesame seed flour at substitution level of 20% with 80% wheat flour (sample L and D) gave significantly higher crude protein of 13.41% and 13.09%, respectively. Increase in protein content due to roasting of sesame seed has also been reported by earlier researchers (Makinde et al., 2016). Jimoh et al. (2011) also reported increase in protein content of defatted sesame seed from 21.78% to 42.21%. Similar increase in total protein content of cookies produced with soy-flour substitution in the range of 8.75% to 24.65% in wheat flour has been reported by earlier researchers (Ndife et al., 2014). The increase was attributed to substitution of whole-wheat flour (12.85% protein) with soya bean flour of 38.50% protein content. Other studies have also reported a similar increase of protein content in soy-composite flours (Singh et al., 2000; Mashayekh et al. (2008). Protein is a major nutrient needed as building blocks for the body, necessary for growth and for the repair of damaged tissues (Wardlaw, 2004).The crude fibre contents of sample E (90/5 wheat/ boiled sesame seed flour cookies) and that of the control were significantly higher at 13.41% and 13.09%, respectively. Carbohydrate was shown to reduce with increase substitution of processed sesame seed flour. increased fibre and the lower carbohydrate content of cookies have several health benefits, as it will aid digestion in the colon and reduce constipation often associated with products from refined grain flours (Slavin, 2005; Elleuch et al., 2011)

Table 2: Proximate Composition of Cookies Produced from Wheat/Processed Sesame Seed Flour Blends (%)

Treatment	Samples Blends	Moisture	Ash	Fat	Protein	Crude Fibre	Carbohydrate
Boiled	A	13.40±0.11[c]	1.74±0.10[cd]	11.95±0.15[f]	11.45±0.61[b]	0.96±0.35[de]	64.71±0.59[a]
	B	13.53±1.06[c]	2.07±0.03[c]	14.21±0.03[e]	12.74±1.22[ab]	0.82±0.25[de]	56.54±0.27[b]
	C	14.98±0.29[bc]	2.08±0.23[c]	17.13±0.43[d]	11.99±1.24[b]	0.31±0.14[h]	53.53±0.76[c]
	D	12.50±0.45[cd]	2.76±0.59[b]	16.11±0.57[de]	13.09±0.61[a]	0.64±0.01[f]	54.92±1.08[b]
	E	9.86±0.17[e]	1.93±0.09[c]	23.46±0.27[a]	10.09±0.00[c]	3.49±0.54[a]	51.18±0.53[cd]
Fermented	F	10.29±0.19[de]	3.46±0.13[a]	20.39±1.65[bc]	11.05±0.00b[c]	0.48±0.23[g]	54.34±1.36[bc]
	G	11.32±0.83[d]	3.59±0.04[a]	21.03±0.23[ab]	10.46±0.61[c]	1.41±0.19[d]	52.21±0.69[c]
	H	7.95±0.91[f]	2.67±0.32[b]	24.69±1.04[a]	11.84±0.00[b]	1.28±0.05[d]	51.59±0.23[cd]
	I	15.70±0.35[b]	1.57±0.13[d]	12.41±1.57[b]	10.64±0.62[c]	0.61±0.00[f]	58.93±1.76[ab]
Roasted	J	16.85±0.34[a]	1.84±0.07[c]	14.17±0.74[e]	10.92±0.00[bc]	1.14±0.22[d]	55.09±0.11[b]
	K	14.93±0.91[bc]	2.77±0.61[b]	12.62±1.48[ef]	11.68±0.00[b]	2.29±0.06[bc]	55.70±0.05[b]
	L	10.32±0.15[de]	2.87±0.14[b]	19.20±0.40[c]	13.41±0.00[a]	0.65±0.01[f]	53.56±0.41[c]
	M	8.50±0.20[a]	2.34±0.01[bc]	21.34±0.35[ab]	11.05±1.24[bc]	1.96±0.005[c]	54.82±1.46[bc]
Germinated	N	9.42±0.26[e]	1.98±0.15[c]	21.39±0.28[ab]	11.82±1.22[b]	0.66±0.00[f]	54.75±0.53[bc]
	O	9.27±0.56[e]	2.15±0.27[c]	22.97±0.81[a]	10.92±0.00[bc]	2.98±0.11[b]	51.72±0.41[cd]
	P	8.80±0.28[ef]	2.51±0.03[bc]	22.42±1.56[a]	12.35±0.61[ab]	0.63±0.00[f]	53.29±0.95[c]
	Q	7.00±0.28[g]	1.40±0.28[e]	16.12±0.28[de]	11.10±0.28[bc]	3.75±0.28[a]	60.63±0.28[a]

Values are Mean ± Standard Deviation of Triplicate Samples. Values Bearing Different Letters in the same Column differ Significantly (P<0.05).

KEY: WF= wheat flour, FSSF= fermented sesame seed flour, BSSF= Boiled sesame seed flour, RSSF= Roasted sesame seed flour, GSSF = germinated sesame seed flour.

A=WF/FSSF cookies (95/5%), B=WF/FSSF cookies (90/10%), C= WF/FSSF cookies (85/15%), D=WF/FSSF cookies (80/20%), E= WF/BSSF cookies (95/5%), F=WF/BSSF cookies (90/10%), G=WF/BSSF cookies (85/15%), H= WF/BSSF cookies (80/20%). I=WF/RSSF cookies (95/5%), J=WF/RSSF cookies (90/10%), K= WF/RSSF cookies (85/15%), L= WF/RSSF cookies (80/20%), M=WF/GSSF cookies (95/5%), N= WF/GSSF cookies (90/10%), O= WF/GSSF cookies (85/15%), P=WF/GSSF cookies (80/20%), Q= control (100% wheat flour cookies).

Energy Value of Cookies Produced from Wheat/Processed Sesame Seed Flour Blends

Energy value of the cookies ranged from 383.10kcal/100g – 475.93kcal/100g as shown in Figure 1. The energy values of cookies produced from wheat flour blended with boiled and germinated sesame seed flour were significantly (P<0.05) higher than those produced from wheat flour blended with fermented and roasted sesame seed flour and also that of the control (sample Q). high energy value could be due to the high fat content of the boiled and germinated blends and this is desired especially in famine and war-torn locations were the next meal is not easy to come by (Ndife et al., 2014). High-energy foods tend to have a protective effect in the optimal utilization of other nutrients (Wardlaw, 2004)

Sensory Properties of Cookies Produced from Wheat/ Processed Sesame Seed Flour Blends

From the results in Table 3, appearance, aroma, crispiness, taste and overall acceptability of cookies produced from wheat in composite with processed sesame seed flour ranged from 4.95 –7.05, 5.20 – 6.85, 4.50 – 5.85, 4.50 – 6.70 and 4.90 – 6.90, respectively. Cookies produced with 80%wheat/20% boiled sesame seed flour and cookies produced from 100%wheat flour gave High mean score for appearance; 7.05 and 7.00, respectively. These values were however not significantly different (P>0.05) from other samples. This may be due to better processing control which include temperature and time regulation and efficient heat transfer in the oven which helped to prevent colour darkening that is attributed to caramelization and Maillard reactions as reported by Alobo (2001). Sample P (80/20% wheat/germinated sesame seed flour) however, gave relatively low value of 4.95 for appearance. The aroma, crispiness and taste of cookies produced from the blended flours compared favourably with those of the control (100% wheat flour). The overall acceptability of the wheat/processed sesame seed flour composite cookies were not statistically different (P>0.05) from that of the control (100% wheat flour), except sample P (80/20% wheat/ germinated sesame seed flour) with 4.90 mean acceptability.

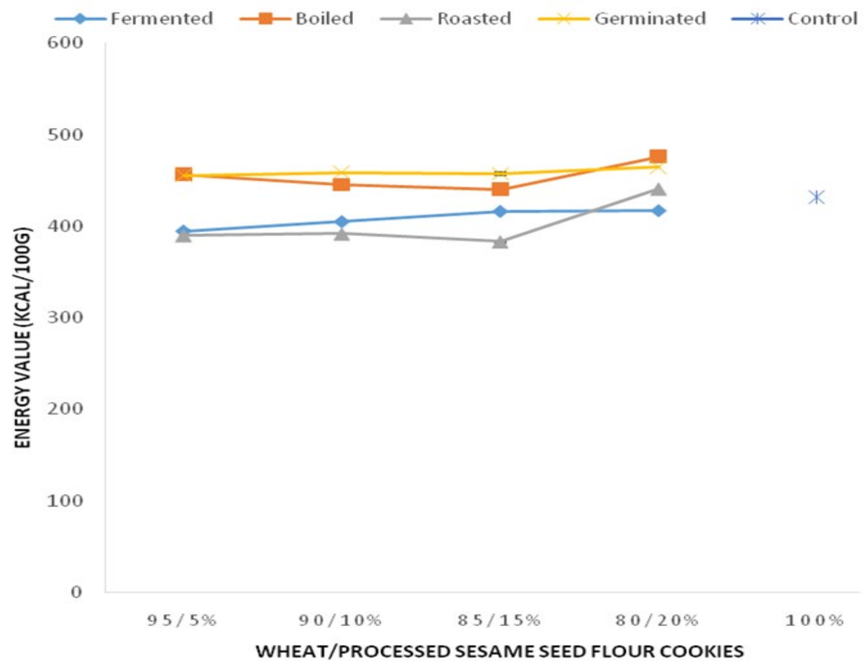

Figure 1: Effect of Treatments and Blend Ratio on the Energy Value of Cookies Produced from Wheat/Processed Sesame Seed Flour

Table 3: Sensory Properties of Cookies Produced from Wheat/Processed Sesame Seed Flour Blends

Treatment	Blends (W/S)	Appearance	Aroma	Crispines	Taste	Overall Acceptability
Boiled	95/5%	6.40±1.64[ab]	6.60±1.43[a]	5.50±1.73[a]	6.20±1.44[ab]	6.50±1.05[a]
	90/10%	6.70±1.47[a]	6.15±2.01[a]	5.35±2.06[a]	5.65±1.79[abc]	6.20±1.64[ab]
	85/15%	6.80±1.00[a]	5.90±1.71[a]	5.40±1.90[a]	5.45±1.47[abc]	5.85±1.57[ab]
	80/20%	7.05±0.55[a]	6.10±1.52[a]	5.85±1.63[a]	6.60±1.05[a]	6.50±1.32[a]
Fermented	95/5%	6.40±1.43[ab]	5.75±1.52[a]	5.60±1.79[a]	5.60±2.14[abc]	5.80±1.94[ab]
	90/10%	6.60±1.27[ab]	5.90±1.37[a]	5.50±1.67[a]	6.10±1.83[ab]	6.50±1.57[a]
	85/15%	6.05±1.82[ab]	5.85±1.57[a]	5.10±1.59[a]	5.95±1.79[ab]	5.80±1.77[ab]
	80/20%	5.70±1.53[ab]	5.85±1.57[a]	5.80±1.94[a]	5.80±1.64[ab]	5.95±1.47[ab]
Roasted	95/5%	6.90±0.37[a]	6.85±0.93[a]	5.45±2.01[a]	6.35±1.66[ab]	6.65±1.31[a]
	90/10%	6.70±0.92[a]	6.30±1.13[a]	5.40±1.54[a]	5.95±1.82[ab]	6.20±1.51[a]
	85/15%	6.65±1.89[ab]	6.10±1.55[a]	5.40±1.57[a]	5.70±1.63[abc]	6.60±1.14[a]
	80/20%	6.55±1.23[ab]	6.35±1.23[a]	5.25±1.52[a]	5.25±1.37[abc]	6.20±1.44[a]
Germinated	95/5%	6.30±1.30[ab]	5.80±1.79[a]	5.25±1.83[a]	5.40±1.88[abc]	6.00±1.49[ab]
	90/10%	5.85±0.81[ab]	5.65±1.42[a]	5.50±1.73[a]	4.80±1.88[abc]	5.25±1.80[ab]
	85/15%	5.10±1.86[ab]	5.65±1.69[a]	5.10±1.48[a]	4.80±1.77[abc]	5.50±1.79[ab]
	80/20%	4.95±1.01[b]	5.20±1.83[a]	4.50±1.54[a]	4.50±2.28[abc]	4.90±2.31[b]
Control (Wheat)	100%	7.00±0.65a	6.50±1.43[a]	5.00±2.15[a]	6.70±1.59[a]	6.90±1.37[a]

Values are Mean ± Standard Deviation of Twenty responses. Values Bearing Different Letters in the same Column differ Significantly (P<0.05).

Key: W/S = Wheat flour/ Processed Sesame seed flour

Conclusion

Production of cookies from wheat flour in composite with processed sesame seed flour enhances its nutrient composition. As shown in the results, ash content of all the blended samples were significantly (P<0.05) higher than that of the control (100% wheat flour cookies), indicating improved mineral content. protein content in all the composite cookies samples increased significantly (P<0.05) with increase in percentage substitution of processed sesame seed flour. Cookies produced from roasted and fermented sesame seed flour at substitution level of 20% with 80% wheat flour (sample L and D) gave significantly higher crude protein of 13.41% and 13.09%, respectively. Processing of sesame seed flour by boiling and germination was shown to enhance the energy value of its composite cookies. The composite cookies received equal overall acceptability as the conventional wheat flour cookies. Germination, fermentation and roasting at 80:20 blend ratio increased the protein content of the cookies obtained from them.

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