

Quality characteristics and sensory evaluation of cookies produced from composite blends of sweet potato (*Ipomoea batatas* L.) and wheat (*Triticum aestivum* L.) flour

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Abstract: Cookies hold an important position in snack foods due to the variety in taste, crispiness and digestibility. Composite flours have better nutritional quality and would be highly desirable for the production of nutritious cookies. A study was carried out to develop cookies from the flour of sweet potato (*Ipomoea batatas* L.) and wheat (*Triticum aestivum* L.) and to evaluate the quality characteristics of the product. The mature sweet potatoes (cv. *Wariapola Red*) were procured from the commercial growers. Tubers were washed, peeled, cut into thin slices of 1 mm thickness and dried in the sun until the pieces were quite brittle. The dried chips were milled, passed through a 250 µm sieve and packed in air tight containers. Different composite blends of wheat flour and sweet potato flour were mixed in the ratios of 100:00, 80:20, 60:40, 40:60, 20:80 and 00:100. The nutritional analysis of sweet potato flour confirmed that it contains 2.3% protein, 9.4% dietary fibre and 85.5% soluble carbohydrates. Physical characteristics such as thickness, volume and spreading factor of the cookies decreased from 0.969 to 0.910 cm, 41.66 to 30.41 cm³ and 6.43 to 5.61, respectively, with increasing of sweet potato flour. The moisture, ash, fibre and soluble carbohydrate content increased significantly ($p < 0.05$) from 1.33 to 1.37%, 2.07 to 2.4%, 2.14 to 8.7, and 80.86 to 85.97%, respectively, while protein content decreased significantly ($p < 0.05$) from 7.04 to 6.22 with the increase in sweet potato flour from 0 to 100% of the composite flour for cookies. The sensory analysis showed that the cookies supplemented with 40% sweet potato flour were well acceptable in terms of colour, texture, taste and overall acceptability compared to other treatments. The mixture of 40% sweet potato flour and 60% wheat flour was successful for the formulation of composite cookies with better nutritional and organoleptic qualities within the universally accepted standards. The outcome of this research can be used as valuable information for the development of high fibre low gluten sweet cookies.

Keywords: Composite flour, cookies, nutritional quality, sweet potato flour

Introduction

Sweet potatoes (*Ipomoea batatas* L.) are an excellent source of nutrition and considered as one of nature's most perfect vegetables. Among the world's major food crops, sweet potato produces the highest amount of edible energy

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per hectare per day (Sukhcharn *et al.*, 2008). Sweet potato consists of about 70% carbohydrates of which the major portion is starch, which can be utilized as a functional ingredient in certain food preparations. They are an excellent source of beta-carotene and also a good source of vitamin C and manganese. A mixture of wheat (*Triticum aestivum* L.) flour and sweet potato flour could make a good baking product, which should increase the nutritive values in terms of fiber and carotenoids (Hagenimana *et al.*, 1992) and the economic value of the final product. This helps in lowering the gluten level and prevents manifestation of coeliac disease.

Starch manufacture is the main industrial utilization of sweet potatoes, which has been used in the preparation of noodles, bakery foods, snack foods, confectionery products and for alcohol production and in brewing industries. The functional properties of the flour are provided not only by the starch, but also by other flour components. The flour is used as a dough conditioner for bread, cookies and cakes, and adds natural sweetness, colour and flavour to processed food products (Giami *et al.*, 2004). The rheological characteristics of the dough are very important.

The use of sweet potato flour for supplementing with wheat flour on the baking could substantially reduce need for wheat, reduction in the usage of sugar on the products, and increase the value of sweet potato. The Government of Sri Lanka aims to reduce per capita consumption of wheat flour from the current quantity of 26 Kg per annum to 16 Kg per annum (Emanthi, 2012). Our approach in the present study was to replace the wheat flour content in cookies by sweet potato flour (gluten-free flour) with a view to increase the content of fiber and other nutrients. The objective was to develop cookies with good nutritional quality, taste, texture and appearance, which resembles the wheat flour-based products as closely as possible.

Materials and Methods

Preparation of sweet potato flour

Good quality sweet potatoes (*I. batatas*, cv. *Wariapola Red*) purchased from the commercial cultivations were washed, peeled and cut into thin slices around 1 mm thickness. The sweet potato slices were sun dried on perforated trays until the pieces were quite brittle and then stored in air tight containers until further use. The dried chips were milled into flour using an electric grinder (Senator Dx-2000) and passed through a sieve (250 μ) to obtain flour of uniform size. The flour was then packed in an air tight container and stored under ambient conditions until further use.

Experimental plan

The experiment consisted of six treatment per 100 g mixture, namely T₁ - Cookie made by 100% wheat flour; T₂ - 20 g sweet potato flour + 80 g wheat flour; T₃ -

40 g sweet potato flour + 60 g wheat flour; T₄ – 60 g sweet potato flour + 40 g wheat flour; T₅ – 80 g sweet potato flour + 20 g wheat flour, and T₆ - cookie made by 100% sweet potato flour

Development of wheat and sweet potato blended cookies

Cookie dough was prepared according to the formula 100g of flour (contain different proportion of sweet potato flour and wheat flour), 50 g of sugar, 20 g of margarine, 2 g of baking powder, 0.5 g of sodium chloride and various proportion of water to make required consistency of dough. The firm dough was rolled out to 5 mm thickness in a baking tray and cut into circles having 7.4 cm diameter with a cookie cutter. The cookies were placed on a greased aluminum tray and baked in a pre-heated oven at 200 °C for 10 min to produce cookies. These cookies were assessed for nutritional and organoleptic qualities.

Nutritional analysis of wheat - sweet potato flour blended cookies

Nutritional quality of the freshly made sweet potato flour and cookies made from wheat-sweet potato flour blend were analyzed using recommended standard AOAC (2000) methods and the difference between means was compared using Duncan's Multiple Range Test. The sensory attributes, including texture, colour, taste, mouth feel and overall acceptability were evaluated by a trained 20 member-panel. Ranking test was used to evaluate the perceptible differences in intensity of an attribute among samples and analysis was done by Friedman test using SAS software statistical package.

Results and Discussion

Nutritional composition of the freshly made sweet potato flour

The nutritional composition of the sweet potato used in the study contained flour 8.1% moisture, 9.4% fiber, 3.6% ash, 2.3% protein and 11.2% total sugar. The nutritional composition of sweet potato flour was closely related to the results obtained by Sukhcharn *et al.* (2008). High fiber content increases the utility of sweet potato flour in various food products. Sweet potato flour also had a lower protein content compared to that the wheat flour (13.7%). Okorie *et al.* (2012) reported that most of the non-wheat flours have lower protein but higher carbohydrate content than wheat flour.

Physical parameters of cookies

The results of the physical parametric analysis of the cookies are shown in Table 1. There were significant differences between the treatments for thickness, volume and spread ratio of cookies as the level of sweet potato flour was increased from 0 to 100% ($p < 0.05$).

Table 1. Physical parameters of the sweet potato–wheat composite flour cookies

Treatments	Thickness (cm)	Volume (cm ³)	Spread ratio
T ₁	0.97 ± 0.003 ^a	41.66 ± 0.84 ^a	6.43 ± 0.07 ^a
T ₂	0.95 ± 0.006 ^b	40.52 ± 0.91 ^{ab}	6.43 ± 0.09 ^a
T ₃	0.93 ± 0.003 ^c	38.87 ± 0.82 ^b	6.29 ± 0.08 ^a
T ₄	0.93 ± 0.002 ^c	34.33 ± 0.41 ^c	5.93 ± 0.04 ^b
T ₅	0.92 ± 0.005 ^{cd}	32.99 ± 0.42 ^c	5.84 ± 0.05 ^{bc}
T ₆	0.91 ± 0.002 ^d	30.41 ± 1.21 ^d	5.61 ± 0.13 ^c

The values are means of four replicates ± standard error.

Within a column, means followed by the same letter are not significantly different by the DMRT at p=0.05.

There was decrease in the thickness of cookies with increase in sweet potato flour up to 100%. The control treatment with 100% wheat flour had the highest mean cookie thickness followed by the blend with 20% sweet potato flour. The result showed that increase in the level of sweet potato flour resulted in a linear decrease in thickness and diameter of cookies. This could be due to the higher water holding capacity of sweet potato flour. The control treatment containing 100% wheat flour had the highest mean cookie volume (p<0.05) while the lowest was recorded from that containing 100% sweet potato flour (T₆). The differences in spread ratio of cookies containing different proportion of sweet potato flour may be attributed to the differences in swelling patterns and rheological properties. This may be due to the higher fiber and solid matter content and also high water holding capacity of the sweet potato flour.

Nutritional analysis of wheat-sweet potato composite flour cookies

The nutritional analysis of cookies made from wheat flour and sweet potato flour blends are shown in Table 2.

Table 2. Nutritional composition of the sweet potato–wheat composite flour cookies

Treatments	Moisture (%)	Ash (%)	Protein (%)	Soluble carbohydrate (%)
T ₁	1.33 ± 0.02 ^a	2.07 ± 0.03 ^b	7.04 ± 0.03 ^a	80.86 ± 0.15 ^e
T ₂	1.34 ± 0.04 ^a	2.08 ± 0.02 ^b	6.83 ± 0.01 ^b	83.67 ± 0.07 ^d
T ₃	1.35 ± 0.12 ^a	2.17 ± 0.04 ^b	6.80 ± 0.03 ^b	84.11 ± 0.22 ^c
T ₄	1.36 ± 0.04 ^a	2.30 ± 0.07 ^a	6.55 ± 0.02 ^c	84.64 ± 0.08 ^b
T ₅	1.36 ± 0.01 ^a	2.37 ± 0.04 ^a	6.41 ± 0.03 ^d	85.78 ± 0.07 ^a
T ₆	1.37 ± 0.12 ^a	2.40 ± 0.02 ^a	6.22 ± 0.02 ^e	85.97 ± 0.14 ^a

The values are means of four replicates ± standard error.

Within a column, means followed by the same letter are not significantly different by the DMRT at p=0.05.

There was an increase in moisture, fiber, ash and soluble carbohydrate contents of the composite cookies as the level of sweet potato flour substitution was increased. The results are in agreement with Peter *et al.* (2007). However, a decrease in the protein and fat contents of the composite cookies observed in this study could be due to the heat imposed that could have led to the destruction of nutrients resulting from high temperature, duration of heating and the pH of the batter (Erdman and Erdman, 1982).

The moisture content of cookies gradually increased from 1.33 to 1.37% with the incremental addition of sweet potato flour from 0 to 100%. The results are in agreement with those of Sneha *et al.* (2012). This could be attributable to the high water binding capacity of sweet potato, which has retained higher moisture content in the ultimate products. The ash content of cookies increased from 2.07 to 2.4% with the increase in the percentage of sweet potato flour in the mixture from 0 (T₁) to 100% (T₆) (Table 2). The ash content of cookies increased significantly due to ash content of sweet potato and externally added fat during the cookie preparation.

The protein content of cookies decreased with increase in the percentage of sweet potato flour in the mixture. The control treatment (cookies made from 100% wheat flour) had the highest mean protein content while the lowest as recorded from that containing 100% sweet potato flour. There was no significant difference between the protein content of flour mixtures with 20% and 40% sweet potato flour ($p > 0.05$).

The soluble carbohydrate content of cookies increased from 80.86 to 85.97% with the increase in the percentage (0–100%) of sweet potato flour in the mixture. The variation in carbohydrate content among the cookie samples may result from the difference in the level of proteins, fat, ash and moisture content of wheat and sweet potato flour. There was a significant difference ($p < 0.05$) between the control treatment (T₁) and the rest of the treatments where cookies were made from incorporated sweet potato flour. The cookies made from 100% sweet potato flour had the highest mean carbohydrate content and the control treatment (T₁) showed the lowest carbohydrate content. The increase in carbohydrate content could be due to the added flour where sweet potatoes are an excellent source of carbohydrates (Eddy, 2004). The fiber content of cookies increased significantly ($p < 0.05$) due to the higher fiber content of sweet potato flour (Figure 1). As fiber absorbs large amount of water, it gives a sensation of fullness. Fiber adds bulk to the foods and aids in bowel movement.

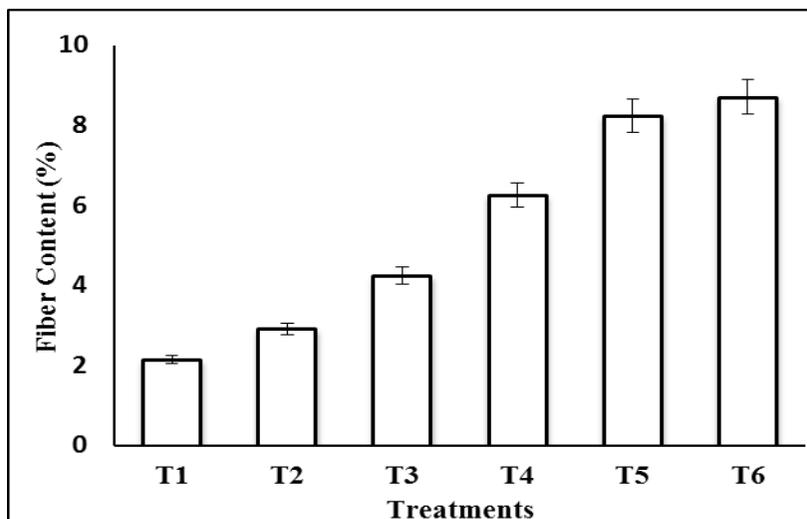


Figure 1. Fiber content of cookies made from blend of wheat-sweet potato flour. The values are means of four replicates. The vertical bars represent the standard error of the means.

Sensory analysis of wheat-sweet potato flour cookies

The sensory evaluation of the cookies revealed that there were significant differences ($p < 0.05$) between the treatments in texture, mouth feel, taste, colour and overall acceptability (Table 3) as the level of sweet potato flour increased from 0 (T_1) to 100% (T_6). The results of the sensor evaluation of the presented study showed a deviated pattern of those reported by Sukhcharn *et al.* (2008). These different directions of score patterns may be due to the different rates of preference and acceptable values of panelists and the quality of finished cookies that were developed.

Table 3. Sensory attributes of wheat-sweet potato composite flour cookies

Treatments	Texture	Taste	Colour	Overall acceptability
T_1	4.85 ± 0.05^a	4.25 ± 0.27^{abc}	4.60 ± 0.11^{ab}	4.75 ± 0.08^a
T_2	4.55 ± 0.11^a	4.30 ± 0.15^{abc}	4.65 ± 0.10^a	4.45 ± 0.11^a
T_3	4.85 ± 0.05^a	4.50 ± 0.11^{ab}	4.80 ± 0.07^a	4.70 ± 0.09^a
T_4	4.45 ± 0.11^a	4.80 ± 0.07^a	4.75 ± 0.08^a	4.60 ± 0.11^a
T_5	3.95 ± 0.15^b	3.95 ± 0.14^{bc}	4.15 ± 0.12^{bc}	3.75 ± 0.17^b
T_6	3.55 ± 0.15^b	3.60 ± 0.15^c	3.70 ± 0.20^c	3.40 ± 0.12^b

The values are means of 20 replicates \pm standard error.

Within a column, means followed by the same letter are not significantly different by the Friedman's test at $p = 0.05$.

Texture is the sensory manifestation of the structure of food and the manner in which the structure reacts to the applied force (Jean-Xavier and Rossella, 1996), and is one of the most important parameters connected to product quality. Texture analysis involves measuring the properties related to how a food feels in the mouth (initial bite). There was no significant difference ($p>0.05$) between the texture of cookies in the control treatment that showed the highest score for texture, and those contained sweet potato flour as a blend up to 40% (T_4). The cookies made out of 100% sweet potato flour (T_6) showed the least mean value for texture.

Taste is the primary factor that determines the acceptability of any product, which has the highest impact as far as market success of the product is concerned. Cookies containing 60% of sweet potato flour had a sweet taste however, those made out of 100% sweet potato flour had either a caramel or burnt taste. This may be due to the caramelization of free sugars in sweet potato during baking (Sukhcharn *et al.*, 2008). The T_4 containing 60% of sweet potato had the highest mean value for taste while the lowest was recorded from those made out of 100% sweet potato flour.

The colour of the cookies changed from light brown to dark brown, with a decreasing trend in the mean scores. The darker colour may be due to Maillard reaction between reducing sugars and protein (Dhingra and Jood, 2000). The overall acceptability included many implications, which is the important parameter in organoleptic estimation. The cookies from the treatment T_3 that consisted of 40% sweet potato flour had the highest mean value than the other sweet potato flour composite cookies for the overall acceptability. Similar results were reported by Nwaojigwa *et al* (2007) that the biscuits made from sweet potato-wheat flour was acceptable up to 40% supplementation level based on the sensory attributes.

Conclusions

Sweet potatoes are one of the nature's wonderful nutritional and economical resources in the world. Mixture of wheat flour and sweet potato flour could make a protein-rich baking product with increased economic value. The use of sweet potato flour to supplement wheat flour on the baking could substantially reduce wheat flour imports and the use of sugar on the bakery products, and increase the value of sweet potato. The results of the study revealed that the sweet potato contained a limited amount of protein, although rich in dietary fiber and carbohydrate contents. Hence, a combination with wheat flour for cookie production would be nutritionally advantageous. The cookies made out of wheat flour supplemented with 40% sweet potato flour were highly acceptable in terms of functional, nutritional and organoleptic qualities compared to other tested combinations. This could lead to the development of high fiber low gluten sweet cookies. The results obtained could also be valuable

in decision making for industries to take nutritional advantage of sweet potato flour as alternative or supplement to cereal flours. Sweet potato flour could be useful in the manufacture of highly nutritious cookies.

References

- AOAC (2000): Official methods of analysis, Association of Official Analytical Chemists. Washington D C, New York, USA.
- Dhingra, S. and Jood, S. (2000): Organoleptic and Nutrition evaluation of wheat breads supplemented with soybean and barley flour. *J. Food Chem.* 77: 479-488.
- Eddy, N.O. (2004): Effect of processing on the chemical composition of some Nigerian foods. M.Sc. Thesis, pp 74-82. University of Uyo, Nigeria..
- Emanthi, P.K. (2012): Preparation and quality evaluation of flour and biscuits from wheat-sweet potato. *J. Food Process. Technol.* 3:12-19.
- Erdman, J.W. and Erdman, E.A. (1982): Effect of home preparation practices of nutritive value of foods. In: Handbook of Nutritive Value of Foods. pp 257-263; Florida, USA..
- Giami, S., Amasisi, T. and Ekiyor, G. (2004): Comparison of bread making properties of composite flour from kernels of roasted and boiled African breadfruit. *J. Raw Material Res.* 12: 64-70.
- Hagenimana, V., Carey, E., Gichuki, S.T., Oyunga, M.A. and Imungi, J. (1992): Changes in carotenoid content after drying and processing sweet potato products. *Ecol. Food Nutri.* 37: 450-473.
- Jean-Xavier, G. and Rossella, M. (1996): The Sensory Perception of Texture and Mouth Feel. *Trends in Food Sci. Technol.* 7(7): 213-219.
- Nwaojigwa, D.M., Lucy, E. and Cintana, S.U. (2007): Nutritional composition, functional and baking properties of wheat-sweet potato composite biscuits and cakes. *Afr. J. Food and Nutri. Dev.* 17: 54-62.
- Okorie, S.U. and Onyeneke, E.N. (2012): Production and quality evaluation of baked cake from blend of sweet potatoes and wheat flour. *Natural and Appl. Sci.* 3: 2-11.
- Peter, S.D., Oyewole, C.O.B., Karim, R.O. and Taylor, G. (2007): Storage quality of biscuits and cookies made from wheat-sweet potato composite flour mixture. *J. Food Agric. Environ.* 9: 175-188.
- Sneha, S., Genitha, T.R. and Vrijesh, Y. (2012): Preparation and Quality Evaluation of Flour and Biscuits from wheat-Sweet Potato. *J. Food Process. Technol.* 3: 12-19.
- Sukhcham, S., Riar, C.S. and Saxena, D.C. (2008): Effect of incorporating sweet potato flour to wheat flour on the quality characteristics of cookies. *Afr. J. Food Sci.* 2: 65-72.