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Development of functional biscuit with wheat flour, soy flour and banana rhizome starch

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Abstract
The research intended to explore the possibility of fortifying the soy flour and banana rhizome starch to formulate the functional biscuit which have the ability to improve the quality of food products due to various functional properties. Soybean has been used in various foods to mitigate the shortage of protein supplies. Supplementation of banana rhizome starch and soy flour with wheat flour was tried at (1:20:79), (2:25:73), (3:30:67), (4:35:61) and (0:0:100) different ratios. The biscuits were evaluated for its quality on the basis of proximate analysis and sensory test. In nutrient estimation of biscuits, protein content was maximum(16.90%) in treatment T_4, fat content was highest (21.59%) in treatment T_4, moisture content was found maximum (4.00%) in control treatment T_5, and the ash content was highest (1.55%) in treatment T_4. It is evident from the experiment that biscuits can be made with substitution of soy flour upto 25% with 2% level of banana rhizome starch without adversely affecting the sensory characteristic of biscuit.

Keywords: Functional biscuits; wheat flour; soy flour; banana rhizome starch; protein

1. Introduction

Biscuit is most popular bakery product worldwide. They are high in carbohydrates, fat, and calorie but low in fibre, vitamin, and mineral which make it unhealthy for daily use. The main ingredients of any bakery products is wheat, which is having deficiency of essential amino acid lysine whereas soybean is richer in lysine and can be complement to wheat in bakery products. This may be achieved through incorporation of protein-rich ingredients from soybean and wheat flour as a fortification of biscuits. Soybean protein is more economical than high priced meat protein and so they are considered as best source of protein especially in vegetarian diet. Soybean is an excellent source of protein contain 35-45% with all essential amino acids required for proper growth and maintenance of body. Amino acid profile of soy protein is excellent amongst plant proteins. Hence, it is superior to other plant proteins as it contains most of the essential amino acids except methionine. (FAO 1970) [2], which is abundant in cereals, and it is the most economical source of dietary protein. Soybean is one of the new protein supplements, which when used partially to replace or complement wheat flour in the production of bakery products such as biscuits, bread and other confectionery could go a long way in improving the nutritional status of such products.

Soybean contain high amount of protein so it is also called as -Poor man’s meat. In terms of protein production per hectare, soybean has the highest yield (800 kg) at the lowest price and compared with all other vegetable proteins, its amino acid composition are one of the best. The protein of soybean is called a complete protein as because it supplies sufficient amount of various kinds of amino acids required for body building and repairing the body tissues. Its food value in heart disease and diabetes is well known. Soybean oil contains a large amount of lecithin and a fair amount of fat soluble vitamins. Lecithin is an important constituent of all organs in human body and especially of the nervous tissue, the heart and lever. That is why soybean is a very complete food [4].

The banana rhizome starch has good residual amount of minerals and dietary fibre along with antimicrobial and antioxidant activity. The flour obtained has beneficial physiological effects, as it acts in the form of fibre, due to the high content of starch resistant to digestion and provides better glycemic and insulinemic responses (Hernández, 2006; Patzi, 2007) [10, 9]. The use of banana rhizome starch as an ingredient in the biscuit manufacturing not only increases its nutritional value it also helps in by-product utilization. The present study was, therefore undertaken to study the compositional evaluation designed to blend banana rhizome starch, soy flour and wheat flour as a source of protein and fibre to make protein and fibre rich biscuits.

2. Material and methods

The seed of JS-335 variety of soybean were procured from Andro Research Farm, Central Agricultural University (CAU), Imphal. The seeds were cleaned manually, dried in sun and stored in plastic containers for further use. Wheat flour was procured from the local market. The flours were screened through a 0.25 mm sieve and stored at 4 ^{0}C in a refrigerator to prevent spoilage particularly rancidity until usage. The composite flour is prepared by substituting the wheat flour with banana rhizome starch and soy flour at different levels i.e. T_1 (1:20:79), T_2 (2:25:73), T_3 (3:30:67), T_4 (4:35:61) and T_5 (0:0:100 as control) of banana rhizome starch: soy flour: wheat flour (Table 1). The preparation of soy fortified biscuits is shown in figure 1.

Table 1: Treatments of composite flour

Treatments		Banana rhizome starch (%)	Soy Flour (%)	Wheat Flour (%)
T1	JS-335	1	20	79
T2		2	25	73
T3		3	30	67
T4		4	35	61
T5	Control	-	-	100

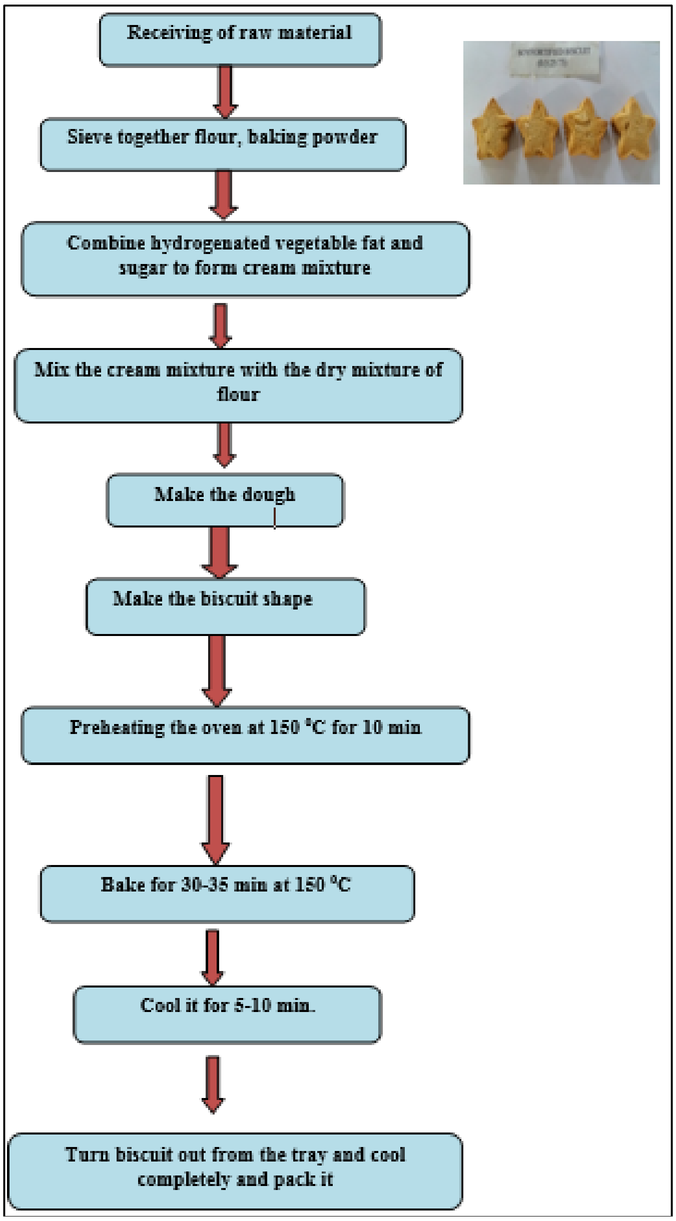

Fig 1: Flowchart for the preparation of soy fortified biscuit

2.1 Proximate analysis

The proximate composition (i.e., moisture, ash, fat, protein, crude fibre) of soy fortified biscuits samples/products were determined according to the standard analytical methods (AOAC 2000) [1]. The protein content was determined by Kjeldahl method.

2.1.1 Determination of moisture

Moisture content was determined by drying a sample in an oven at 70 ^{0}C for 12 hr, the weight loss incurred was calculated as:

Moisture (%) =weight loss on drying/weight of the sample x 100

2.1.2 Determination of ash

Crucibles were first dried for about 2 hr at 100 ^{0}C in an oven and placed in a desiccators. They were cooled and about 2 g of sample was weighed into the crucible. The samples were then placed in a furnace at 600 ^{0}C for 4 hr. Percentage ash content was determined by weighing the resulting inorganic residue.

$$\text{Weight of ash(g/100g of sample)} = \frac{\text{(weight of the crucible+ ash)- (weight of the crucible)}}{\text{Weight of the sample}} \text{x100}$$

2.1.3 Determination of fat

Fat content was determined using the Soxhlet extraction method. In this method, fat was determined by extracting the dried materials (food samples) with a light petroleum fraction in a continuous extraction apparatus. The solvent was distilled off and the extract was dried and weighed.

2.1.4 Determination of protein

Protein content of the samples was determined using the Kjeldahl method. The method consists of three basic steps: 1. Digestion of the sample in sulphuric acid with a catalyst, which results in conversion of nitrogen to ammonia; 2. Distillation of the ammonia into a trapping solution; and 3. Quantification of the ammonia by titration with a standard solution. According to this method, percentage of crude protein content of the samples = % nitrogen x 6.25

2.1.5 Determination of crude fibre

The moisture and fat-free sample was boiled with 0.255N H_2SO_4 and 0.313 N NaOH, consecutively, for 30 min under a reflux condenser and each time the sample was washed well with boiling water to remove acid and alkali residues. The sample was then transferred into a crucible, dried overnight at 100 ^{0}C and weighed (W_1) in an analytical balance. The crucible was heated in a muffle furnace at 600 ^{0}C for 20 min, cooled, and weighed again (W_2). The difference in the weights (W_1-W_2) represents the weight of crude fibre.

$$\text{Crude fibre (g/100 g of sample)} = \frac{W_1-W_2}{\text{Weight of the sample}} \text{x100}$$

2.2 Sensory evaluation

The sensory evaluation of the products was done on the basis of 9-point hedonic scale scorecard. Each attribute was scored based on its intensity scaled on a 9-point hedonic scale (1= disliked extremely, 2=disliked very much, 3=disliked moderately, 4=disliked slightly, 5= neither liked or disliked, 6= liked slightly, 7= liked moderately, 8= liked very much, 9= liked extremely) for colour, taste, texture, flavour and overall acceptability.

2.3 Statistical analysis

Data on nutritional and sensory evaluation of biscuits were analysed statistically by Completely Randomized Design (CRD).

3. Results and Discussion

The results for moisture, ash, fat, protein, crude fibre are given in table 2. The moisture content (4.00%) was highest in control (T_5) biscuit. The results revealed that the moisture content decreased from 4.00 to 2.98% with the increase in soy flour and banana rhizome starch. This may be due to the greater amount of total dry solids in soy flour with high emulsifying properties compared to wheat flour. The results are supported by the findings of Sutharshan *et al*. (2001) [6] who reported that increase in proportion of soy flour reduces the moisture content of the soy flour supplemented biscuits.

Ash content indicated an estimate of the total mineral content in a given quantity of food substance. The highest ash content (1.55%) was recorded in treatment T_4 (4:35:61) and lowest (1.20%) in control (T_5). The ash content gradually increased from 1.20-1.55 with the increase in banana rhizome flour/starch. Angelica *et al*. (2017) [11] and Ayo *et al*. (2014) [4] reported the similar results on the supplementation of banana rhizome starch and wheat flour for the preparation of biscuits.

Appraisal of data in table 2 revealed that there was no significant difference in the fat content of soy fortified biscuit (Table 2). The highest fat content (21.59%) was found in treatment T_4 and lowest (12.51%) was recorded for control (T_5) treatment. The increase in fat content in the present study may be due to the higher percentage of fat in soy flour than wheat flour. This results are in agreement with previous studies (Akubor and Ukwuru 2005; Banureka and Mahendran 2009; Ayo *et al*. 2014) [3, 5, 4].

In the present investigation a gradual increasae in the protein content was found with the increase in soy flour (Table 2). The results of protein content revealed that there was high significant difference between the samples. Protein content was maximum (16.90%) in the treatment T_4 and minimum (9.43%) in control (T_5) biscuits. This increase could be due to the increase in the proportion of soy flour in the flour blend as addition of soy flour improve the quantity and quality of protein of protein content of the food product, thereby has the great potential in combating with protein energy malnutrition. Ugwuona (2009) [7] showed protein content of biscuits increased with increasing soy fortifications. Rihana *et al*. (2017) [8] also reported the similar results in the soy fortified biscuits.

The crude fibre content of the biscuit increased with the increase in supplementation. The increase in fibre content could be due to the rise fraction of blended flour. Since dehulled soya flour was used, thus banana rhizome starch has higher fibre content than both soy flour and wheat flour as shown in treatment T_4 (2.82%) than the control T_5 (0.12%) (Table 2).

Table 2: Proximate composition of soy fortified biscuits

Treatments	Parameters				
	Moisture (%)	**Ash (%)**	**Fat (%)**	**Protein (%)**	**Crude Fibre (%)**
T1	3.97	1.33	21.40	14.20	0.48
T2	3.90	1.41	21.42	14.98	1.02
T3	3.20	1.48	21.53	15.70	2.20
T4	2.98	1.55	21.59	16.90	2.82
T5	4.00	1.20	12.51	9.43	0.12
S.Ed (±)	0.41	0.05	0.56	0.71	0.12
C.D	0.90	0.11	1.25	1.59	0.26

Plate 3: Soy fortified biscuits prepared from 25% soy flour (JS-335) with different percentage of banana rhizome starch and wheat flour

Mean score for sensory evaluation of biscuit given in table 3, revealed that there are significant differences between treatments for sensory attributes like colour, taste, texture and overall acceptability. With increasing level of substitution, the mean score of colour was declining. The colour score was highest (7.63) for treatment T_1 (1:20:79) and lowest (7.10) for treatment T_4 (4:35:61). The colour of biscuit turned from light brown to dark brown, leading to lower acceptance. A similar trend was also reported by Banureka and Mahendran (2009) [5].

The taste is the primary factor which determines the acceptability of any product, which has the highest impact. The score for taste was decreased from 7.60 to 7.00 with the increase in the level of incorporation of banana rhizome starch and soy flour. Table 2 shows that treatment T_2 with 2:25:73 ratio of banana rhizome starch, soy flour and wheat flour got the highest score (7.6) and treatments T_3 and T_4 got the lowest score (7.0). There was a decreasing trend in the quality score for the texture of the biscuits with an increase in the soy flour addition. Flavour of the biscuits was not significantly different (Table 3). All treatments were in the acceptable range.

Overall acceptability was determined on the basis of quality scores obtained from the evaluation of colour, flavour, and texture of the biscuit. The mean regarding overall acceptability of biscuit (Table 3) revealed that the overall acceptability of T_2 (2%banana rhizome starch: 25% soy flour:

73% wheat flour) was highest (7.60) while T_4 (4% banana rhizome starch: 35% soy flour: 61% wheat flour) has lowest acceptability (6.05). At 2% banana rhizome starch, 25% soy flour and 73% wheat flour level of incorporation, treatment (T_2) biscuit had highest scores for the entire sensory attributes than other treatment.

Table 3: Sensory scores of soy fortified biscuits

Treatments	Parameters				
	Colour	**Taste**	**Texture**	**Flavour**	**Overall acceptability**
T1	7.63	7.53	7.00	7.60	7.60
T2	7.37	7.60	6.58	7.80	7.90
T3	7.10	7.00	5.20	7.50	6.50
T4	7.10	7.00	5.00	7.13	6.05
T5	7.11	7.11	7.00	7.82	7.07
S.Ed (±)	0.19	0.26	0.24	0.41	0.30
C.D	0.43	0.58	0.54	0.90	0.66

Conclusion

The biscuits fortified T_4 (4:35:61) banana rhizome starch, soy flour and wheat flour were nutritionally superior to that of the whole wheat flour biscuits. With regard to the sensory characteristics of T_2 (2% banana rhizome starch, 25% soy flour and 73% wheat flour) was found to be the best. The other treatments were also found to be acceptable. The formation of composite flour not only provides a handsome amount of nutrients but also gives a new range of products with amazing sensorial characteristics. It is also an economical approach to overcome the malnutrition, especially in school going children.

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