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Research Article
Utilization of Wheat-Pumpkin Seed Composite Flour for Biscuit

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Abstract

Background and Objective: Pumpkins provide substantial amounts of alpha-carotene, beta-carotene, lutein and zeaxanthin, which effectively makes them an excellent source of antioxidants. Pumpkin also offers healthy amounts of fiber, potassium, riboflavin, vitamin C and iron. In addition, pumpkin is a good, low-fat source of vitamin E. Then as a consequence, a successful combination of pumpkin flour with wheat flour for biscuits production would be nutritionally advantageous. This study was conducted to know whether the Pumpkin flour can be used for the production of high quality biscuits with improved nutritional values. **Materials and Methods:** Supplementations of full fat pumpkin flours to wheat flours at 5, 10 and 15% levels were carried out to test the effects on organoleptic and nutritional parameters of the supplemented biscuits. Addition of 15% full fat pumpkin flour to wheat flour produced acceptable biscuits. However, substitution of full fat pumpkin flours to wheat flour at 5 and 10% levels did not produce organoleptically acceptable biscuits compared to control and 15% full fat pumpkin flour biscuits. Various nutritional parameters such as moisture, ash, protein, fiber, oil extract and carbohydrate, mineral profile, ash and protein for biscuit samples and amino acids content were determined. **Results:** The results of chemical composition of both samples wheat and pumpkin flour revealed that the pumpkin flour was significantly ($p<0.05$) higher in all proximate composition parameters tested and minerals profile (Calcium, magnesium, potassium, phosphorus and sodium) . The increasing of the level of substitution from 5-10% of full fat pumpkin seeds flour to wheat flour significantly ($p<0.05$) increased protein (from 9.42-10.52, 10.95-11.22%) respectively, ash (from 0.514-0.641, 0.770-0.971%) respectively for 5, 10 and 15% pumpkin flour levels in biscuit flour. Amino acids result for both samples showed that pumpkin flour protein had better amino acids profile compared to wheat flour mainly for those amino acids considered as most limiting amino acids in cereal protein such as lysine, tryptophan ,and threonine. Wheat Flour was significantly ($p\leq0.05$) higher in moisture and carbohydrate content while the pumpkin flour was significantly ($p\leq0.05$) higher in fat, protein, ash and crude fiber. **Conclusion:** It is concluded that bsiscuits supplemented with full fat pumpkin flour, up to a 15% level, are organoleptically and nutritionally acceptable.

Key words: Wheat, pumpkin seed flour, biscuits, nutritional assessment, sensory evaluation, wheat flour

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Competing Interest: The authors have declared that no competing interest exists.

Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

Pumpkin is native to North America and it is extensively grown all around the world. It belongs to the genus Cucurbita of the family Cucurbitaceae. There are three typical types of pumpkin in the world that is Cucurbitapepo, Cucurbita maxima and Cucurbitamoschata[1].

Pumpkins vary greatly in shape, size and colors. In terms of colors it comes in either orange or yellow. In addition, some varieties may be dark to light green, brown, white, red and gray. The thick shell of pumpkin contains seeds and pulp. In composition, fruit pulp has golden-yellow to orange color. In Vietnam, Pumpkin is grown year-round, it is well adapted to hot and humid tropical climates.

A biscuit is a kind of cake which is small flat, crisp and made from flour[2]. Biscuits represent a fast growing segment of food because of consumer demands for convenient and nutritious food products. The consumers' demand has increased for quality food products with taste, safety, convenience and nutrition. Thus nutrition has emerged as an added dimension in the chain of food product development. Biscuits are popular foodstuff consumed by a wide range of population due to their varied taste, long shelf life and relatively low cost[3,4]. Since biscuits are dried to low moisture content and this can ensure their long shelf life storage and especially free from microbial spoilage .

Moreover, Pumpkin contains a high content of Beta carotene, pectin, some vitamin, material salts, etc. Pumpkin also included the various source of carotenoids and ascorbic acid[5], which have essential roles in nutrition as pro-vitamin A (antioxidant). Nevertheless, α, β-carotenes, lutein, cryptoxanthin and zeaxanthin, etc. as natural poly-phenolic flavonoid compounds in pumpkin. Pumpkin flour is a good source of food containing a high and healthy amount of dietary fiber[6].

Heinonen and Albanes[7] suggested that the human body can be protected against lung and oral cavity cancers by increasing vitamin-A in the body. Zeaxanthin is an active biological compound found in Pumpkin, which is a natural anti-oxidant included with ultra-violet rays that gives sieving actions in the macula lutea in the retina of the eyes[8].

Although, many studies on the evaluation and use of pumpkin have been conducted as mentioned above, there is no information on how to prepare and improve the quality of flour and the made biscuits from the pumpkin. So, it is scientifically and economically important to know whether the Pumpkin flour can be used for the production of high quality biscuits with improved nutritional values. Also, consequence of various proportion of Pumpkin to wheat flour in biscuits formation needs to be determined in order to make, high quality final biscuits products.

MATERIALS AND METHOD

Collection of samples: Samples were collected from Bahri State market in Khartoum State and consist of pumpkin and wheat biscuit.

Preparation of samples: For the first stage, pumpkin samples were cut using a stainless steel knife then the seeds were collected and dried at room temperature, then converted to soft powder by the mechanical grinder. Supplemented samples were made of full fat pumpkin flours to wheat flours at 5, 10 and 15%. In addition, levels were carried out to test the effects on organoleptic and nutritional parameters.

Chemical analysis: Analysis of moisture content, ash and crude fiber was done by standard method of the Association of Official Analysis Chemist[9]. Protein content was determined by the Kjeldahl method according to the AOAC[9]. Fat content was determined by using the sox let extraction method using petroleum ether as the solvent[9].The carbohydrate content was calculated by difference between 100 and total sum of the percentage of moisture, protein, fat, fibre and ash while the energy values were calculated using Atwater formula[10]. Calcium (Ca), Magnesium (Mg), Sodium (Na), Potassium (K) and phosphorus (P) were determined according to Atomic Absorption Spectrometer[11]. Amino acids were determined by amino acid analyzer according to the AOAC[9].

Sensory Evaluation: Sensory evaluation was done by the scoring method of Ihekronye and Negoody[12].

Statistical analysis: Statistical analysis was done by the method of SAS[13]. Results were presented as means ± standard deviations of triplicate experiments. Significant difference was established at $p \leq 0.05$.

RESULTS AND DISCUSSION

Chemical composition of wheat and pumpkin flour: Table1 shows the chemical composition of wheat and pumpkin flour. The moisture, fat, protein, ash, crude fiber and carbohydrate values were 7.30, 1.36, 9.42, 0.514, 0.078 and 81.33% respectively while the values of similar parameters for pumpkin flour were 6.47, 39.93, 32.12, 3.21, 3.17 and 15.10%

Table 1: Chemical composition of wheat and pumpkin flours

Sample	Moisture content (%)	Fat content (%)	Protein content (%)	Ash content (%)	Crude fibre (%)	Carbohydrate (%)
Wheat	7.30±0.23[a]	1.36±0.11[b]	9.42±0.10[b]	0.514±0.006[b]	0.078±0.002[b]	81.33±0.24[a]
Pumpkin	6.47±0.12[a]	39.93±0.52[a]	32.12±0.19[a]	3.210±0.09[a]	3.170±0.07[a]	15.10±0.52[b]
$LSD_{0.05}$	0.8429[n.s]	14.8605**	9.0867**	1.2856*	0.9813*	19.7738**
SE±	0.0365	2.8471	0.8756	0.0758	0.0769	5.9817

Mean±SD value(s) bearing same superscripts within a column are not significantly different ($p \leq 0.05$)

respectively. The moisture content of biscuit flour was lower than the values reported by Barba *et al.*,[14] who reported that the moisture content of the Mexican wheat flour was 11.2% and Badi *et al.*[15] who found that the moisture content of Sudanese wheat flour harvested in 1975 was between 10-11% while the fat content of biscuit flour was lower than the result that revealed by Alias and Linden[16] which showed that the crude fat for wheat is 1.9% and values reported by FAO[17] which explained that Wheat fat content ranged from 2-3%. The protein content significantly ($p \leq 0.05$) lower than the results reported by Badi *et al.*,[15] who stated that protein content of the Sudanese wheat cultivars ranged from 11-14% and agreed with results stated by Ahmed[18] who found that the protein content of Sudanese wheatflour cultivars, Nasser, Elneilain, Condor and Debeire are ranged from 8.21-12.26%. Ash content of biscuit flour was significantly ($p \leq 0.05$) lower than the result stated by Egan *et al.*,[19] who found that the ash content of the whole wheat flour ranged from 1.2-1.8%. D'appolonia and Young's[20] reported 1.89% for ash content and Alias and Linden[16] reported 1.4%.

Protein and ash contents of biscuit samples: Table 2 shows the protein and ash contents of biscuit samples made of wheat flour and wheat flour replaced by pumpkin flour at different levels (5, 10 and 15%). The protein contents of biscuit with 0% pumpkin flour, biscuit flour substituted by 5% pumpkin flour and biscuit flour substituted by 15% pumpkin flour were 9.42, 10.52, 10.95 and 11.22% respectively. The gradual substitution of pumpkin flour with different ratios (5, 10 and 15%) significantly increased the protein content of biscuit flour by 11.78, 16.27 and 19.14% respectively.

The ash contents of biscuit flour substituted by 0, 5 and 15% were 0.514, 0.641, 0.770 and 0.971% respectively. The gradual substitution (5, 10 and 15%) of pumpkin flour in biscuit wheat flour increased the ash content by 24.7, 51.7 and 90.8%. The results on the nutritional analysis presented in Table 2 showed that the incorporation of pumpkin flour resulted in a considerable improvement in protein and ash contents. Our results are in line with the results reported by Hooda and Jood[21], who concluded that incorporation of raw, soaked and germinated fenugreek flour at a 10% level increased the protein, ash contents of biscuit samples. Ahuja

Table 2: Protein and ash contents of biscuit samples

Sample	Protein content (%)	Ash content (%)
Control	9.42±0.01[d]	0.514±0.10[d]
D.C.E.F 5%	10.52±0.01[c]	0.641±0.08[c]
D.C.E.F 10%	10.95±0.01[b]	0.770±0.04[b]
D.C.E.F 15%	11.22±0.02[a]	0.971±0.10[a]
$LSD_{0.05}$	0.1575*	0.0005954*
SE±	0.0483	0.0001826

Mean±SD values bearing the same superscript(s) within a column are not significantly different ($p \leq 0.05$)

and Vishwanatham[22]reported the highest nutritive value at 60% wheat flour, 28% defatted soy flour and 12% defatted sunflower flour in terms of protein quantity and quality. The ash content in mustard flour has been reported to be around 6%[23]. An increase in the ash content of fortified pumpkin biscuit with increase in level of pumpkin flour (Table 2) is obviously due to the high ash content of pumpkin flour as compared to wheat flour. The major nutritional problem in most of the developing world is protein-calorie malnutrition. This acuteproblem is, of course, due to factors such as high birth rates, increased population, insufficient agricultural products and limited supply of high quality proteins. Therefore, looking for inexpensive high protein materialsis considered an important task for nutritionists in these countries. Such materials will improve andenhance the nutritional quality of the diets and the health of the people thereafter and recognition of the beneficial nutritional attributes of grain legumes and oilseeds (pumpkin flour) due to the complementarily of their protein and its essential amino acids with those of cereals, has led to world-wide attempts to fortify traditional bakery products, such as bread biscuits (cookies).

The mineral profile of wheat and pumpkin flour: Table 3 shows the mineral contents of wheat flour and pumpkin flour. The calcium, magnesium, potassium, phosphorus and sodium contents of wheat flour were 21.65, 22.27, 30.58, 93.51 and 97.82% respectively while the same mineral contents for pumpkin flour were 40.25, 95.95, 92.48, 209.42, 161.25% respectively. The results of pumpkin mineral contents were significantly ($p \leq 0.05$) higher compared to wheat flour. From the mineral content perspective of pumpkin flour, there will be a marked increase in all mineral contents of the final biscuit

Table 3: Minerals profile of wheat and pumpkin flours

Sample	Calcium (mg/100 g)	Magnesium (mg/100 g)	Potassium (mg/100 g)	Phosphorus (mg/100 g)	Sodium (mg/100 g)
Wheat	21.65±0.58^{b}	22.27±0.48^{b}	30.58±0.55^{b}	93.51±0.60^{b}	97.82±0.43^{b}
Pumpkin	40.25±0.11^{a}	95.95±0.55^{a}	92.48±0.64^{a}	209.42±0.55^{a}	161.25±1.05^{a}
$LSD_{0.05}$	19.8564**	23.8569**	21.8564**	39.5261**	28.9317*
SE±	7.8521	12.6582	9.8247	16.3284	14.5217

Mean±SD values bearing the same superscripts within a column are not significantly different ($p \leq 0.05$)

Table 4: Sensory assessment of biscuit samples

	Color	Taste	Texture	Flavor	General acceptability
A	2.33±1.01^{b}	2.33±1.18^{bc}	3.27±1.01^{a}	2.33±1.1^{b}	2.53±0.8^{b}
B	1.40±0.63^{C}	1.80±0.94^{c}	1.33±0.6^{c}	1.80±0.6^{b}	1.33±0.4^{c}
C	3.33±0.8^{a}	2.60±1.12^{ab}	2.53±0.9^{b}	2.33±1.1^{b}	2.67±0.11^{b}
D	2.93±0.9^{ab}	3.20±0.77^{a}	2.73±0.9^{ab}	3.33±0.9^{a}	3.46±0.74^{a}
LSD	0.6432*	0.7427*	0.6696*	0.7591*	0.6194*
SE±	0.2267	0.2622	0.2364	0.268	0.2186

Mean±SD values bearing same superscripts within a column are not significantly different ($p \leq 0.05$)

products due to substitution with pumpkin. These will be mainly related to pumpkin flour which is a good source of minerals. Biscuit baked with full fat pumpkin flour had higher contents of micro- and macroelements than those of wheat biscuit flour.

The amino acid content of wheat and pumpkin flour: Table 5 shows the amino acid content of wheat and pumpkin flour. Aspartic, therionine, serine, glutamic, glycine, alanine, valinemethionine, isoleucine, leucine, tyrosine, phenylalanine, histidine, lysine, arginine, cystine and proline were estimated in both samples. Proline, alanine, valine, lucine and isolucine were detected as higher level in wheat proteins respectively while pumpkin flour having higher value in wheat flour while had high level of aspartic, glutamic, alanine, valine, lucine, isolucine, phenylalanine and proline. Pumpkin flour has higher values of all detected amino acids compared to wheat flour except in proline. Three methods for improving cereal protein quality are discussed. Two older methods are supplementation with limiting essential amino acids and with protein concentrates high in those amino acids. The most recent method is the replacement of the normal cereal grain with its high lysine mutant counterpart. Three high lysine cereals are now available, corn, barley and sorghum. In animal feeding, least cost formulas will determine which of the three improvement methods will be used. In human nutrition, cost, availability, palatability and acceptance are all equally important factors. In animals, pounds of gain per pound of feed will be the final measure of cereal protein quality. In humans, especially preschool children, the most important criterion will be the ability of the improved cereal protein to build a strong immune defense system.

Animal studies show that protein quality is more important than calories when calories are restricted to less than *ad libitum* consumption. It is therefore essential that children restricted in the total energy intake have the best cereal protein quality possible to protect their immune system[24].

Table 5: Amino acids content of wheat and pumpkin flour (mg/100 g)

Amino acid (mg/100 g)	Pumpkin	Wheat
Aspartic	917.535	35.557
Therionine	398.791	7.791
Serine	267.091	9.135
Glutamic acid	1162.860	54.676
Glycine	768.808	6.034
Alanine	1013.530	202.442
Cystine	90.135	19.730
Valine	1161.490	205.433
Methionine	204.640	4.750
Isolucine	938.030	174.165
Lucine	1361.920	175.311
Tyrosine	497.252	9.953
Phenylalanine	894.790	74.920
Histidine	453.290	13.105
Lysine	690.084	3.023
Arginine	2971.970	70.294
Proline	877.612	1469.055

Mean±SD values bearing same superscript(s) within a column are not significantly different ($p \leq 0.05$)

Since the initial reasons for considering the use of pumpkin flour was to improve the nutritional quality of biscuit flour, the significant enhancement seen in biscuit sensory rating was surprising and gratifying (although at the low levels of addition required), the nutritional benefits would be marginal. The improvement in organoleptic acceptability of biscuit may be due, in part, to a pleasant flavor and attractive yellowish color which pumpkin flour imparts to the biscuit. Ptitchkina *et al.*[25] stated that the small addition of pumpkin powder improves the nutritional and organoleptic attributes of bread samples. Results of sensory evaluation in terms of sensory attributes such as color, flavor, texture and overall acceptability are presented in Table 4. Biscuit containing 15% pumpkin flour showed mean maximum color, texture, flavor, taste and general acceptability score , which were the highest obtained among the treatments andcontrol. The flavor, taste

and overall scores were also highest in the 15% full fat pumpkin fortified biscuit. The results reported in the study are similar to the findings of Singh *et al.*,[26] who reported highest sensory scores at 15% incorporation levels of green gram, black gram and bengal gram each while preparing biscuits from composite flours. Eneche[27] reported the highest sensory scores in terms of flavor, texture and general acceptability for the biscuits prepared from 65% millet flour to 35% pigeon pea flour. Singh *et al.*[28] have reported highest overall acceptability scores of sensory evaluation at 30% soy flour incorporation level.

CONCLUSION

Pumpkin flour proteins can be used for fortification of cereal-based foods. Biscuits supplemented with fullfat pumpkin flour, up to a 15% level are organoleptically and nutritionally acceptable.

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