

FORMULATION OF WHEAT - SOYBEAN BISCUITS AND THEIR QUALITY CHARACTERISTICS

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ABSTRACT

A research study was conducted to evaluate the quality characteristics of protein enriched biscuits which could be used as a protein supplemented cereal snack food. The use of soy flour to substitute it with wheat flour from 0 to 25 % and the possibility of using soy flour for the production of biscuit was investigated. Prepared biscuits were subjected to nutritional and organoleptic analysis to evaluate the suitability of the biscuits for consumption. Protein, fat and energy (calorie) value of soy flour supplemented biscuits increased with progressive increase in proportion of soy flour and 10% soy flour added biscuits obtained values of 9.9%, 20% and 453.58 kcal/g respectively, while lowest values of 5%, 14.5% and 417.36 kcal recorded for the wheat flour biscuits. The moisture and ash were decreased with corresponding increase in the percentage of soy flour. Nine-point hedonic scale ranking method was used to evaluate the organoleptic characteristics of prepared biscuits. Generally the mean scores for all the assessed organoleptic characteristics decreased with increase in the soybean flour. Organoleptic evaluation indicated that there were no significant ($p < 0.05$) differences between the control treatment and 10% soy flour supplemented biscuits in the organoleptic attributes of taste, texture and flavour but differences were significant in colour and overall acceptability. From the overall acceptance rating, 10% soybean flour incorporated biscuit obtained the highest preference compared to other combinations.

Key words: Nutritional quality, Organoleptic characteristics, Protein enrichment, Wheat – soy biscuits

INTRODUCTION

The consumption of cereal snack foods such as biscuits, cookies, wafers and short bread has become very popular in Sri Lanka especially among children. Among these biscuits possess several attractive features including wider consumption base, relatively long shelf-life and good eating quality. Long shelf-life of biscuits makes the possibility of large scale production and distribution. Good eating quality makes biscuits attractive for protein fortification and nutritional improvements, particularly in children feeding programmes, for the elderly and low income groups. Enrichment of cereal-based foods with other protein sources such as oil seeds and legumes has received considerable attention (Ayo and Olawale 2003). This is because of oil seeds and legume proteins are high in lysine, an essential limiting amino acid in most cereals.

Grain legumes, like Soybean (*Glycine max*) is an excellent source of protein (40-45%); hence the seeds are the richest in food value of all plant foods consumed in the world (Kure *et al.* 1998). It is also rich in calcium, iron, phosphorous and most of the vitamins. It is the only source that contains all essential amino acids. The usefulness of the grain legumes in developing high protein foods in meeting the needs of the vulnerable groups of the population is now well recognized and several high protein energy foods have been developed industrially

in different parts of the world (Mooriya 2003). Soybean plays a vital role in balancing the protein deficiency of our diet. Protein content of soybean is about 2 times of other pulses, 4 times of wheat, 6 times of rice grain and 4 times of milk. Soybean has 3% lecithine, which is helpful for brain development (Akubor and Ukwuru 2005). Wheat (*Triticum aestivum* L) is one of the important cereal grains because of its use for the preparation of many baked products. Unfortunately, lysine is the first limiting amino acid in wheat flour and more than 10% of which is being destroyed during baking. (Saab *et al.* 1981).

Many countries have made great strides to improve their food and nutrition situation, but hunger and malnutrition remain as a serious problem in many parts of the world especially in third world countries (FAO 2007). There are large number of people in the world who are chronically undernourished. Most of them are small children who are suffering from acute or chronic deficiency problems. Chronic diet-related diseases are also emerging as serious health problems in both developed and developing countries. Sri Lanka faces one of the most serious nutritional problems in protein energy malnutrition. According to the Demographic and Health Survey 2006, child nutritional status in Sri Lanka stated that prevalence of malnutrition in children aged less than 5 years are 29.4% under-weight, 14% wasting and 13.5% stunting (UNICEF 2008). A protein in the diet is

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expected to provide all essential amino acids, in correct proportion for maximum usage in the body. High prices for meat protein restrict regular consumption of meat protein in most of the developing countries. Vegetable proteins provide a great potential as a direct protein source for human consumption.

In this study, efforts have been made to supplement wheat flour with soybean flour to develop nutritionally protein-enriched biscuits. At the same time, the utilization of soybean may encourage the farmers to grow more soybeans. Thus, the malnutrition problem may be solved and the poverty in the country could be reduced to a certain level.

METHODOLOGY

Raw materials

Commercially available wheat flour and soybean seeds were procured from wholesale trader.

Preparation of soybean flour

The soybean seeds were processed into flour using the method of IITA (1990). The process ensures effective removal of most anti-nutritional factors. Soybean seeds were sorted and roasted until light brown. The roasted seeds were boiled for 20min. Thereafter, seeds were drained and dried at 100-120°C for 3h. The dried seeds were milled into flour. The flours were screened through a 0.25mm sieve and stored at 4°C in a refrigerator to prevent spoilage particularly rancidity until usage. Wheat flour was mixed with soy flour and biscuits were prepared according to the following treatments using the recipe described below:

Treatments:

- T₁ - Biscuit made by 100% wheat flour
- T₂ - 0g Soybean flour /100g mixture (5+95g)
- T₃ - 5g Soybean flour /100g mixture (10+90g)
- T₄ - 10g Soybean flour /100g mixture (15+85g)
- T₅ - 15g Soybean flour /100g mixture (20+80g)
- T₆ - 20g Soybean flour /100g mixture (25+75g)

Development of Protein enriched biscuits

Hydrogenated fat (margarine) 50g and powdered sugar 50g were creamed together by electric beater. All purpose wheat flour and baking powder 3g were sieved twice together. The sieved flour and egg were added to the creamed paste. As per the treatment, firm dough was prepared from all mixture. The dough was rolled out to 2.5mm thickness in a baking tray and cut into round in shape having 5cm diameter with a biscuit cutter. The biscuits were placed in greased aluminum trays and baked in a pre-heated oven at 150°C for 4min. These biscuits were assessed for nutritional and organoleptic qualities.

Nutritional analysis

The moisture, ash, protein and fat of the biscuits were determined according to the standard AOAC (2000) methods. The carbohydrate content was determined by calculated difference and calorie value was estimated by multiplying the proportion of protein, fat and carbohydrate by their respective physiological energy values and taking the sum of the products (Eneche 1999).

Sensory analysis

The sensory attributes including taste, colour, texture, flavour and overall acceptability were evaluated by a trained 20-member panel. The evaluation was held either 10 am for the morning session and at 3 pm for the afternoon session. The Nine-point hedonic scale was used to evaluate the degree of liking and disliking for preference of the biscuits. The mean scores were analyzed using analysis of variance (ANOVA) method and difference separated using Turkey's test.

RESULTS AND DISCUSSION

Composition of soybean flour

The nutritional composition of studied soy flour were moisture 11.5%, protein 40.2%, fat 19.7%, ash 4.6% and total soluble carbohydrate 24.1%. This is accordance with Gopalan *et al.* (1991).

Nutritional composition of wheat - soybean biscuits

The nutritional analysis of the biscuits indicated that all the biscuits contained favorable proportion of protein and fat.

Protein content

Nutritionally, soybean protein is an excellent complement to lysine-limited cereal protein, hence the basis for the use of soy flour as an economical protein supplement in biscuit, bread, pasta and other cereal products (Hegstad 2008). The protein content of the biscuits increased from 5.0 to 14.2% (Fig.1) with the increase in soybean flour from 0 to 25%.

The increase in protein content could be due to the increase in the proportion of soybean in the flour blend. Soybean is a high protein legume and incorporation of soy flour inevitable increase the protein content in the biscuits. Addition of soy flour increase the protein, fat and the essential amino acids content thereby has a greater potential in overcoming protein-calorie malnutrition in the world (Akubor and Ukwuru 2005).

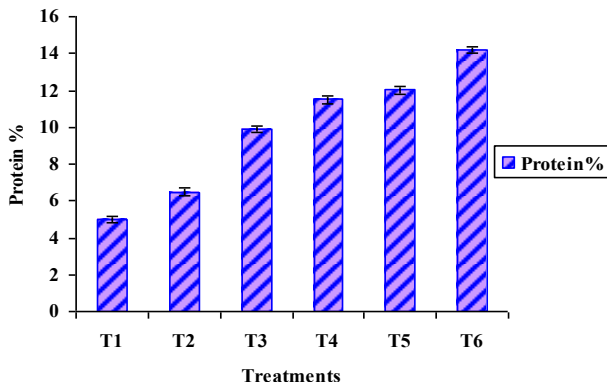


Figure 1: Changes in protein content of wheat – soybean biscuits (Vertical bars indicate the standard errors)

Fat content

Soybean is a protein rich oil seed, which is presently number one edible oil source globally. Soybean is rich in polyunsaturated fats, including the two essential fatty acids, linoleic and linolenic, that are not produced in the body. Linoleic and linolenic acids aid the body's absorption of vital nutrients and are required for human health (Hegstad 2008). Soybean oil is 61% polyunsaturated fat and 24% monounsaturated fat which is comparable to the total unsaturated fat content of other vegetable oils (85%). The fat content of the biscuits increased from 14.6 to 24.0% with increase in soybean flour from 0 to 25% (Fig. 2).

The increase in the fat content could be due to the increase in the proportion of soybean in the flour blend. This could be due to the fact that soy flour contained higher percentage of fat than wheat flour. Our results are in agreement with the finding of Akubor and Ukwuru (2005). Reddy (2004) reported that soy flour contained 20–24% of fat whereas wheat flour contains 0.9–1.1% and most of which are unsaturated in nature.

Moisture and Ash content

The highest moisture content of 2.9% was observed in control biscuit. The results showed that the moisture content gradually decreased from 2.90 to 1.53% with the increase of soy flour from 0 to 25% as shown in table 1.

This is due to the fact that soy flour contained greater amount of total dry solid with high emulsifying properties compared to wheat flour. The

Table 1: Moisture and ash content of wheat-soybean biscuits (Values are means of triplicates ± standard error)

Treatments (% of Soy flour)	Moisture (%)	Ash (%)
T ₁ (0%)	2.9±0.10a	11.6±0.7a
T ₂ (5%)	2.87±0.06a	10.0±0.1ab
T ₃ (10%)	2.57±0.05b	9.0±0.2bc
T ₄ (15%)	2.47±0.04b	8.9±0.1c
T ₅ (20%)	1.83±0.05c	7.0±0.15d
T ₆ (25%)	1.53±0.04d	5.1±0.07e

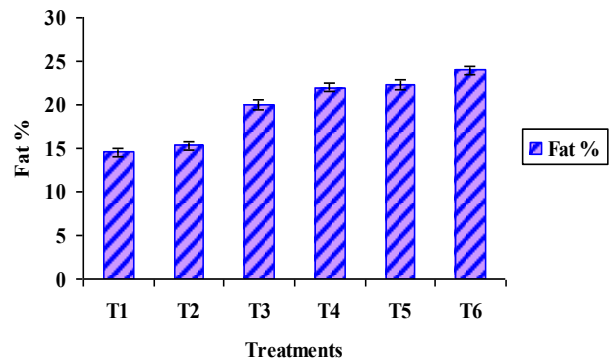


Figure 2: Changes in fat content of wheat - soybean biscuits (Vertical bars indicate the standard errors)

moisture content of the biscuit decreased with the increasing amount of soy flour in the blend due to low moisture content of the beans. This is in agreement with the findings of Sutharshan *et al.* (2001) in which they have reported that increase in proportion of soy flour reduces the moisture content of the soy bean flour supplemented biscuits. The ash content decreased from 11.6 to 5.1% with increase in the percentage of soy flour from 0 to 25% as shown in table 1. It was found that the ash content was the highest in control biscuit and the lowest value was recorded for the biscuits made from flour mixture containing 25% of soy flour. Akubor and Ukwuru (2005) reported that the moisture and ash contents of the flour blend biscuits decreased with increasing levels of soy flour from 0 to 100%.

Energy value

Food energy is the amount of caloric available from food that is available through oxidation. Nutritionists usually talk about the number of calories in a gram of a nutrient, but this implies that the food actually contains energy. Fats have the greatest amount of food energy 9kcal/g while proteins and most carbohydrates have about 4kcal/g. The calorie content of the biscuits has been increased from 417.36 to 495.63kcal with the addition of soy flour from 0 to 25% (Fig. 3).

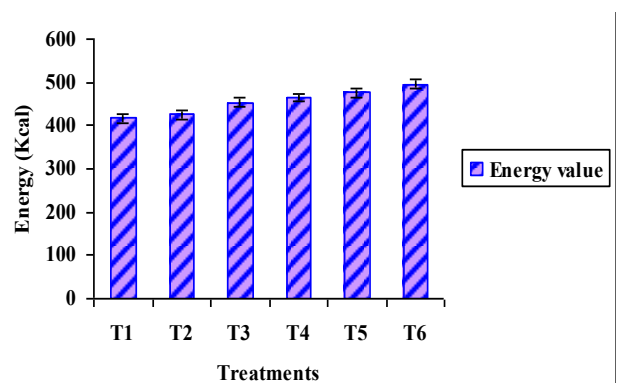


Figure 3: Changes in energy value of wheat-soybean biscuits (The vertical bars indicate the standard errors)

Organoleptic Evaluation of wheat-soybean biscuits

The organoleptic evaluation of the biscuit revealed that there were significant differences between the treatments for the organoleptic qualities such as taste, colour, texture, flavour and overall acceptability (Table 2).

Taste is the primary factor which determines the acceptability of any product, which has the highest impact as far as market success of product, is concerned. The score for taste had also been decreased from 7.5 to 5.95 with the increase in the level of substitution of soy flour. Biscuit containing 25% soybean flour was rated poorest in taste (5.95). The control treatment (T1) has the highest mean value and 25% soy flour added biscuit (T6) has the least mean value. The colour of the biscuit changed from creamy to dark brown, with a decrease trend in the mean scores from 6.95 to 6.5. The darker colour may be due to Maillard reaction between reducing sugar and protein (Dhingra and Jood 2000).

The texture of the crust was related to the external appearance of the biscuit top which implies smoothness or roughness of the crust. The texture of crust was decreased from 7.05 to 5.75 with the increase in substitution of soybean flour from 0 to 25% to the biscuits. The control treatment had the highest mean value and 25% soy flour added biscuit had the least mean value. Flavour of biscuit decreased from 6.95 to 5.45 with increasing in the substitution of soybean flour. This could be due to the beany flavour of soy flour (Akubor and Ukwuru 2005). Overall acceptability includes many implications, which is the important parameter in organoleptic estimation. The 10% soy flour added biscuits had the highest mean value and 25% soy flour added biscuits had the least mean value for the overall acceptability. At 10% level of soy flour incorporation, biscuits had higher scores for all the sensory attributes evaluated. Above this level, biscuits received lower sensory scores.

CONCLUSIONS

This research was conducted to reduce the Protein - Energy Malnutrition (PEM) of the Sri Lankan children through the development of biscuits, enriched with soyflour and to increase protein nutrient consumption in human diet. The finding of this research revealed that, the biscuits produced with soy flour substitution, upto 25%, were nutritionally superior to that of the whole wheat flour biscuits. To obtain biscuits of high nutritional and organoleptic qualities, wheat flour could be substituted with 10% of soy flour. The biscuits with the preparation of 90% wheat flour and 10% soy flour could provide

Table 2: Sensory attributes of biscuits incorporated with different levels of soy flour

Treat-ments	Taste	Colour	Texture	Flavour	Overall Acceptability
T ₁	7.5±0.2a	6.9±0.3bc	7.0±0.2a	6.9±0.3a	6.5±0.2dc
T ₂	7.2±0.3a	6.2±0.3c	6.9±0.3a	6.9±0.2a	6.9±0.2bc
T ₃	7.2±0.3a	7.8±0.2a	6.8±0.3a	6.8±0.3a	7.8±0.2a
T ₄	7.0±0.2ab	6.9±0.3bc	6.7±0.3ab	6.4±0.3a	7.3±0.2ab
T ₅	6.3±0.2bc	7.1±0.2ab	6.4±0.3ab	6.2±0.2ab	6.2±0.3dc
T ₆	5.9±0.2c	6.5±0.3bc	5.8±0.4b	5.4±0.3b	6.0±0.3d

The values are means of 20 replicates ± standard error.

The means with the same letters are not significantly different from each other at 5%.

the needed daily nutrient requirement because these biscuits contain 9.9% protein, 20% fat and the energy value of 453.6kcal. The economic impact of using wheat-soybean composite flour in the manufacturing of biscuit would impart reduction in the volume of wheat flour importation. As biscuit consumption in Sri Lanka is high, wheat-soybean biscuit will serve as a vehicle for increasing intake of protein, fat and calories for Sri Lankan population.

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