

Formulation and Quality Evaluation of Biscuits Supplemented with Defatted Pumpkin Seed Flour

Mamoun Omer Abdelgadir^{1*} and Nada Ahmed Fath Elrahman Mohamed²

^{1,2}National Food Research Centre, P.O. Box 213, Khartoum North, Sudan
mamounabdelgader@yahoo.com*; +249123001498

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Abstract

This study was carried out on the formulation of new nutritious biscuits at different levels of supplementation. Supplemented biscuits were produced by mixing wheat flour with dried pumpkin seed flour in the ratios of 0, 5, 10, and 15% (w/w). The outcomes of produced biscuits were positively affected by the supplementation of pumpkin seed flours. As the supplementation ratio of pumpkin seed flour increased from 0 to 15% (w/w), the protein content, ash content, crude fiber and total carbohydrates were increased. The biscuits with the ratio of 15% (w/w) pumpkin seed flour recorded the highest values of protein (8.8%), ash (1.12%), fiber (4.25%) and total carbohydrates (97.84%). The results of sensory evaluation revealed that the biscuit supplemented with the level of 15% (w/w) had higher overall acceptability, taste, texture, color and flavor and it was found to be more acceptable compared with other supplemented biscuits. However, a descending trend in acceptability was noticed with increasing level of pumpkin seed flour for all the sensory attributes.

Keywords: Nutritious biscuits, pumpkin seed flour, crude fiber, overall acceptability, sensory attributes.

Introduction

A healthy and well-nourished person depends on healthy food system. Nowadays, malnutrition imposes high cost on society. It comes in many forms and under nutrition is most prevalent form in developing countries. In 2017, the number of undernourished people is estimated to have increased to 821 million around one out of every nine people in the world. While some progress continues to be made in reducing child stunting, levels still remain unacceptably high. Nearly 151 million children under five are affected by stunting in 2017 (FAO, IFAD, UNICEF, WFP and WHO, 2018). Moreover, about 2 billion people in the world lack vitamins and minerals which are essential for healthy life (FAO/WHO 2004). Pumpkin, a member of the *Cucurbitaceae* family is one of the largest families in the vegetable kingdom, consisting of largest numbers of edible plant species (Manjunath et al., 2008). Pumpkin is an important dietary source of fibre, carotene, minerals (copper, zinc, iron and magnesium) and vitamins (Loy and Broderick, 1990; Djutin, 1991). Seed is an excellent source of protein and also has pharmacological properties such as anti-diabetic activity (Quanhong et al., 2003). In addition of benefit; pumpkin is inexpensive and widely distributed. Pumpkin seed flour can be used to fortify soups, cookies, pancakes and breads. Moreover, it is also used to fortify wheat flour to produce bakery products like pastries with unique and nutty taste.

In addition, pumpkin seed flour is gluten-free ingredient, therefore it can be recommended to the patients suffering from gluten intolerance or celiac disease (Patel, 2013). In Sudan, the awareness of the health benefits of pumpkin seeds start to grow day by day. Nowadays, pumpkin seeds are eaten side by side with water melon seeds named (Tsaly) after roasting, which is presented for hospitality purpose in different felicitous occasions especially marriage. Although, Sudanese pumpkin seeds are directly consumed but large quantities are considered as by products. Recently, several research projects have been conducted to endorse the nutritional and health aspects of pumpkin seeds and vouch for their use in dietary intervention. Supplementary foods are used to reduce the malnutrition; and supplementation could be applied in ready to eat bakery products and drinks (Opawale et al., 2011).

Biscuits are one of the oldest baked goods and consumed extensively worldwide by all age groups. The popularity of biscuits comes from their attributes, such as high palatable, nutritious, quickly released energy and available in convenient sizes, as well as in various forms. In addition, the biscuits formulation can be modified easily to meet the nutritional demands of the target consumers (Ashaye et al., 2015).

*Corresponding author

All properties of pumpkin seed flour make it potentially valuable supplement to food products to offer high quality and nutritious products for Sudanese peoples. Therefore, the aim of the present study was to formulate new nutritious biscuits at different levels of supplementation and to assess the composition, quality characteristics and consumer acceptability of the product.

Materials and methods

Materials: Pumpkin seeds were obtained from a local cultivar (*Cucurbita moschata*) from the central market for fruits and vegetables, Khartoum North, Sudan. The seeds were cleaned and freed from foreign materials. The seed hulls were removed manually, milled in laboratory mill and then defatted. Refined groundnut oil was brought from Bittar Co. Ltd., Khartoum North, Sudan. Wheat flour and sugar were purchased from local market. Chemicals and solvents used in this study were of analytical grade and were purchased from Prime Company for Chemical and Instruments, Sudan.

Preparation of biscuit: The biscuits were made in the bakery lab of Cereal Technology Department, National Food Research Center (NFRC), Sudan using standard recipe consisting of refined wheat flour at different ratios (100 g/95 g/90 g/85 g), sugar (50 g), fat (60 g), sodium bicarbonate (0.5 g) and baking powder (2 g). The baking process was carried out at 180°C for 12 min. Biscuits were allowed to be cool and stored in air tight polyethylene bags for 12 h before analysis. The formulations of different recipes are shown as follows:

Sample A= 0% (control) free of dried pumpkin seed flour

Sample B= 5% of dried pumpkin seed flour

Sample C= 10% of dried pumpkin seed flour

Sample D= 15% of dried pumpkin seed flour

Analytical methods

Proximate analysis and sensory evaluation: The proximate composition (moisture, ash, fat, fiber and protein) of the samples was carried out using the method reported by AOAC (2008). Total carbohydrate (NFE) content was estimated by difference according to AOAC (1990). Sensory evaluation was conducted according to Ihekorony and Ngoddy (1985) and 15 of semi-trained panelists from the staff of National Food Research Center were partaken.

Statistical analysis: Statistical analysis was performed using SPSS version 16.0 (SPSS Inc., Chicago, USA). All experiments were presented in triplicate for mean values with the standard deviation and analyzed using one way analysis of variance (ANOVA). To separate means at a significance level of ($P < 0.05$), Duncan's multiple range test (DMART) was applied. Sensory evaluation results were analyzed using the method described by Ihekorony and Ngoddy (1985).

Results and discussion

Moisture content: Proximate analyses of biscuit processed by different recipes of defatted pumpkin seed flour are described in Table 1. The moisture content was found to be 4.05%, 4.03%, 3.84% and 3.84% for samples A, B, C and D, respectively, while paste sample achieved 1.93%. It can be noticed there were significant differences between samples A, B and samples C, D. On the other hand, there was no significant difference between the sample treated with 10% dried pumpkin seed flour (Sample C) and the sample treated with 15% dried pumpkin seed flour (Sample D). These results are in accordance with those found by Hamed *et al.* (2008), who reported 5.47 and 6.10% for unroasted and roasted flour, respectively. Generally, slight decrease in moisture content was observed when the concentration of pumpkin flour increased. However, sample A (0% control) achieved highest value (4.05) compared to sample C (10%) and sample D (15%), which achieved the lowest value (3.84). This phenomenon might be due to water adsorption capacity and binding ability that characterized pumpkin flour. The moisture content of processed samples was at a reasonable level, which offers additional benefit in view of the samples' shelf life. These findings are consistent with the results of Nyam *et al.* (2013) and Kanwal *et al.* (2015).

Fat content: Based on the data presented in Table 1, fat content was found to be 20.13%, 20.77%, 20.50% and 20.17% for samples A, B, C and D respectively. The highest value of fat content was found in sample B (20.77%), whereas the lowest value of fat content was found in sample A (20.13%). As shown in this study, instability for fat content could be noticed. Even though, there was a slight change in the fat content in all supplemented samples of biscuits, it was statistically similar. These results are not far from the findings obtained by Kanwal *et al.* (2015), who revealed 28.29% fat content in his study who evaluated the physio-chemical properties of biscuits supplemented with pumpkin seeds to fight under nutrition in children of Pakistan. The high fat content could be due to the level of fat content in the pumpkin flour. Elinge *et al.* (2012) found that the fat content of pumpkin seed flour was 38%. As reported by Toan and Thuy (2018), the high quality pumpkin flour biscuits revealed fat content ranged between 11.91% and 13.7%.

Crude protein: As illustrated in Table 1, an obvious increase of protein content was recorded due to an increase of pumpkin seed flour. The sample supplemented with 15% dried pumpkin seed flour recorded the highest protein content (8.80%) compared to control sample, which achieved 6.63%, while paste sample achieved 33%. Verged results were recorded by Saima Kanwal (2015) who reported 12.3% for the sample treated with 20% of pumpkin.

Table 1. Proximate analysis of biscuit produced by different recipes of defatted pumpkin seed flour.

Sample code	Moisture content %	Fat%	Protein%	Ash%	Fiber%	CHO%
Control A	4.05 ± 0.07 ^a	20.13 ± 0.35 ^b	6.63 ± 0.15 ^e	0.78 ± 0.02 ^c	1.67 ± 0.03 ^c	93.00 ± 0.11 ^d
Sample B	4.03 ± 0.11 ^a	20.50 ± 0.50 ^b	7.37 ± 0.06 ^d	0.94 ± 0.01 ^{bc}	1.20 ± 1.00 ^d	92.38 ± 0.92 ^{de}
Sample C	3.84 ± 0.01 ^b	20.77 ± 0.06 ^b	8.30 ± 0.00 ^c	1.00 ± 0.09 ^b	2.50 ± 2.10 ^b	94.75 ± 2.38 ^c
Sample D	3.84 ± 0.08 ^b	20.17 ± 0.25 ^b	8.80 ± 0.30 ^b	1.12 ± 0.12 ^b	4.25 ± 1.65 ^a	97.84 ± 0.94 ^b
Paste	1.93 ± 0.04 ^c	42.40 ± 0.70 ^a	33.60 ± 0.10 ^a	9.11 ± 0.15 ^a	4.00 ± 0.40 ^{ab}	106.25 ± 0.32 ^a

Mean ± standard deviation (n=3). Mean values within a column followed by a different letter are significantly different (P<0.05).

Table 2: Sensory evaluation of biscuit processed by different recipes of pumpkin seed flour.

Sample code	Color	Flavor	Taste	Texture	Over all acceptability
Control A	36 ^a	36 ^a	33 ^a	39 ^a	31 ^a
Sample B	37 ^b	44 ^b	39 ^b	46 ^b	41 ^b
Sample C	44 ^c	52 ^c	53 ^c	48 ^c	50 ^c
Sample D	72 ^d	60 ^d	64 ^d	57 ^d	68 ^d
Paste	36 ^a	36 ^a	33 ^a	39 ^a	31 ^a

Mean ± standard deviation (n=3). Mean values within a column followed by a different letter are significantly different (P<0.05).

These results are in line with the findings of Toan and Thuy (2018), who explained that the protein content increased with increasing of pumpkin flour substitution. Although, the protein content of supplemented samples was low, the increase of protein content might be attributed to the good amount of protein that exists in pumpkin seed flour. These findings reflect positive effect of addition of dried pumpkin seed flour for consolidation nutritional value of biscuits. Many reasons cause reduction of protein content due to different factors during baking process including heat treatment. Modawi (2006) investigated the effect of roasting process on defatted pumpkin seed flour in terms of nutritional, anti-nutritional and functional properties. It was observed that roasting process reduced the protein content and increase the fiber and carbohydrate content. Hamed *et al.* (2008) recommended that pumpkin seeds as rich sources of nutrients could be supplementary ingredients especially in Africa and Asia to alleviate the problem of nutrient/protein malnutrition.

Ash: In respect to the results of ash content, significant differences were mirrored between sample A (0.78%) and B (0.94%), whereas no significant differences were observed between samples C (1.00%) and sample D (1.12%). An obvious effect could be seen when higher level of pumpkin flour used in biscuits making. Hence, the biscuits sample (D) had the highest ash content (1.12%), while the control sample (A) had the lowest value (0.78%). These results had the same increasing trend of ash content with findings, which reported by Kanwal *et al.* (2015). The observed increase of ash content could be most likely due to high mineral content of pumpkin variety.

According to Onabanjo and Dickson (2014), the ash content of food material could be known as an indication of mineral constituents of the food because of that is the inorganic residue remaining after the water and organic matter have been removed using heat with the presence of an oxidizing agent. Caili *et al.* (2006) mentioned that pumpkin contain high beta-carotene, pectin, some vitamin, material salts, etc.

Fiber: The data presented in Table 1 indicate that the average fiber content of investigated samples A, B, C and D of pumpkin powder biscuit was 1.67%, 1.20%, 2.50% and 4.25%, respectively. Generally, the mean fiber content of the biscuit increased with the increase in amount of the pumpkin powder. As expected, the fiber content was observed to be higher, however the fiber content in samples B, C and D was higher than sample A. Thus, it can be stated that the significant effect was observed in fiber content of samples B, C and D. In addition, similar observation was reported by Giwa and Abiodun (2010). This finding is in support with the incorporation of pumpkin seed flour in biscuit making. Plenty of studies concentrated on the nutritional value of the dietary fiber. Pumpkin flour is a good source of food containing high and healthy amount of dietary fiber (Kulaitiene *et al.*, 2014). Eleazu and Ironua (2013) stated that dietary fiber is an available tool in controlling oxidation in food products and as a functional food ingredient.

Carbohydrates: The total carbohydrates ranged from 93% to 97% (Table1). Sample (D) recorded the highest value (97%), while sample (B) recorded the lowest value (92%). The results indicated that the carbohydrates in supplemented biscuits samples were increased.

According to the findings of this study, all supplemented samples had carbohydrate content significantly different from the control sample. The importance of carbohydrates in health was established earlier. However, from scientific and practical point of view, determining the total carbohydrate content of the studied food materials become an important issue. Revathy and Sabitha (2013) indicated that one fourth cup of pumpkin seed contains 200 calories and 15 to 50% of many crucial nutrients, such as protein, iron, zinc, magnesium, manganese etc. Beneficial fatty acids, amino acids and antioxidants are also present in abundance in these seeds. They also contain good amount of vitamins like tocopherol and carotenoids.

Sensory evaluation: The utilization of pumpkin seed flour with different ratios to produce biscuits was sensory evaluated and compared to control biscuit, which contained 0% pumpkin seed flour (Sample A). As shown in Table 2, supplementation of biscuits with different ratios of pumpkin seed flour significantly affected the sensory attributes of produced biscuits.

Color: As shown in Table 2, the mean score for color varied from 36 to 72. Obviously, the mean scores increased as the concentration of pumpkin seed flour increased. Subsequently, the control biscuit had the lowest score (36), while the biscuit sample supplemented with 15% of pumpkin seed flour (Sample D) had the highest score (72). Sensory evaluation findings indicated that the increase of supplementation ratio up to 15% of pumpkin seed flour prominently increased the acceptance of biscuit color as the color became gradually better. The results are complying with those reported by Kanwal *et al.* (2015). Similar findings were obtained by Siddiqui *et al.* (2003), who found that increase in the color score with the increase in supplementation level. An increase in the color score of biscuits is attributed to the sugar caramelization and maillard reactions between sugars and amino acids. Other factors that might contribute to the color of final products were ingredients, composition and time of baking (Cronin and Preis, 2000).

Flavor: The mean score for color varied from 36 to 60. It was observed that the mean scores increased with increasing the concentration of pumpkin seed flour, whereas the samples supplemented with 5%, 10% and 15% of pumpkinseed flour were 44, 52 and 60, respectively compared to the control (Sample A), which was 36. Similar observation of increasing trend in all sensory attributes was recorded by Kanwal *et al.* (2015), who evaluated the nutritional composition and organoleptic characteristics of biscuits supplemented with different ratios of defatted pumpkin seed flour.

The same author concluded that pumpkin seed flour can be incorporated successfully to partial replacement with wheat flour to prepare highly nutritious and wholesome biscuits without disturbing their overall acceptability. The development of flavor could be attributed to the roasting of pumpkin seeds during processing, which is necessary for the development of aroma characteristics in seeds as stated by Siegmund and Murkovic (2004). These aromatic seeds lead to improve the flavor in produced biscuits.

Taste: Regarding the taste, Table 2 shows significant differences among all supplemented biscuits. The mean score for color varied from 33 to 64. Apparently, the mean scores increased with increasing the concentration of pumpkin seed flour. However, the biscuit sample supplemented with 15% of pumpkin seed flour (Sample D) recorded the highest score (64) followed by (53) and (39) for samples (C) and (B), respectively, while the control (Sample A) recorded the lowest score (33).

Texture: It is clearly evident from Table 2 that there were significant differences among all supplemented samples of biscuits. Biscuit sample supplemented with 15% of pumpkin seed flour recorded the highest score (57) and the samples supplemented with 5% and 10% of pumpkin seed flour scored (46) and (48), respectively, whereas the control recorded the lowest score (39). The difference in texture could be explained by higher protein content in the raw material. Kanwal *et al.* (2015) observed improvement in the texture of biscuits supplemented with pumpkin seed flour. Moreover, Atuonwu and Akobundu (2010) noticed enhancement in the texture of cookies fortified with pumpkin seed flour.

Overall acceptability: Data regarding the overall acceptability differ significantly among the treatments. The highest score (68) recorded by sample (D), which containing 15% of pumpkin seed flour and the samples supplemented with 5% and 10% of pumpkin seed flour were 41 and 50, respectively, whereas control sample was the lowest score (31). From these values it can be noticed that an increase of pumpkin seed flour in the formulation improved overall acceptability of biscuits for panelists. Kanwal *et al.* (2015) stated that overall acceptability was totally different quality parameters and it was not affected by individual trend of color, texture and flavor. Similarly, the results obtained by Atuonwu and Akobundu (2010) are consistent with the findings of this study.

Conclusion

The results of this study mirrored the potentiality of supplementation biscuits using different ratios of pumpkin seed flour. The proximate analyses of supplemented biscuits revealed significant increase of protein, ash, fiber

and total carbohydrates as the levels of pumpkin seed flour increased. Whereas, the sample supplemented with 15% pumpkin seed flour recorded the highest values. In terms of consumer acceptability, the panelists gave preference to the sample supplemented with (15%) pumpkin seed flour which is superior to the control sample (0%) pumpkin seed flour. However, we could produce biscuits using different ratios of pumpkin seed flour with good quality and sensory properties, the thing that could expand the industrial utilization and nutritional value of pumpkin seed flour.

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