Original Article

Quality assessment of cookies produced from wheat and red kidney bean flour

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Abstract

Background: The effect of substitution of wheat flour with red kidney bean flour in cookies' production was investigated. Cookies were produced using different levels of wheat flour substituted with red kidney bean flour ranging from 0% to 40% and using 100% wheat flour as control.

Material and Methods: The proximate composition, mineral composition, and sensory properties of cookies were determined using standard methods.

Results: The proximate analysis results showed that moisture, ash, and protein content increased from 5.23% to 6.93%, 1.50% to 4.73%, and 10.77% to 13.98%, respectively, whereas fat, fiber, and carbohydrate decrease from 33.31% to 17.37%, 2.65% to 1.21%, and 61.93%–40.10% with increased substitution of red kidney bean flour. The mineral content shows that there was increase in phosphorus, iron, molybdenum, magnesium and calcium from 27.41 to 51.22, 2.15 to 3.55, 0.02 to 0.09, 2.66 to 3.55, and 13.49 to 27.66 mg/l. Sensory evaluation showed no significant differences ($P < 0.05$) in sensory attributes analyzed. Sample B (90:10) was preferred in terms of color, taste, and overall acceptability with mean scores of 7.80, 6.90, and 8.10, respectively.

Conclusion: This study, therefore, shows an improvement in the nutritional contents and organoleptic properties of cookies. Hence, the fortification of wheat flour with red kidney bean flour should be encouraged.

Keywords: Cookies, fortification, red kidney bean flour, wheat flour

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Submitted: 05-Jun-2020 **Revised:** 22-Jul-2020 **Accepted:** 21-Sep-2020 **Published:** 31-Dec-2020

INTRODUCTION

Cookies are consumed extensively all over the world as a snack food and on a large scale in developing countries where protein and caloric malnutrition are prevalent.[1] A cookie is a baked or cooked food that is small, flat, and sweet. It usually contains flour, sugar, and some type of oil or fat. It may include other ingredients such as raisins, oats, chocolate chips, and nuts.[2]

Access this article online	
Quick Response Code:	Website: www.ijfans.org
	DOI: 10.4103/IJFNS.IJFNS_13_20

Wheat is one of the most important staple food for humans.[3] The kernel consists of wheat germ and the endosperm, which is full of starch and protein.[4] Usually, the whole grain is milled to leave just the endosperm for white flour, while the by-products of bran and germ are discarded. It has been shown that the whole grain is a concentrated source of essential nutritional components such as vitamins, minerals, protein, fat, and fiber, while the refined grain is mostly starch.[5,6]

How to cite this article: Noah AA, Adedeji MA. Quality assessment of cookies produced from wheat and red kidney bean flour. Int J Food Nutr Sci 0;0:0.

Red kidney beans *(Phaseolus vulgaris*) have greatest popularity in the United States of America as well as play a great role been part of traditional plant-based diet in many countries. Red kidney bean (*P. vulgaris L.*), a grain legume, is one of the tropical legumes that can be used to improve the diets of millions of people who cannot afford expensive animal protein known for its high protein content.[7] Red kidney beans are excellent sources of vegetable protein, starch, soluble and insoluble fiber, and minerals (especially zinc, magnesium, and manganese). They are very low in fat.[8]

The need for strategic development in the use of inexpensive local resources in the production of staple foods has been promoted by organizations such as the Food and Agricultural Organization and the United Nations refugee feeding programs. This led to the initiation of the composite flour program. This is because compositing with red kidney bean is expected to substantially improve the protein efficiency ratio.[9] Recently, attempts had been made to produce cookies from nonwheat-based composite flours with high nutritional and sensory properties from unripe plantain and defatted sesame flour blends,[1] cassava groundnut – corn starch blends[10] and pigeon pea, cocoyam, and sorghum flour blends.[11] A current trend in nutrition is the consumption of functional foods advocated by world nutrition bodies due to different health problems related with wheat consumption such as celiac disease, diabetes, and coronary heart diseases. This situation has created the need for the consumption of low carbohydrate diets, slowly digested starchy foods as well as an increased intake of functional foods.[12] This study, however, was carried out to determine the potential of red kidney bean with wheat flour blends in cookie production and to evaluate the nutritional and sensory acceptability.

MATERIALS AND METHODS

The production of cookies from wheat flour, fortified with red kidney bean flour, was the principal raw materials for this study. The wheat flour and other ingredients were purchased at Sayedero market Ilaro, Ogun state, whereas the red kidney bean used for this study was purchased from Agricultural Research Product, Agege, Lagos.

Preparation of red kidney beans

The red kidney bean seeds were sorted, cleaned, and soaked in cold water for 10 min, after which it was dehulled using plate mill with 6 mm clearance between the plates and dried at 65°C for 12 h in a cabinet drier to a moisture content of 10%. The dried sample was milled and sieved and stored in an airtight polyethylene bag.

Preparation of composite flour

Flours were prepared by homogenous mixing of wheat flour with red kidney bean flour in the percentage proportion 100:0, 90:10, 80:20, 70:30, and 60:40. A digital weighing balance was used for weighing and mixing the flours, respectively.

Preparation of cookies

The wheat flour was mixed with varying inclusions of 0%, 10%, 20%, 30%, and 40% of the red kidney bean flour and was labeled as samples A, B, C, D, and E, respectively. Sample A (100% wheat) served as control as shown in Table 1. Cookies were prepared using the method of Nishiber and Kawakishi[13] with slight modifications. Instead of glucose and butter in the original formula, granulated sugar (sucrose) and margarine were used in this preparation. Cookie formulations include flour (49.50), margarine (20.00%), beaten egg (10.00%), sugar (20.00%), and baking powder (0.50%). The flour, sugar, and baking powder were manually mixed inside a bowl (500 cm^3). Margarine and beaten whole egg were well creamed for 60 s then dried ingredients were added at once and mixed for another 60 s. The batter was shaped using cutter and baked in an air oven at 180° for 8 min. They were allowed to cool on a rack, after which they were packaged in low-density polyethylene bag and kept in a plastic container.

Table 1: Formulation of wheat and red kidney bean composite dough

	Cookie samples				
	A	B	C	D	E
Whole wheat flour (g)	100	90	80	70	60
Red kidney flour (g)	0	10	20	30	40
Sugar (g)	20	20	20	20	20
Margarine (g)	20	20	20	20	20
Baking powder (g)	0.5	0.5	0.5	0.5	0.5
Egg (whole)	10	10	10	10	10

Sample A: 100% WF, Sample B: 90% WF 10% RKF, Sample C: 80%WF 20% RKF, Sample D: 70% WF 30% RKF, Sample E: 60% WF 40% RKF. WF: Wheat flour, RKF: Red kidney bean flour

Proximate analysis

The proximate analysis of cookie samples was done using the method of AOAC.[14] The determination of proximate composition of the cookie samples, namely, moisture content, ash, protein, fat, and crude fiber was determined following the procedure outlined by AOAC, whereas the carbohydrate content was calculated by difference.

Mineral analysis

The cookie samples were digested by the wet ashing method before mineral content determination using atomic absorption spectrophotometer for Ca, Mg, P, and Fe.[15]

Sensory analysis

Sensory evaluation of the composite cookie samples was carried out by twenty panelists made up of students and staffs of Food Technology Department of The Federal Polytechnic, Ilaro were used for the sensory evaluation of the cookies. The sensory attribute included color, taste aroma, texture, crunchiness, and overall acceptability was evaluated using a 9-point hedonic scale ranging from 9 (extremely like) to 1 (extremely dislike) and 5 (neither like nor dislike) as described by Ihekoronye and Ngoddy.[16]

Statistical analysis

All data obtained were subjected to statistical analysis of variance using SPSS software version statistical pages. Means were separated using Duncan multiple range tests.

RESULTS AND DISCUSSION

Proximate composition

Table 2 shows result of the proximate composition of the cookies. Cookies with increased red kidney flour substitutions were found to be nutritionally superior, having higher proximate values of protein, ash, and mineral contents to whole wheat cookies. This similar trend was observed with soy substitution by Ndife *et al.*[17] There was an

Table 2: Proximate composition of the cookies produced from wheat and red kidney bean flour

Parameters	A (100:0)	B (90:10)	C (80:20)	D (70:30)	E (60:40)
Moisture	5.23±0.03^{a}	5.89±0.01^{b}	6.11±0.01^{e}	6.59±0.11^{d}	6.93±0.02^{e}
Ash	1.50±0.07^{c}	2.22±0.01^{b}	3.53±0.04^{e}	4.12±0.01^{d}	4.73±0.02^{e}
Fat	33.31±0.24^{e}	22.73±0.18^{d}	21.07±0.06^{c}	19.39±0.07^{b}	17.37±0.38^{a}
Fiber	2.65±0.06^{e}	2.13±0.03^{d}	1.21±0.01^{a}	1.32±0.01^{b}	1.76±0.05^{c}
Protein	10.77±0.01^{a}	11.27±0.02^{b}	12.13±0.08^{c}	12.54±0.02^{d}	13.98±0.02^{e}
Carbohydrate	61.93±0.13^{e}	59.18±0.10^{d}	55.46±0.16^{c}	52.61±0.23^{b}	40.10±0.23^{a}

Values are mean, standard deviation of triplicate determination. A: Cookies from 100% wheat flour (control), B: Cookies from 90% wheat flour and 10% red kidney bean flour, C: Cookies from 60% wheat flour and 40% red kidney bean flour, D: Cookies from 70% wheat flour, and 30% red kidney bean flour, E: Cookies from 60% wheat flour and 40% red kidney bean flour, Mean in the same row with different superscript are significantly different ($P \leq 0.05$)

increase in the protein content of the cookies with red kidney flour substitution in the range of 10.77%–13.98%. This increase is as a result of substitution of wheat flour with red kidney flour. Protein is needed as building blocks for the body, necessary for growth, and for the repair of damaged tissues.[18]

The moisture content increased slightly from 5.23% to 6.93% in the cookie samples. Sample E (60:40%) had the highest percentage of moisture when compared to sample A (100% wheat flour cookies). The data show that there is a significant difference $P \leq 0.05$ between the samples. High moisture content has been associated with the short life of baked products, as they encourage microbial proliferation that leads to spoilage.[3,19]

The ash content increased from 1.50% to 4.73%, with sample E (60:40) having the highest ash content. The data show that there is a significant difference. Ash is an indication of mineral content in foods, and nutritionally, it aids in the metabolism of other organic compounds such as fat and carbohydrate.[20] The fat content decreased from 33.31% to 17.37%, with the control (100:0) having the highest value of 33.31%. The high oil content of the cookies will affect the shelf stability.[5] Fat is an 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.[18]

The fiber content ranged from 2.65% to 1.76%, with a significant difference $P \leq 0.05$). Vitali *et al.*, 2009[21] reported that using whole wheat flour in combination with legumes in cookie production resulted in improved nutritional and functional properties of the final products.

The protein content of the cookie samples ranged from 10.77% to 13.98%. Sample E (60:40) had the highest protein of 13.98, and the data show a significant difference $P \leq 0.05$) between all the samples. Protein is needed as building blocks for the body necessary for growth and for the repair of damaged tissues.[18] The carbohydrate content of the cookie samples decreased from 61.93 to 40.10. The data show a significant difference $P \leq 0.05$). The lower carbohydrate content of cookies has several health benefits, as it will aid digestion in the colon and reduce constipation often associated with products from refined grain flours.[19]

Mineral analysis

The mineral compositions of the cookie samples are as shown in Table 3. Phosphorus is the most abundant element in all cookie samples. The highest phosphorus content (51.22 mg/100 g) was recorded in sample E (60:40% substitution). The mineral content of the cookie samples increased with red kidney flour substitution for the entire mineral analyzed. The result shows that there was an increase in the phosphorus content across all the samples with a significant difference ($P < 0.05$), the result indicates that phosphorus contributes to the blood formation and supportive structure of the body.

The iron content ranges from 2.15 to 3.55, and the lowest was recorded in sample A (100:0) with the highest increase in sample E (60:40) with a significant difference $P \leq 0.05$. The molybdenum content of the cookie samples increases across the sample B and C, while sample D has the lowest and the highest is sample C (80:20). The magnesium content value increases across all the samples, while the control sample has the lowest and the highest is sample E (60:40). The result shows that sample E (60:40) has the highest calcium, while sample A (100:0) has the lowest, but there is a significant difference as shown in Table 3, the high calcium exhibited maybe as a result of high calcium in the red kidney bean to wheat flour.

Sensory analysis

Table 4 summarizes the result for the sensory evaluation and overall acceptability of different cookie samples. The statistical analysis revealed that there were no significant differences $P \leq 0.05$) among the cookie samples in the sensory attributes observed. Sample A (whole wheat) had the highest score (7.90), whereas sample D (70:30) and sample E (60:40) had the lowest score (6.58) in terms of color. The panelists showed a preference for the lighter color of sample A (Wheat flour). Browning in the cookie samples could have been due to Maillard type reaction, resulting from the presence of reducing sugars, proteins, and amino acids and caramelization due to the effect of severe heating during processing.[4]

The result for aroma, taste, and texture (softness and smoothness) shows that there is no significant difference $P \leq 0.05$) between all the samples. The result for crunchiness (chew ability) of the cookie samples was affected by red kidney bean flour substitution. The whole wheat cookies (sample A) had the highest score (7.65) for crunchiness (chewiness). The result for texture (softness and smoothness) shows that there is no significant difference $P \leq 0.05$ among all the samples. This could be due to the texture of the product that is affected at the level of substitution of flours incorporation used.

The results for the overall acceptability of cookies samples range from 6.58 to 8.65. The baking conditions (temperature and time variables), the state of the cookie constituents such as fiber, starch, protein (gluten), weather damaged or undamaged, and the amounts of absorbed water during dough mixing will all contribute to the final outcome of the overall acceptability.[5] The cookie samples

Table 3: Mineral composition of the cookies produced from wheat and red kidney bean flour

Parameters	Cookie samples (mg/100g)				
	A (100:0)	B (90:10)	C (80:20)	D (70:30)	E (60:40)
Phosphorus	27.41±0.1[a]	34.13±0.01[a, b]	41.21±0.01[a, b]	44.81±12.71[b]	51.22±0.1[e]
Iron	2.15±0.1[a]	2.37±0.01[b]	3.12±0.01[a]	3.24±0.01[d]	3.55±0.01[e]
Molybdenum	0.03±0.00[a]	0.07±0.00[a]	0.09±0.11[a]	0.02±0.00[a]	0.05±0.04[a]
Magnesium	2.66±0.01[a]	2.84±0.01[a]	3.03±0.01[c]	3.55±0.01[c]	3.17±0.02[d]
Calcium	23.29±0.01[c]	27.07±0.01[d]	13.49±0.0[a]	18.23±0.01[b]	27.66±0.01[e]

Values are mean, standard deviation of duplicate determination, Mean in the same row with different superscript are significantly different ($P \leq 0.05$)

Table 4: Sensory evaluation of the cookies produce from wheat and red kidney bean flour

Parameters	A (100:0)	B (90:10)	C (80:20)	D (70:30)	E (60:40)
Color	7.90±1.26[a]	7.80±0.86[a]	6.75±1.76[a]	6.58±1.51[a]	6.58±1.44[a]
Taste	6.13±1.83[a]	6.90±0.87[a]	6.65±1.91[a]	6.33±1.38[a]	6.35±1.50[a]
Aroma	6.26±1.80[a]	7.13±1.56[a]	7.93±1.30[a]	6.50±1.98[a]	6.33±1.30[a]
Texture	5.35±1.82	6.07±1.15[a]	6.40±1.58[a]	6.76±1.13[a]	6.80±1.75[a]
Crunchiness	7.65±1.81[a]	6.08±1.16[a]	6.48±1.78[a]	6.68±1.15[a]	6.60±1.63[a]
Overall acceptability	8.65±2.11[a]	8.10±2.10[a]	7.53±1.16[a]	7.10±1.83[a]	6.58±1.51[a]

Values are mean standard deviation of duplicate determination, Mean in the same row with different superscript are significantly different ($P \leq 0.05$)

showed that they were liked by the panelist. Cookie samples A and B had the highest preference in terms of overall acceptability ratings of 8.65 and 8.10, respectively. Among the fortified samples, sample B (90:10) cookie had the best overall acceptability.

CONCLUSION

The study showed that cookies with red kidney bean substitution were found to be nutritionally superior (having higher ash, protein, and mineral content) to wheat cookies. Thus, the cookies can conveniently be regarded as a balanced whole meal. The overall acceptability of the cookies shows that sample B (90:10) cookies prepared from 90% wheat and 10% red kidney bean flour compared favorably with the control and had the best overall acceptability.

Recommendation

We recommend the fortification of red kidney bean flour in cookie production. Further investigation on functional and microbial quality of cookies should be determined. However, further research work should also be focused on the shelf stability of the fortified cookies.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

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