



Effects of Soy and Water Chestnut Flour on the Quality of Cookies

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ABSTRACT

Background: Protein deficiency and micronutrient deficiencies lead to growth problems, mental and physical development. To tackle these deficiencies issue, fortification is the best tool which improves public health and best suited for present lifestyle. So, aim of this research paper is to develop soy and water chestnut flour fortified cookies and to examine influence of soy and water chestnut flour on physical, chemical and sensory properties of cookies.

Methods: To develop cookies with improved nutrition, flat cookies were prepared using soy and water chestnut flour blends replacing wheat flour at different proportions *i.e.* 20%, 25%, 30%, 35% and 40%. Physical, chemical and sensory evaluation was done to analyze the acceptability of cookies. Cookies were prepared with these blends and analyzed for physical properties such as diameter, thickness and spread ratio. To study the nutritional improvement in fortified cookies, chemical analysis was performed for protein content, fat content, ash and moisture values. Furthermore, sensory evaluation was done for crispiness, taste, colour and overall acceptability.

Result: In this research work, it was found that increasing percentage of soy and water chestnut blends in wheat flour, improved the nutritional quality. Cookies baked with soy and water chestnut flour blends were higher in protein and micro nutrients. Cookies prepared with 30% blend of soy and water chestnut flour were observed the most acceptable with improved nutritional quality and better taste.

Key words: Cookies, Fortification, Soy flour, Water chestnut.

INTRODUCTION

Biscuits and cookies are ready to eat well liked snack food that are consumed by large section of people of all age groups due to their affordability, availability, shelf stability and nutritious worth (Devi and Khatkar, 2016; Sinha and Sharma, 2017). Wheat is the most important staple cereal crop of India and cookies are generally made by wheat flour. Wheat flour lacks very important amino acids and micronutrients which is the major problem with most bakery products (Khapre *et al.* 2015). Staple food can be fortified to add the vitamins and minerals to the diets of people which is a potent, affordable and supplementary method, when appropriately implemented.

Nutrition is found to be a major determinant which can be modified with scientific evidence to overcome the adversity of chronic diseases, it supports the view that modification in diet have significant effects on health. People who consume cereal or starchy food as their main diet tend to suffer with protein malnutrition. Beans are generally low in sulphur containing amino acids *i.e.* methionine and cysteine while grains are typically low in lysine. Essential amino acids in the cereal proteins can be balanced by soybean protein (Akbar *et al.* 2016) also soybean is rich source of micronutrients like calcium, phosphorus, carbohydrate and vitamins A and B (Joshi and Rahal, 2018). Micronutrient deficiencies can lead to serious health consequences, such as immune competence, growth problems, mental and physical development across all age

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groups including children and women of reproductive age being most vulnerable (Looman *et al.* 2019).

Soybean flour is rich in protein with well-balanced amino acid profile. Soybean flour is a great source of dietary fibres and important bioactive compounds such as isoflavin (antioxidant) and also a good source of vitamin K, vitamin B9 molybdenum (essential trace element), copper, manganese, phosphorus and thiamine. Water chestnut flour is a gluten free and abundant source of starch, minerals, amino acids and vitamins, fat, fiber and mineral (Hussain *et al.* 2016). The water chestnut kernel is good source of minerals such as calcium phosphorus, iron, copper, manganese, magnesium and potassium.

Fortification of cookies has been done earlier with different materials such as maize, soybean flour, water chestnut flour, sesame seeds flour, mushroom flour, flaxseeds flour, millets flour, watermelon seeds flour *etc.* separately as well as together as blends. But water chestnut flour and soybean flour blends has not been used together to fortify cookies while water chestnut flour and soybean flour blends can be used to fortify cookies along with wheat flour to formulate cookies which are rich in protein, micronutrients, dietary fibres, minerals and vitamins with well-balanced amino acid profile. So, aim of this research paper is to develop soy and water chestnut flour-based cookies and to study impact of different levels of soy and water chestnut flour on physical, chemical and sensory properties of cookies.

MATERIALS AND METHODS

Preparation of soybean flour

Soybean seeds were bought from the local market. Seeds were cleaned manually and milled. Milled seeds were allowed to pass through 52 BSS (British standard sieve) or 300 microns to get fine particle sized flour and stored for further use.

Preparation of water chestnut flour

Water chestnut seeds (Meeng) were bought from local market. Seeds were cleaned manually and milled. Milled seeds were allowed to pass through 36 BSS (British standard sieve) or 420 microns to get fine particles sized flour and stored for further use. The study was carried out during the period of January 2020 to May 2020, in Surya Food and Agro Ltd, Greater Noida, UP.

Preparation of treatments

Wheat flour was replaced by soy and water chestnut flour at different proportions. Blends of concentrations of 20%, 25%, 30%, 35% and 40% soy and water chestnut flour were prepared.

Preparation of cookies

Cookies were prepared according to AACC approved method 10-50D (American Association of Cereal Chemists 2000) with slight modifications. Dry ingredients were weighed using an electronic weighing scale and mixed by taking sugar, fat, sodium bicarbonate, skimmed milk powder, salt and water added to flour. Dough was thoroughly kneaded and spread into sheet of 5mm thickness and cut into rectangular shapes with the help of a mould of size 34mm width. Baking was done in laboratory oven at 135°C for 25 minutes. Baked cookies were cooled at room temperature before packing in air tight plastic container and stored for quality parameters evaluation.

Physical analysis of cookies

Width, thickness and spread ratio was calculated empirically. For thickness six cookies are stacked and measured with

the help of a scale and average values was determined. Spread ratio was calculated as per the formula given below.

$$\text{Spread ratio} = \frac{\text{Width or diameter of cookies}}{\text{Thickness or height of cookies}}$$

Chemical analysis of cookies

Determination of moisture, ash, fat and protein contents was done. Moisture analysis of cookies was done using a Digital Moisture Analyser. Ash content of cookies was extracted by Muffle Furnace. Ash was extracted by taking cookie sample in to crucible and put into muffle furnace for 5-6 hours at 550°C. Crucible weight was taken and ash content was calculated. Protein was calculated using Kjeldahl method, divided into three steps: Digestion, neutralization and titration. Fat was extracted by pouring petroleum ether on the cookie sample added in to a dried thimble in the Soxhlet apparatus. Solvent was evaporated off and fat was collected. Percentage values of chemical analysis were examined.

Sensory evaluation of cookies

For sensory evaluation of cookies crispiness, taste, colour and overall acceptability, the cookies were presented to a panel of judges. The panel then tested the cookies and evaluated the sensory qualities and gave marks out of 10.

Statistical analysis

Each parameter was analysed in triplicates and expressed as mean. The significance difference between treatments were examined by one way ANOVA. All statistical analysis was performed using SPSS software version 16.0 (SPSS Inc).

RESULTS AND DISCUSSION

Wheat flour was replaced by soy and water chestnut flour at different proportions. Five formulations were prepared (Table 1) to observe the effect of different concentrations of soy flour and water chestnut flour on physical, chemical and sensory properties of cookies.

Physical properties of cookies

Physical properties of cookies influenced significantly by inclusion of soy flour and water chestnut. Results of physical parameters are shown in (Table 2). It was found that width of cookies decreased upto 30% replacement of wheat flour with soy and water chestnut flours. Results were found in accordance with Claughton *et al.* (1989); Akubar (2003). There was no significant difference found in width of cookies at 30% and 35% replacement of wheat flour. Width slightly increased at 45% supplementation. Thickness of cookies increased with increased soy and water chestnut flour supplementation but slightly decreased in treatment T₄ (Table 2). Spread ratio, which is the prime quality parameter for cookies (Devi and Khatkar, 2018) decreased with increased in soy and water chestnut flour supplementation and increased dramatically in treatment T₄. The finding of this study is in agreement with earlier study (Singh *et al.* 2011). Composite flours may form aggregates with increased numbers of hydrophilic sites that compete for limited free

Table 1: Formulation of composite flour.

Treatment	Blend (%)	Wheat flour (g)	Soy flour (g)	Water chestnut flour (g)
T ₀	0	45.00	0.00	0.00
T ₁	20	36.00	4.50	4.50
T ₂	25	33.75	5.62	5.62
T ₃	30	31.50	6.75	6.75
T ₄	35	29.25	7.87	7.87
T ₅	40	27.00	9.00	9.00

Table 2: Physical parameters of fortified cookies.

Treatments	Width (mm)	Thickness (mm)	Spread ratio
T ₀	37.0 ^d	8.50 ^a	4.35 ^f
T ₁	36.5 ^c	10.12 ^c	3.60 ^d
T ₂	36.0 ^b	10.40 ^d	3.46 ^b
T ₃	35.5 ^a	10.40 ^d	3.41 ^a
T ₄	35.5 ^a	9.70 ^b	3.65 ^e
T ₅	36.0 ^b	10.12 ^c	3.55 ^c

Values with the same letter are significantly different ($p < 0.05$).

water in cookies dough thereby increasing dough viscosity and limiting cookie spread (McWatters, 1978).

(Table 2) displayed that width, spread ratio and thickness followed a constant decrease and increase trend respectively upto 30% supplementation of wheat flour with soy and water chestnut flour. According to (Claughton and Pearce, 1989), spread ratio is affected by the competition of ingredients for available water. Flour or any other ingredients will reduce the spread ratio during dough mixing because the water in such a system would be insufficient to dissolve the sugar during baking, which increases the viscosity of dough mix resulting in cookies spreading at a slower rate (Akubar, 2003).

Increased in cookie thickness and decreased in width and spread ratio with increased level of soy flour supplementation could be attributed to the improved protein contents as soy is rich source of protein. Protein has water binding power which restricts increase in spread with the increased inclusion of soy flour (Akbar *et al.* 2016).

Chemical properties of cookies

The effect of substitution at different levels was expected to increase the protein and fat content as shown in (Table 3) and it is clear that protein percentage increased with increased level of soy and water chestnut flour as soybean is a great source of protein. Similarly (Banureka and Mahendran, 2009; Ayo *et al.* 2014) reported increase in protein content in the composite flours as compared to control, which might be due to the increase in the proportion of soy flour in the flour blend as soybean is a high-protein legume.

Fat percentage increased significantly with increase in soy and water chestnut flour as soybean being a significant source of fat also. Earlier study also reported an increase

trend in fat on the incorporation of soy flour for the preparation of biscuits (Banureka and Mahendran, 2009; Ayo *et al.* 2014).

Ash content is increased up to 0.17% as compared to controlled sample (T₀). This increased ash content attributed because of increase in incombustible mineral materials. Results are agreement with the findings of Ayo *et al.* (2014).

Moisture was found the highest for control sample T₀. Moisture content decreased with the increased level of blend percentages. Results of the present study are in accordance with the findings of Banureka and Mahendran (2009). Higher level of protein content in soy flour might have role in decreased moisture of fortified cookies.

This study showed that the incorporation of soy and water chestnut flour has improved the nutritional quality of cookies. Protein and fat percentages increased with increased in soy and water chestnut flour blends.

Sensory evaluation of cookies

Cookies prepared by different level of soy flour and water chestnut flour are shown in (Fig 1). The scores of sensory evaluations are shown in (Table 4). Cookies made by different blend formulations varied significantly in terms of appearance, colour, taste, crispiness and overall acceptability. Colour of the cookies is strongly influenced by soybean and water chestnut flour levels. It was observed that the colour of cookies turned darker with increased inclusion of soy and water chestnut flour blends (Fig 1).

Taste is an important aspect for acceptability of a food product. Taste of cookies improved with increased concentration of soybean and water chestnut flour up to T₃ (30% blend) in formulation. However, 35% and 40% blends resulted in unusual taste of cookies and score decreased as displayed in (Table 4). At first crispiness of cookies increased with increasing amount of fortification materials but after 30% inclusion, further fortification made cookies too hard and brittle. The highest score for crispiness was observed for 25% and 30% level of soy and water chestnut flours. According to the data shown in Table 1, cookies with treatment T₁ with 0% blend inclusion did not score good in terms of crispiness and taste, furthermore colour of these cookies was too light. Hence, cookies without any blending were found the least acceptable. Preference scores increased with increased in blend percentage. Cookies made with treatment T₃ with blend percentage 30% were the most acceptable in terms of crispiness, taste and colour with good

Table 3: Proximate chemical composition of cookies.

Treatments	Moisture (%)	Ash (%)	Fat (%)	Protein (%)
T ₀	0.89	0.41	23.85	11.06
T ₁	0.84	0.47	25.17	12.63
T ₂	0.82	0.48	25.49	13.02
T ₃	0.80	0.51	25.83	13.42
T ₄	0.85	0.55	26.16	13.78
T ₅	0.83	0.58	26.50	14.21

Values are reported as the average.

**Fig 1:** Cookies prepared by different blends of soy flour and water chestnut flour.**Table 4:** Sensory parameters of cookies.

Treatments	Crispiness	Taste	Colour	Overall acceptability
T ₀	4	4	2	3.5
T ₁	6	6	7	6.5
T ₂	8	7	6	7
T ₃	8	8	8	8.5
T ₄	7	5	6.5	6.5
T ₅	6	4	7	5.5

appearance and had the maximum overall acceptability (Fig 1, Table 4). Water chestnut flour on baking gave a pleasing nutty taste on account of which cookies prepared by 30% replacement of wheat flour with water chestnut flour received the highest scores for taste hence influencing scores for overall acceptability. Similar findings were reported by Singh *et al.* (2011) and (Sarabhai and Prabhasankar, 2015).

After 30% blending, acceptability decreased as cookies became over crispy and taste of soybean tend to overpower other ingredients in the treatments T₄ and T₅ with blend percentages 35% and 40% respectively, as a result, cookies made from treatments T₄ and T₅ were less acceptable as compared with cookies made from treatment T₃. It can be summarized that blending of soy and water chestnut flour with wheat flour not only gives a new product but improved sensory characteristics also.

CONCLUSION

Physical, chemical and sensory characteristics of cookies produced with the soy and water chestnut flour blends to

the wheat flour were studied. Cookies width and spread ratio decreased with increased concentration of soy and water chestnut flour while thickness of cookies increased with increased soy and water chestnut flour supplementation. However, cookies prepared with 30% blend of soy and water chestnut flour were the most acceptable in terms of overall acceptability. From this study it is concluded that soy and water chestnut flour supplementation results in increased content of protein and micronutrients with better taste and sensory characteristics which gives a new range of products and is an economical approach to overcome the malnutrition. Hence, application of soy and water chestnut flour in cookies is recommended.

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