PHYSICO-CHEMICAL AND SENSORY PROPERTIES OF CAKES SUPPLEMENTED WITH DIFFERENT CONCENTRATION OF SOY FLOUR

A THESIS

BY

MORIOM AKTER
Student ID.: 1405202
Session: 2014-2015
Semester: July-December, 2015

MASTER OF SCIENCE
IN
FOOD PROCESSING AND PRESERVATION

DEPARTMENT OF FOOD PROCESSING AND PRESERVATION

HAJEE MOHAMMAD DANESH SCIENCE AND TECHNOLOGY UNIVERSITY DINAJPUR-5200

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Submitted to the
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Hajee Mohammad Danesh Science and Technology University, Dinajpur

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Approved as to style and content by

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Chairman of the Examination Committee
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DEPARTMENT OF FOOD PROCESSING AND PRESERVATION

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DECEMBER, 2015

Dedicated
To My
Beloved Parents

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First and foremost, I would particularly like to express my deepest gratitude to Almighty Allah for the guidance and giving me the strength to complete this study successfully.

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December, 2015 *The author*

ABSTRACT

The aim of this work was evaluation of some physicochemical and sensory properties of cake supplemented with soy flour as partially substituted of wheat flour at different levels (5, 10, 15 and 20 %). The protein content of cake samples was increased with increasing percentage of soy flour addition. During storage period the level of peroxide value and acid value were reasonable range 10-20 mEq/kg which were more acceptable. Though L^*value decreased, a^* and b^* values were nearly same after 20 days storage period but for crumb color, while the level of soy flour increased, the L^*, a^*, and b^* values decreased. Though the control sample was more acceptable than soy based cakes in terms of sensory properties, but the prepared samples had significant difference with flavor, color and taste. Overall, soy based cake could be developed as a food with more effective protein content.

CONTENTS

CONTENTS (Contd.)

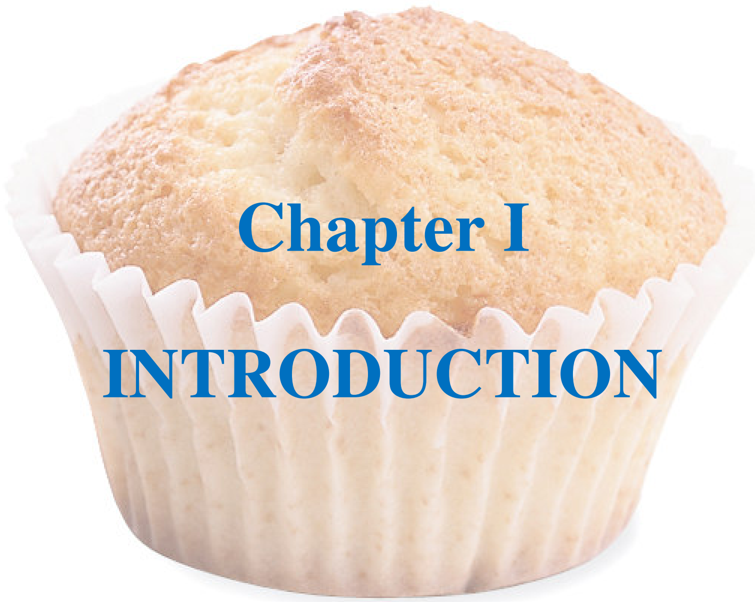
LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

LIST OF ABBRIVIATION

µm	= Micrometer
AOAC	= Association of Analytical Chemists
AV	= Acid Value
BL	= Baking loss
BR	= Bradford Reagent
BSA	= Bovine Serum Albumin
DPLS	= Discriminant Partial Least Squares Analysis
et.al.	= and others
FAO	= Food and Agriculture Organization
gm	= Gram
HDPE	= High Density Polyethylene
hr	= Hour
IW	= Initial Water
mg	= Milligram
min	= Minute
ml	= Milliliter
N	= Normality
^{o}C	= Degree centigrade
ppm	= Parts per Million
PV	= Peroxide value
RWF	= Refined wheat flour
SCI	= Specular Component Included
SF	= Soy flour



Chapter I

INTRODUCTION

CHAPTER I

INTRODUCTION

Generally legumes are known as “a poor man’s meat”. Soybeans (*Glycine max*) belonging to the family leguminosae constitute and it is one of the oldest cultivated crops of the tropical and sub-tropical regions. It is one of the richest and cheapest sources of plant protein that can be used to improve the diet of millions of people, especially the poor and low income earners in developing countries. It contents the greatest amount of protein and used in food like bread, cake, biscuit etc. (Man Liu, 2000).

Nutritionally, soybean proteins are mainly vegetable protein more closely animal protein. They supply protein, complex carbohydrates, fibre, essential vitamins and minerals to the diet, which are low in fat and contain no cholesterol. Soybean contains, 43% protein, 9.5% fat, 21% carbohydrate and provides 432 kcal per 100g (Gandhi, 2005).

In Bangladesh, in terms of area and production soybean is such a minor crop concentrated only in few distinct locations. The total cropping area of soybean is 5000 ha and the total production of the country stands at 4000 tons (Sattar, 2005). Improved variety and irrigation can improve the yield of soybean (Rabbani *et al.,* 2004).

Soybean provides high quality nutrition, nutraceuticals and therapeutic ingredients that help people to feel better and live longer with enhanced quality of life. According to the FDA, the risk of heart diseases and cancer can reduce by adding more soy to the diet. From the last few decades soy protein has an increasing role in human nutrition (Riaz, 2001). Health benefits which include in soy protein are reduced blood pressure, lower cholesterol levels and improved bone health (Adelekun *et al., 2005*). Nine essential amino acids also present on soy protein (Riaz, 2001).

Soy proteins have been widely accepted in applications because they provide desirable functionalities in fabricated foods with lower costs (Amudha, 2002). Soy has been researched when incorporated in cookies, bread, extruded puffs, pasta (Buck *et al*., 1987) or in combination with rice (Payumo *et al*., 1982) or with corn.

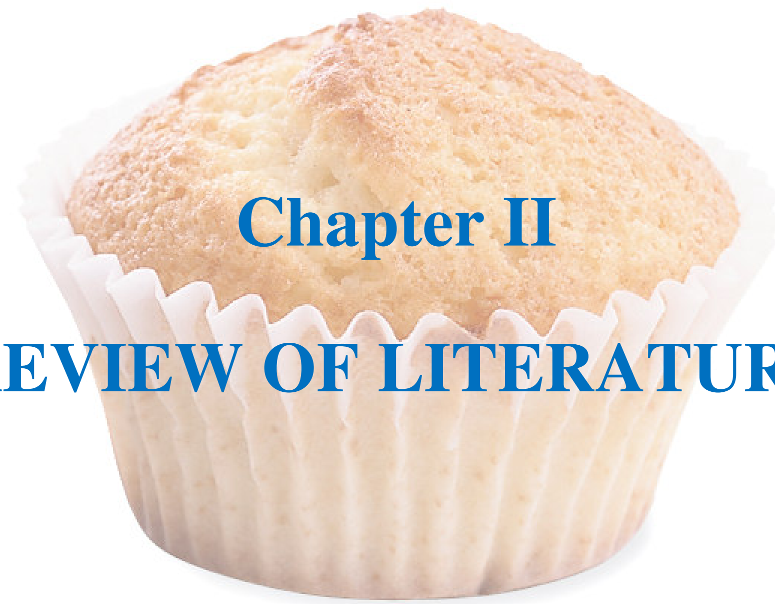
Cakes are baked products highly appreciated by the consumers worldwide, being characterized by a dense, tender crumb and sweet taste. Their quality mostly depends on ingredients used in the recipe, i.e. wheat flour, eggs, sugar, fat or oil and leavening agents, as well as on conditions prevailing during their preparation e.g. mixing & baking (Contorti, 2014).

The term food fortification or enrichment is the process of adding micronutrients (essential trace elements and vitamins) to food. Soybean fortified cereals and tubers have increased which reported several studies previously. These make a very significant contribution towards the alleviation of protein related malnutrition (Kolapo and Sanni, 2005).

The research intended to explore the possibility of adding soya to formulate the functional cake which has ability to improve the quality of food products due to various functional properties. Being a good source of protein and minerals, soy flour also helps in keeping good health. With all ingredients in value added products the utilization of soy flour in convenience food has a long way to utilize the flour with value addition for marketability and to create employment among rural women for economic empowerment.

The utilization of soy flour in an industrial level is important for product market strategy. Hence, the study with of making soy flour based cake was undertaken with following specific objectives.

a) Prepare cake supplemented with soy flour as a functional food for improved protein quality.
b) Analysis of physical and proximate composition of prepared cake samples.
c) To measure color and sensory properties of soy based cakes.



Chapter II

REVIEW OF LITERATURE

CHAPTER II

REVIEW OF LITERATURE

Soybean produces the greatest amount of used as food by man and women which can be used to improve the diet of millions of people, especially the poor and low income earners in developing countries (Liu, 2000).

Nutritionally, soybean proteins are mainly vegetable protein. It plays important role in the enrichment of cereal based baked goods because it constitutes about 40% of the total solid. It is also a rich source of vitamin, minerals and is relatively low in crude fibre (Fukushima, 1999). Liu (1997) found that dry soybean contain 36% protein, 19% oil, 35% carbohydrate (17% of which dietary fiber), 5% minerals and several components including vitamins. According to Kulkarni (2005), soybean contains 43% protein, 9.5% fat, 21% carbohydrate and provides 432 kcal energy per 100g. 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% (Gopalan *et al.,* 1991).

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. Bangladesh faces one of the most serious nutritional problems in protein energy malnutrition.

Protein malnutrition is a serious problem in Bangladesh due to cereal base dietary pattern. Therefore, various preparations based on cereal pulse combination are of paramount importance to improve the protein quality of Bangladeshi diet. FAO (2007) suggested that to meet the recommended dietary allowances of infants, preschool children, adolescent girls, pregnant and lactating women, low cost supplementary foods could be processed domestically by simple, inexpensive processing technology.

2.1 Health benefits of soybean

The health effects of soy components have been extensively studied through human clinical trials, experimental animal studies, and in vitro cell culture studies. Going further, we will confine our discussion to various scientifically validated/supported health benefits of soybean consumption to ameliorate various human health issues, though there are few studies which present less promising and unfavorable role of soybean in human health.

At present situation cardiovascular disease (CVD) has become a major problem around the world including developing countries. The role of soy in the prevention of CVD, particularly LDL cholesterol lowering effects, has been the subject of numerous controlled clinical studies (Van Horn *et al.,* 2008).

Many researchers have investigated that the person who consume soybean in their diets regularly relatively lesser risk of different cancers in countries (Messina *et al*., 1997). Researchers have evaluated dietary differences between Japan and the Western nations to try to explain variations in death rates from cancer (Lichtenstein, 2000).Many investigators found that soy components have anticancer activity, such as isoflavones, protease inhibitors, phyto-sterols, saponins, phenolic acids and phytates. Most of the data report that isoflavones are responsible for the anticancer effects of soybean (Messina, 1997). Osteoporosis is a major problem for women. Bone breakdown and loss of more calcium via urine when menopause occur. Because menopause leads to rapid decrease in estrogen levels. Many studies observed that soybean or soybean isoflavones are a possible alternative option for the prevention of osteoporosis. Randomized controlled studies Morabito (2002) and Chen (2003) that used isoflavone extracts or pure genistein reported that soy isoflavones have a mild but significant and independent effect on the maintenance of bone mineral density at doses ranging between 35 to 54 mg.

Soybean diet may be a good option in type 2 diabetes individuals due to its effect on hypertension, hypercholesterolemia, atherosclerosis and obesity, which are very common diseases in diabetic patients (Holt *et al.,* 1996). Furthermore, substituting animal protein for soybean or other vegetable protein may also decrease renal hyper filtration, proteinuria, and renal acid load and therefore reduces the risk of renal disease in type-2 diabetes (Jenkins *et al.,* 2003).

2.2 Yield of soybean in Bangladesh

Soybean is a crop which can produce high quality and highest quantity of protein (seed contains about 40% protein) per unit area. While all other pulses contain about 1-2% oil (Rahman, 1992). In Bangladesh, in terms of area and production soybean is such a minor crop concentrated only in few distinct locations. The total cropped area of soybean is 5000 ha and the total production of the country stands at 4000 tons (Sattar, 2005). Soybean yield varies from 1500-2000 kg per ha depending on variety and agronomic management practices. Improved variety and irrigation in particular can improve the yield of soybean (Rabbani *et al.,* 2004).

2.3 Production or preparation of soya flour

Soybean seeds were processed into cooked soy flour to remove all anti-nutritional factors as shown in Figure 2.1

Soybean seeds

↓

Sorting/cleaning

↓

Roasting (until light brown)

↓

Boiling (20 min)

↓

Decortication (i.e. testa removal)

↓

Draining

↓

Drying (100-120°C for 3-4 h)

↓

Dry milling

Figure 2.1. Flow diagram for the production of cooked soy flour (Adapted from IITA, 1990).

According to Okoye *et al.* (2008)

Soybean seeds

↓

Washing

↓

Soaking in water (for 8h)

↓

Dehulling

↓

Draining and Removal of hulls

↓

Boiling (100°Cfor 30 min)

↓

Drying (65°C for 6 hr)

↓

Milling (Attrition mill)

↓

Sieving (Fine sieve, 400m)

↓

Cooked full-fat soybean flour

↓

Packaging

Fig 2.2: Flow Chart for The Production of Cooked full-fat Soybean flour.

2.4 Use of soya flour

Noorfarahzilah *et al.* (2014) conducted a research in which composite flours are used for development of food products for increasing and attracting much attention from researchers, especially in the production of bakery products and pastries. It was found that composite flour used to produce food products is still able to maintain similar characteristics to products made from full-wheat flour. The positive effects of the use of composite flour can be seen in the final product related to the functional and physicochemical properties and health benefits of raw blended flour along with percentage blending.

The FAO (2007) reported that the application of composite flour in various food products would be economically advantageous if the imports of wheat could be reduced or even eliminated, and that demand for bread and pastry products could be met by the use of domestically grown products instead of wheat.

Jisha *et al*. (2013) reported that the bakery products produced using composite flour were of good quality, with some characteristics similar to wheat-flour bread, though the texture and the properties of the composite flour bakery products were different from those made from wheat flour, with an increased nutritional value and the appearance. Apart from being a good source of calories and other nutrients, wheat is considered nutritionally poor, as cereal proteins are deficient in essential amino acids such as lysine and threonine

Okoye *et al.* (2008) studied on the use of wheat and soybean flour blends in the preparation of biscuits. The flour blends of wheat (WF) and soybean (SF) were composite at replacement of different percentage. The biscuits produced were evaluated for their proximate composition and sensory attributes. They reported that the protein content of the blends increased steadily with increasing content of soybean flour while carbohydrate decreased. In the same way, the energy content of the biscuits increased as the level of soybean flour inclusion increased.

Aleem Zaker *et al.* (2012) conducted a research on physical, sensorial and nutritional properties with incorporation of defatted soy flour. This study showed that 20% addition of defatted soy flour had higher overall acceptability, taste, texture and flavor. The nutritional value of the biscuit as determined through nutrient analysis-moisture Protein, Fat, ash and total energy with 20 percent of defatted soy flour was comparable to control (wheat flour) biscuit.

Banureka *et al*. (2009) reported that 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.

Soybean is a good source of protein, which 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 the final product. Hence this work was aimed at determining the effect of soy flour additions on the chemical and physico-chemical properties of malted-sorghum flour for probable industrial use.

Since the 1960, soy protein products have been used as nutritional and functional food ingredients in several food categories available to the consumer. Currently the food industry has incorporated soy protein, either as flours, textured, concentrates or protein isolates in the manufacture of numerous products (infant formulas, bakery products, dairy and meat) because it is a good quality protein, low cost and good functionality. The nutritional benefits of adding legumes protein to grain are well known (Gomez, 1985 and Messina, 1999).

Regarding nutritional aspects, soybean could be used in cereal based products in order to improve nutritional quality of these types of foods (González, 2009). Moreover, soybean flour is a rich source of iron, zinc and calcium, so it could when it is added improve the content of these minerals when added to foods formulated with other components. However, the bioavailability of iron is markedly reduced, not only because of the effect of the same protein (Lynch *et al*., 1994), but also for its high content of phytates (inositol hexaphosphate).

2.5 Cake Supplemented with different flour

Cake is a form of bread or bread-like food. In modern forms, it is typically a sweet baked dessert. In oldest forms, cakes were normally fried breads or cheesecakes and normally had a disk shape.

Cakes are made from different type of flour such as wheat flour, soy flour, rice flour, millet flour etc.

Okorie *et al*., (2012) carried out the use of composite of sweet potato flour and wheat flour at various levels of substitution (10-15%) in cake production. The proximate composition showed that wheat flour had higher protein content (18.64%) and lower carbohydrate content (73.72%). While sweet potato had lower protein content (11.89%) and higher carbohydrate content (79.29%). Other composition such as fat, ash and moisture were increased as the dilution of wheat flour with sweet potato flour increased followed by reduction in crude fibre and carbohydrate contents.

Bean *et al.* (2004) reported that the treatment with water just before use can enhance the functionality of rice flour in baked products. When hydration occurred mixing and or holding time improves eating quality, volume and appearance of layer cake. This result also showed that the changes in Protein and/or other components are involved in functional improvements. Flours from U.S. short and medium- grain rices gave superior cake textural characteristics compared to those from U.S. long grain rice.

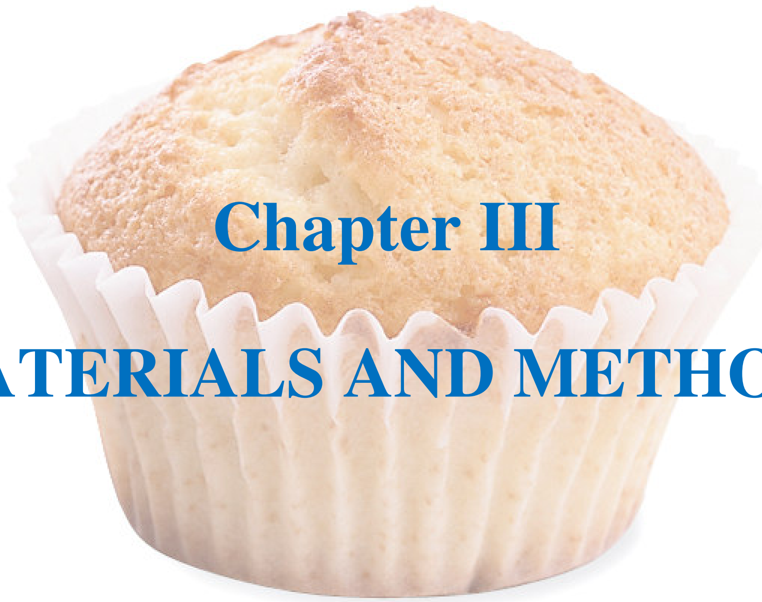
Baiano *et al.,* (2005) reported that a novel formulation of sponge cake was studied. Instant Tea Powder (ITP) with high ester catechins content was used to replace 0, 7.5, 12.5, and 17.5% of flour to make sponge cakes, hereafter referred to as the control, ITP1, ITP2, and ITP3, respectively. The results also showed the sponge cakes with ITP had good antimicrobial and antioxidant activity compared with the control, and the shelf life of ITP-treated cakes could be extended as a consequence.

Lu *et al.* (2010) studied that green tea powder was used to substitute 0%, 10%, 20%, and 30% of wheat flour to make sponge cakes, called the control, GT10, GT20, and GT30, respectively. The viscosity and specific gravity in cake batter, and hardness, gumminess, chewiness, crumb a value, protein, total dietary fibre, and ash content of baked cakes increased with increasing green tea levels whereas the volume, cohesiveness, adhesiveness, springiness, resilience, crust L, a, b and crumb L, b values of samples showed a reverse trend. No differences were found in all hedonic sensory results for control, GT10, and GT20 whereas GT30 were rated lower in all sensory results.

Rao *et al.,* (2009) observed that acid value (AV) is an important parameter to illustrate the quality as well as degree of refining of peanut oil. Regarding qualitative evaluation, the classification of qualified peanut oil (with an acid value of less than or equal to 3 mg/g) and unqualified peanut oils (with an acid value of more than 3 mg/g) was conducted by using discriminant partial least squares analysis (DPLS). The results showed that DPLS technique was an effective method of classification model building, with a high correct percent of 96.55%.

Im and Kim, (1999) studied that effect of green tea addition on the quality of white bread and found the lightness values of bread crust decreased and lightness and redness value of bread crumb was not affected, but b values decreased with the increase of green tea powder contents. The volume was significantly reduced with addition of green tea powder up to 5.0% level, compared to that of control. The addition of green tea powder at 2.5% was not affected in most of texture parameters (hardness, springiness, cohesiveness, gumminess and chewiness). But, 10% green tea powder addition to the bread increased significantly hardness, gumminess and chewiness.

Shin *et al.,* (2007) also studied on the physical and sensory characteristics of sponge cakes prepared with different levels (0, 2, 4, 6, 8 and 10%) of freeze-dried steamed garlic With increasing steamed garlic and Yuza powder content, the L- and b-values of the crust decreased, but the a-value increased, when compared to the control group. The L-value of the crumb was insignificant within each group. Compared to the a-value of the 0~2% added groups, the a-value of the 4~10% added groups, increased with increasing steamed garlic and Yuza powder contents. However the b-value decreased in the 8 and 10% steamed garlic and Yuza powder groups.



Chapter III

MATERIALS AND METHODS

CHAPTER III

MATERIALS AND METHODS

This chapter deals with the materials and methods used to carry out the present research work during the year 2015 (June-December). The materials and methods adopted forthe study are recorded in this section.

3.1 Experimental site

The research work was carried out in the laboratories under the Faculty of Engineering, Hajee Mohammad Danesh Science and Technology University and Agro-Processing and Marketing unit of Rural Development Academy in Bogra.

3.2 Materials

Soybeans flour was purchased from the Karwan bazar, Central region of Dhaka and refined wheat flour, shortening, baking powder, milk powder, salt, ghee and other general ingredients were procured from the local market.

3.2.1 Chemicals required

All analytical grade chemicals were supplied from food processing laboratory of Hajee Mohammad Danesh Science and Technology University, Dinajpur

3.3 Methods

3.3.1 Recipe for cakes

In order to justify the use of cakes as a healthier product, ghee was used instead of using other flavor components. Sugar powder was also used as a sweetener and coloring agent.

3.3.2 Formulation of composite flour for cake preparation

This experimental work was done with different levels of Soy Flour (SF) incorporation so in formulating composite flour for cakes. Through trial and error, coupled with continued informal sensory evaluation by trained panelists, as a result of preliminary trials, not more than 20% of soy flour could be used in preparation of composite flour of cake preparation. If this percentage increased, it could be resulted in a drastic reduction of overall acceptability of product. Further systematic studies have been carried out by considering following composite flour formulation for cake preparations.

T_0 - Refined wheat flour (RWF) without incorporation of soy flour (SF)

T_1- 5% replacement of RWF with SF

T_2 - 10% replacement of RWF with SF

T_3 - 15% replacement of RWF with SF

T_4- 20% replacement of RWF with SF

Recipe

Wheat flour – 23%	Milk powder – 1.6%
Sugar - 23%	Baking powder- 1.8%
Egg – 23%	Ghee – 1.8%
Oil – 20%	Salt - .17%

3.3.3 Process of cake manufacturing

In cake preparation, ingredients were used according to above stated recipe. All sieved flour, milk powder, baking powder and salt were mixed together to obtain a uniform blend. Then egg were beaten with a beater in which gradually added ghee and oil and mixed properly. After proper blending added powdered sugar and mixed gradually. Then added all flour and powder mixture and mixed properly. Then poured into a well-greased cake shaper and baked for 20 minutes at temperature 180 ºC. After baking removed and placed in a clean place for cooling. Then, they were wrapped in transparent HDPE polyethylene to prevent drying and stored at room temperature

At first all sieved flour, powder, powder and salt were mixed together

↓

Then beaten egg added with ghee and oil and mixed properly

↓

Then mixed with powdered sugar gradually

↓

Then poured in a cake shaper and baked for 20 minutes at temperature 180 ºC

↓

Cooling

↓

Then wrapped in transparent HDPE polyethylene and stored at room temperature

Fig 3.1: Flow diagram of cake manufacturing procedure

3.4 Proximate composition analysis

3.4.1 Determination of Moisture content

Moisture content was determined by oven drying method (AOAC, 2004) as described below.

Working Procedure

First of all, weight of empty previously dried crucible with cover was recorded, and 5g of sample was taken in it. Then the crucible was placed in an air oven (thermostatically control) and dried at a temperature of 105^{o}C for 24hr. After drying, the crucible with sample was kept in a desiccator to cool. It was then weighed with covered glass.

Calculation

Moisture content was determined as follows:

$$\text{Moisture content}\,(\%) = \frac{M_1 - M_2}{M_1 - M_0} \times 100$$

Where,

M_0 = Mass of the crucible

M_1 = Mass of the crucible and test sample before drying

M_2 = Mass of crucible and test sample after drying

3.4.2 Determination of Ash content

(AOAC, 2000) was used to determine the total ash content in sample as described below.

Working procedure

The sample (5g) was taken in a previously cleaned, dried and weighed porcelain crucible. At first, the crucible containing sample was placed in oven at 105^{o}C for 4hr to remove moisture. The moisture free sample was completely charred followed by heating in a muffle furnace for 6hr at 550^{o}C and ignited until light gray ash resulted (or to constant weight). It was cooled in desiccators and weighed. To ensure the completion of ashing, the crucible was again transferred in muffle furnace for half an hour and then cooled in desiccator and weighed again. This process was repeated until a constant weight was obtained and the ash became almost white and grayish in color.

Calculation

Total ash content was calculated using the following formula:

$$\text{Ash Content}\,(\%) = \frac{M_1 - M_2}{M_0 - M_2} \times 100$$

Here,

M_1 = Mass of the crucible and residue after ashing
M_2 = Mass of the crucible
M_0 = Mass of crucible and test sample before ashing

3.4.3 Determination of Protein content

Bradford method was used to determine the crude protein content in sample with quite modification as described by (Kruger, 1997).

Working Procedure

5ml of BR solution was taken in a test tube. Then 100µl of sample solution was added to BR solution and mixed using vortex mixer. It was allowed to incubate for five minutes. Then absorbance was measured at 595nm against sodium chloride blank. A standard curve was prepared using BSA solution.

Calculation

The protein content of the sample was calculated using prepared standard curve.

3.4.4 Determination of Fat content

Fat content of the sample was determined according to the method (AOAC, 2004) as described below.

Working procedure

The dried sample remaining after moisture determination was taken in tracing paper and transferred to thimble. Top of thimble was then tightly plugged with fat free cotton. The thimble was dropped into the extraction tube attached to a Soxhlet flask. Roughly, 90-120ml of anhydrous petroleum ether was poured into the Soxhlet flask. The top of the fat extraction tube was attached to the condenser. The sample was extracted for 16hr on heater at 70-80^{o}C. At the end of fat extraction, the thimble was removed from extraction tube, and most of the ether was distilled off by allowing or collected in Soxhlet tube. The ether was poured off when the extraction tube was nearly full. When the ether reached a small volume, it was poured in a previously dried and weighed beaker.

The flask was rinsed and filtered thoroughly, using ether. The ether was evaporated on heater at low heat, and it was then dried at 100°C for 1hour, cooled and weighed. The difference in the weights gave the ether soluble material present in the sample.

Calculation

Fat content was calculated by the following formula:

$$\text{Fat Content}\ (\%) = \frac{\text{Weight of ether extract}}{\text{Sample weight}} \times 100$$

3.4.5 Color measurement

The color attributes (L^*, a^* and b^* values) of the cake samples from the crust of the cakes were measured using a color measurement spectrophotometer (Minolta Camera, Tokyo, Japan).

Working procedure

At first, colorimeter was calibrated where zero calibration was performed first and then white calibration. After that, color values were measured in terms of L^*, a^* and b^* values where L^*, a^* and b^* values indicates lightness, redness and yellowness respectively.

3.4.6 Cross- sectional observation and color determinations of soya cake

The center of each cake was cut lengthwise after cooling the cake and the picture of the section was taken with a digital camera (Sony). The color determinations of the soya cake samples (Crumb only) from the midsection of the cakes were measured using a color spectrophotometer set for L^* (lightness), a^* (redness), b^* (yellowness) and ΔE (total color difference) values. The results of the L^*, a^* and b^* values from three replicates.

$\Delta E = \sqrt{}\ (L_{sample} - S_{tandard})^2 + (\ a_{sample} - s_{tandard)}^2 + (\ b_{sample} - s_{tandard})^2$

3.4.7 Volume determination of soybased cake

The volumes of cakes were determined immediately after baking by the rapeseed displacement method. Baking loss (BL) was determined by weighing cakes 24 h after baking and using the following equation

BL (%) = [(B-C)/IW] × 100

Where, BL is the weight loss during baking, B is the weight (in grams) of batter before baking, C the weight (in grams) of cake after baking and IW is the initial water content (in grams).

Working procedure

At first rapeseeds were poured into a container until it overflowed. The seed was leveled by passing a ruler across the top of the pot once followed by using a measuring cylinder to measure the volume of seeds. Then, a sample was placed in the empty pot and seeds were poured into the pot until it overflowed. The seeds were leveled by passing a ruler across the top of the pot. The seeds were measured by measuring cylinder once again to obtain the volume of the seed around the product (Campbell, *et al*., 1987). Five samples (cake) were used for this test.

Volume of sample = (Volume of empty container (ml) – Volume of seed around the product (ml)

Specific volume of sample (ml) = Volume of sample/ Mass of sample

3.4.8 Preparation of Lipid Extract

The preparation of lipid was according to the modified (Baiano *et al.,* 2005) procedure. The lipid was extracted from sponge cake sample (100 g), mixed with 200mlpetroleum ether in a flask with a stopper, and kept at room temperature over night, then filtered through Whatman No. 1 filter paper. The extracted lipid was stored for subsequent determination.

Peroxide Value

Peroxide value (PV) of extracted lipid was determined according to the GB/T of the Chinese standard (GB/T 5009.37-2003).Three grams lipid samples were mixed with a mixture of chloroform and acetic acid (2:3) solution. Then, 1 ml saturated potassium iodide was added and the solution was kept in the dark for 3 minutes. After stabilization, 100 ml distilled water and 1ml starch solution (1 g 100 mL-1) was added into the solution and titrated with $Na_2S_2O_3$ until reaching the end point (colorless). Peroxide values were calculated as follows:

Where, *V1* is the titration amount of standard volumetric $Na_2S_2O_3$ for the sample (ml); *V2* is the titration amount of standard volumetric $Na_2S_2O_3$ for the blank (ml); *c* is the concentration of standard volumetric $Na_2S_2O_3$ (mol L-1), and *m* is the weight of the sample (g).

Acid Value

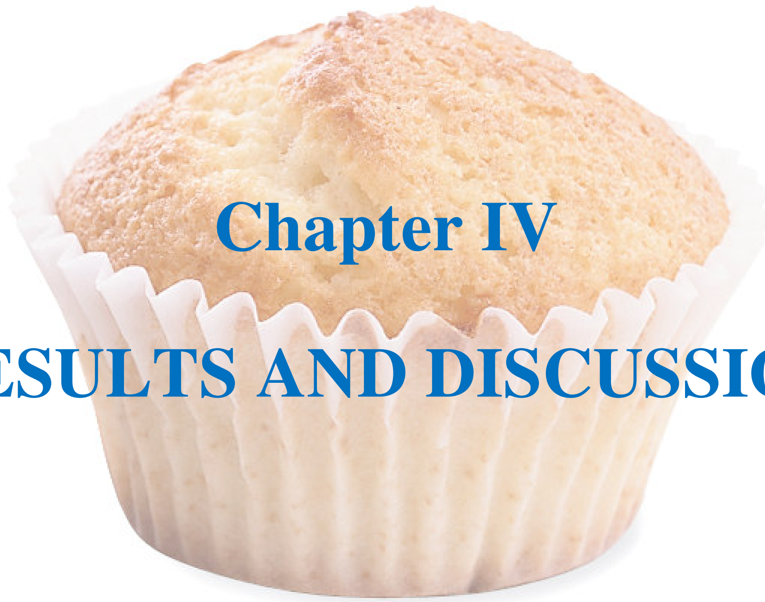
Acid value (AV) of the extracted lipid was determined according to the GB/T of the Chinese standard (GB/T 5009.37-2003). Three grams lipid sample was weighed and 50ml mixture of diethyl ether and ethanol (2:1) was added. Then, 0.1mlphenolphthalein indicator was poured in to the solution. The solution was titrated with0.05 mol L^{-1}KOH until reaching the endpoint (reddish). Acid values were calculated as follows:

$$\text{Acid value} = \frac{v \times C \times 56.1}{m}$$

Where, Vis the titration amount of standard volumetric KOH solution used (ml); c is the concentration of the standard volumetric KOH solution (mol L-1), and *m* is the weight of the sample (g).

3.5 Organoleptic quality of cakes

The sensory evaluation of prepared soya cakes was carried out by a 15 member trained panel comprising of undergraduate and postgraduate students and academic staff members of faculty who had some previous experience in sensory evaluation of bakery products. The panel members were requested in measuring the terms identifying sensory characteristics and in use of the score. Judgments were made through rating products on a 9 point Hedonic Scale with corresponding descriptive terms ranging from 9 ‘like extremely’ to 1 ‘dislike extremely’.



Chapter IV

RESULTS AND DISCUSSION

CHAPTER IV

RESULTS AND DISCUSSION

As considering poor man's meat, soy flour is a good source of protein and has several potentialities for value addition. The results of the studies on soy based cake in terms of physical and compositional properties, storage quality, and standardization and consumer acceptability of value added product are presented in this chapter.

4.1 Proximate composition of wheat - soybean cakes

The nutritional analysis of the cakes indicated that all the cakes contained favorable proportion of protein, fat and other nutritional composition.

Table 4.1 Proximate compositions of prepared cake samples.

Samples	Moisture (%)	Protein (%)	Fat (%)	Ash (%)	Carbohydrate (%)
T1	12.81±0.20^{a}	12.55±0.07^{d}	21.51±0.01^{e}	1.71±0.00^{c}	51.40±0.28^{a}
T2	12.56±0.06^{b}	15.04±0.10^{c}	27.73±0.04^{d}	1.58±0.05^{c}	43.08±0.16^{b}
T3	11.00±0.02^{c}	18.06±0.43^{b}	27.95±0.01^{c}	1.92±0.01^{bc}	40.17±0.43^{c}
T4	11.94±0.03^{c}	19.08±0.69^{b}	28.40±0.01^{b}	2.2±0.08^{b}	38.38±0.81^{c}
T5	11.88±0.02^{c}	21.21±1.55^{a}	32.90±0.01^{a}	2.88±0.33^{a}	31.13±1.92^{d}

Mean ± standard deviation values (n = 5) followed by a different lower-case letter within the same column are significantly different (*P* <0.05) by Duncan's multiple range test.

4.1.1 Moisture

The highest moisture content of 12.81% was observed in control cake. The results showed that the moisture content gradually decreased from 12.81 to 11% with the increase of soy flour from 0 to 10% as shown in table 4.1. 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 moisture content of the cake decreased with the increasing amount of soy flour in the blend due to low moisture content of the beans. This is an agreement with the findings of (Sutharshan *et al*., 2001) who reported that increase in proportion of soy flour reduces the moisture content of the soy bean flour supplemented cake. But suddenly the moisture content increased 11 to 11.94% with increase of soy flour from 10 to 15%.The moisture content of the cake increase with the increase in supplementation this is could be due to the fact that soya and wheat flour absorb moisture in baked product.

4.1.2 Protein content

The basic use of soy flour as an economical protein supplement in cake, biscuit, bread, pasta and other cereal products, hence the soybean protein is an excellent complement to lysine-limited cereal protein (Hegstad, 2008).The protein content of the cakes were increased from 12.55 to 21.21% (Table 4.1) with the increase in soybean flour from 0 to 20%.

In the flour blend the proportion of soybean increased so that the protein content could be increased. The quantity &quality of protein content of the food product improved by adding of soy flour. Soybean is a high protein legume and incorporation of soy flour inevitable increase the protein content in the cakes. 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).

4.1.3 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 cakes increased from 21.51 to 32.9% with increase in soybean flour from 0 to 20% (Table 4.1). 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 were 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.

4.1.4 Ash Content

These are the inorganic material present in ash. Ash content indicated an estimate of the total mineral content in a given quantity of food substance. From Table 4.1 it is observed that the mineral content of the most preferred composite cake was higher mineral content (2.88) as compare to the control (1.71). The increase in mineral content could be due to the soya flour has higher mineral content as compare to wheat flour.

4.2 Peroxide Value

The peroxide value (PV) was employed for determining the formation of lipid oxidation products during storage of the cakes. The changes in PV of lipids are shown in Table 4.2.

Table 4.2 Peroxide value and Acid value of prepared cake samples.

Storage time(day)	Analysis value	Samples T1	T2	T3	T4	T5
0	PV	11.02±0.03	10.11±0.13	8.52±0.23	6.17±0.11	4.05±0.42
	AV	2.62	2.13	2.07	1.78	1.75
7	PV	13.62±0.01	10.92±0.07	9.19±0.06	8.01±0.53	5.11±0.15
	AV	2.09	1.78	1.71	1.28	1.32
14	PV	16.45±0.06	12.02±0.04	11.08±0.02	9.92±0.51	7.31±0.07
	AV	1.72	1.22	1.35	1.07	0.99
20	PV	17.22±0.12	13.96±0.17	11.82±0.34	11.32±0.22	8.82±0.18
	AV	1.26	1.03	1.11	0.98	0.81

Peroxide values are mean ± standard deviation for (n=5) samples, PV in mEq/kg and AV in mlequiv O_2/ Kg

PV range of 10-20 mEq/kg indicate that food product is considered rancid but still acceptable, while more than 20 mEq/kg, the food product will considered already rancid and unacceptable to consume (Pearson, 1970). In present study, all samples were considered not rancid and still acceptable. Among all samples, the cakes treated with marjoram showed the lowest PV throughout storage period than control sample. These results suggested that soy flour were effective in suppressing the oxidation of cakes. Similar findings have been reported by (Lu *et al.,* 2010); however, they did not study the changes of PV during long period. This result indicated that lipid oxidation in cakes could be inhibited by the use of antioxidant activity (Juskiewicz *et al.,* 2008).This result is slightly less with green tea having high anti oxidative and radical-scavenging activity (Almajano *et al.,* 2008 and Huvaere *et al.,* 2011).

4.3 Acid Value

The acid value (AV) measures free fatty acids and is usually considered to be one of the main parameters reflecting the quality of food during the storage period (Rao *et al.,* 2009). The effect of changes in formulation of lipids is shown in Table 4.2.Acid value of the control and others concentrations samples at zero time were 2.62, 2.13, 2.07, 1.78 and 1.75 mlequiv O_2/ Kg., after three weeks of storage they changed to 1.26, 1.03, 1.11, 0.98 and 0.81 ml equiv. O_2 /kg respectively. Wagdy and Taha (2012) reported that acid value (AV), IV and PV of the control butter cake was fortified with jojoba hull at zero time were 0.71%, 37.60 g/100g , and 2.7 ml equivalent O_2/ Kg., after three weeks of storage changed to3.88%, 19.63 g/100g, and 15.37ml. equiv. O_2/kg, respectively. The increase in AV when compared to control at zero time is explained by the hydrolysis of the oil to free fatty acids which will lead to further formation of aldehydes and ketones (Kun, 1988).

4.4 Physical characteristics of prepared cake samples

4.4.1 Crust and crumb color

All color data are expressed as Hunter L, a, and b values corresponding to lightness, redness, and yellowness respectively. The crumb and crust color of sample were affected by replacement of cake flour with soy flour (Table 4.3).

In general, as soy flour level increased, the crust color became darker, as measured by the color spectrophotometer. The crust of the control (T1) cake was lighter and more yellow compare with the other samples. There was significant difference in crust color of samples and T3 sample contained more similarities to control sample (T1). For crust color as the percentage of soy flour increased L and a values slightly increased, but the total color difference ΔE value showed and increasing trend, indicating that a darker, redder and deep yellow crust was obtained as result of soy flour substitution.

On the other hand, the crumb color became darker as the increasing of percentage of soy flour. The crumb of control (T1) cake was lighter yellow compare with the other cake samples. Im and Kim (1999) also reported that for crumb color, the addition of green tea powder or chive powder caused L and a value increased.

Table 4.3 Physical characteristics of prepared cake samples.

Properties	T1	T2	T3	T4	T5
Crust color					
L	34.7±1.67[b]	44.8±0.47[a]	43.85±0.39[a]	38.67±3.34[ab]	32.44±3.2[ab]
A	13.84±0.56[a]	16.38±1.04[a]	17.1±0.59[a]	13.66±1.21[a]	15.11±1.66[a]
B	23.6±1.26[b]	32.56±1.51[a]	30±0.97[a]	28.12±1.90[ab]	26.49±2.1[ab]
ΔE	109.87±1.03	98.71±1.26	100.04±.95	105.60±1.13	108.27±1.34
Crumb color					
L	51.17±0.81[a]	59.86±3.6[a]	58.41±3.3[a]	56.02±4.6[a]	63.45±5.6[a]
A	4.97±0.79[a]	2.1±0.16[c]	2.83±0.27[bc]	3.51±0.23[b]	3.72±0.18[b]
B	29.31±2.0[a]	26.01±1.72[ab]	23.49±0.83[b]	25.32±1.37[ab]	26.09±1.33[ab]
ΔE	106.96±1.72	108.96±1.53	110.22±1.27	109.12±1.9	106.99±0.1
Weight (g)	28.46	35.26	35.71	38.4	42.5
Volume (cm^3)	65.0	74.5	75.0	80.4	83.7
Sp. Volume (g/cm^3)	2.28	2.11	2.10	2.09	1.97
Firmness (kg/min)	0.29±0.02[a]	0.316±0.01[a]	0.32±0.03[a]	0.42±0.11[b]	0.82±0.34[c]

Mean ± standard deviation values (n = 5) followed by a different lower-case letter within the same column are significantly different (P <0.05) by Duncan's multiple range test.

Browning degrees by amino carbonyl reactions and pyrolysis are reported to influence the chromaticity of prepared cake. In the case of adding a powder different from flour, browning is influenced by the type and color of the added flour, in addition to the folding process in confectioneries and the baking of products (Shin, Choi and Kwon, 2007)

4.4.2 Weight, volume & Specific volume of prepared cake samples

According to (Table 4.3) cake volume increased as the soy flour percentage increased. During the baking process, baking powder generates gasses, which should be retained in order to guarantee good cake volume, and in that respect flour quality has an important role to play.

The specific volume of the samples gradually decreased with the increasing of soy percentage of cake. Howard *et al.* (1972) pointed out for layer cakes, whereas Mizukosh *et al.* (1997) reached the same conclusion for sponge cakes. On the contrary, no significant effect was observed due to the kind of soy flour on volume in prepared cakes. These results indicated the lower effects of the changes in soy flours in cakes.

4.4.3 Firmness of cake

Cake prepared without soy flour had lower firmness than cake prepared with soy flour. From table (4.3), the firmness of prepared soy based cake samples ranges from 0.31 to 0.89 kg/min. Firmness depends on transfer of water from moist to dry zone into cake. Another one is starch retro gradation (Zhou *et al.,* 2011).

4.5 Sensory analysis

Sensory attributes like color, flavor, texture, taste and overall acceptability of prepared soy based cakes were evaluated by using 15 experienced panelists. Mean score for sensory evaluation of soy based cakes were given in (Table 4.4).

Table 4.4: Mean score of sensory attributes of soya based cakes

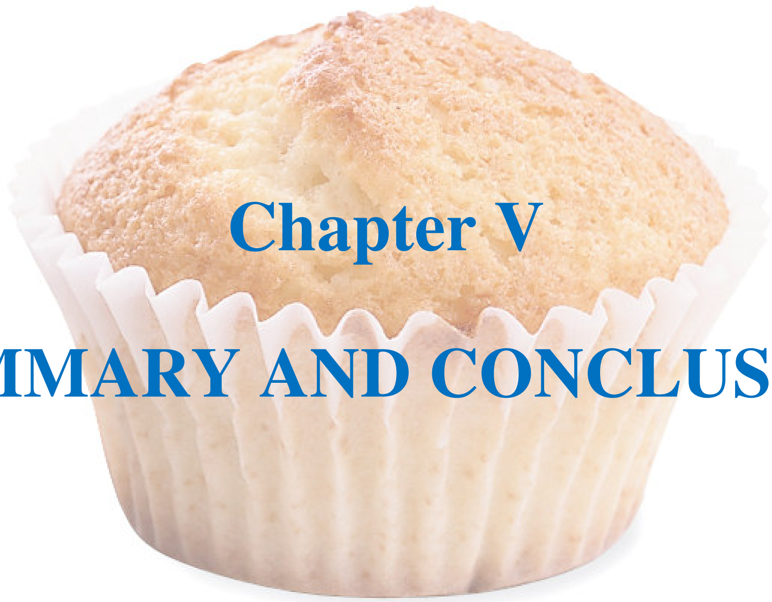
Sample	Color	Flavor	Texture	Taste	Overall acceptability
T1	7.67 ± 0.62^{ab}	7.93 ± 0.88^{a}	8.20 ± 0.68^{a}	8.20 ± 0.68^{a}	8.20 ± 0.86^{a}
T2	8.33 ± 0.62^{a}	7.93 ± 0.70^{a}	7.73 ± 0.70^{ab}	8.13 ± 0.74^{a}	7.67 ± 0.98^{a}
T3	7.93 ± 0.88^{ab}	7.53 ± 0.63^{a}	7.47 ± 0.92^{ab}	7.67 ± 1.29^{a}	7.87 ± 0.83^{a}
T4	7.87 ± 0.91^{ab}	7.27 ± 0.79^{a}	7.20 ± 0.68^{b}	6.80 ± 1.52^{b}	7.67 ± 0.98^{a}
T5	7.53 ± 1.25^{b}	7.33 ± 1.39^{a}	5.53 ± 1.59^{c}	5.40 ± 1.35^{c}	5.27 ± 1.33^{b}

From Table 4.4 the sensory analysis of cake for color (ANOVA) shows that there was slightly significance difference among the samples (Appendix I). The color of the ranked of control treatment T1 (8.33) at top due to excellent appearance, whereas T2 (7.93), T3 (7.67) and T4 (7.87) while minimum color was observed in T5 (7.53). The mean score of color had been decline from 8.33 to 7.53 with increasing level of substitution. Due to color change of cake from light brown to dark brown which leads to lower acceptance (O latidoye op *et al.,* 2011). The non enzymatic reaction (Maillard reaction) between reducing sugar molecules and lysine protein occurs so that the color may be darker (Dhingra and Jood, 2000).

There were no significant differences in terms of flavor among the five cake samples. Flavor of cake decreased from 7.93 to 7.33 with increasing in the substitution of soybean flour. This could be due to the beany flavor of soy flour (Akubor and Ukwuru, 2005). The texture of the cake was related to the external appearance which implies smoothness or roughness of the crust. The texture of crust was decreased from 8.20 to 5.53 with the increased in substitution of soybean flour from 0 to 20% to the cakes. The control treatment had the highest mean value and 20% soy flour added cake had the least mean value.

Taste is the important factor which determines the acceptability of any product, which has the highest impact as far as market success of product. The score for taste had also been decreased from 8.2 to 5.40 with the increased in the level of substitution of soy flour. Cake containing 20% soybean flour was the poorest in taste (5.40). The control treatment (T1) has the highest mean value and 20% soy flour added cake (T5) has the least mean value.

Overall acceptability includes many implications, which is the important parameter in organoleptic estimation. The 10% soy flour added cake had the highest mean value and 20% soy flour added cakes had the least mean value for the overall acceptability. At 10% level of soy flour incorporation, cakes had higher scores for all the sensory attributes evaluated. Above this level, cakes received lower sensory scores.



Chapter V

SUMMARY AND CONCLUSION

CHAPTER V

SUMMARY AND CONCLUSION

Soy based cake has much more nutritional quality than previously thought since the protein, carbohydrates, fibre, potassium and magnesium contents observed in this study were quite high. Significant difference was found in organoleptic quality of cakes and T_3 sample (15% replacement of refined wheat flour with soy flour) has more acceptances in terms of color, texture and taste from other samples. Though the color values L^*, a^*, b^* are nearly same but as the percentage of soy flour increased, the color become dark. The volume and firmness of cake samples gradually increased with the percentage of soy flour. The peroxide value and acid value was slightly increased of soy based cakes that refined wheat flour cake and keep good after 20 days. In the point of nutritional view though the cake samples were slightly dark but had more protein as sufficient as to supply as school tiffin.

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APPENDICES

APPENDICES

Appendix I

Rating score for color of prepared cake samples.

No. of Panelists	Sample T1	Sample T2	Sample T3	Sample T4	Sample T5
1	7	8	9	8	8
2	8	9	9	8	8
3	7	8	6	8	8
4	8	9	8	7	8
5	8	6	8	9	6
6	9	8	7	8	7
7	9	8	7	8	8
8	9	9	7	7	9
9	8	7	8	8	8
10	9	7	9	9	8
11	8	7	9	7	8
12	8	8	8	8	7
13	8	8	7	7	8
14	9	8	7	8	6
15	9	8	7	8	6
Total	124	118	116	118	113
Mean	8.3	7.87	7.73	7.87	7.53

Appendix II

ANOVA (Analysis of variance) for color of prepared cake samples.

Source of variance	Degree of Freedom	Sum of squares	Mean square	F-value (Calculated)
Sample	4	5.200	1.300	1.641
Error	70	55.467	0.792	
Total	74	60.667		

DMRT (Duncan's Multiple Range Test) for color of prepared cake samples.

Types of sample	Original order of means	Types of sample	Ranked order of means
T_1	8.33^{a}	T_1	8.33^{a}
T_2	7.87^{ab}	T_2	7.87^{ab}
T_3	7.73^{ab}	T_4	7.87^{ab}
T_4	7.87^{ab}	T_3	7.73^{ab}
T_5	7.53^{b}	T_5	7.53^{b}

Appendix III

Rating score for flavor of prepared cake samples.

No. of Panelists	**Sample T1**	**Sample T2**	**Sample T3**	**Sample T4**	**Sample T5**
1	7	8	9	7	6
2	8	9	8	8	5
3	7	8	6	6	6
4	8	9	8	7	5
5	8	6	8	7	6
6	8	8	7	8	6
7	8	8	7	7	4
8	8	9	7	7	4
9	8	7	8	8	6
10	8	8	8	7	5
11	8	7	8	7	6
12	8	8	8	8	5
13	8	8	7	7	4
14	9	8	7	8	6
15	8	8	7	7	5
Total	119	119	113	109	79
Mean	7.93	7.93	7.53	7.26	5.2

Appendix IV

ANOVA (Analysis of variance) for flavor of prepared cake samples.

Source of variance	Degree of Freedom	Sum of squares	Mean square	F-value (Calculated)
Sample	4	66.453	16.613	22.307
Error	70	52.133	0.745	
Total	74	118.587		

DMRT (Duncan's Multiple Range Test) for flavor of prepared cake samples.

Types of sample	Original order of means	Types of sample	Ranked order of means
T_1	7.93^a	T_1	7.93^a
T_2	7.93^a	T_2	7.93^a
T_3	7.53^a	T_3	7.53^a
T_4	7.27^a	T_4	7.27^a
T_5	5.40^b	T_5	5.40^b

Appendix V

Rating score for taste of prepared cake samples.

No. of Panelists	Sample T1	Sample T2	Sample T3	Sample T4	Sample T5
1	9	8	9	7	6
2	8	9	8	6	5
3	9	8	8	6	6
4	8	9	8	7	5
5	8	9	8	7	6
6	8	8	7	6	6
7	8	8	7	7	5
8	8	9	8	7	5
9	8	7	8	8	6
10	8	8	9	7	5
11	8	7	8	7	6
12	8	8	8	6	5
13	8	8	9	7	4
14	9	8	7	7	6
15	8	8	9	7	5
Total	123	122	121	102	81
Mean	8.2	8.13	8.07	6.8	5.4

Appendix VI

ANOVA (Analysis of variance) for taste of prepared cake samples.

Source of variance	Degree of Freedom	Sum of squares	Mean square	F-value (Calculated)
Sample	4	89.253	22.313	19.267
Error	70	81.067	1.158	
Total	74	170.320		

DMRT (Duncan's Multiple Range Test) for taste of prepared cake samples.

Types of sample	Original order of means	Types of sample	Ranked order of means
T_1	8.20^a	T_1	8.20^a
T_2	8.13^a	T_2	8.13^a
T_3	8.07^a	T_3	8.07^a
T_4	6.80^b	T_4	6.80^b
T_5	5.40^c	T_5	5.40^c

Appendix VII

Rating score for texture of prepared cake samples.

No. of Panelists	Sample T1	Sample T2	Sample T3	Sample T4	Sample T5
1	8	8	6	8	6
2	8	8	8	6	6
3	9	8	8	6	6
4	8	6	8	8	7
5	8	8	8	7	6
6	8	8	7	6	6
7	9	8	7	8	5
8	8	6	8	7	5
9	8	7	8	8	5
10	8	8	6	7	5
11	8	8	8	8	5
12	9	8	8	6	5
13	8	8	9	7	6
14	8	9	7	8	5
15	8	8	6	8	5
Total	123	116	112	108	83
Mean	8.2	7.73	7.46	7.2	5.53

Appendix VIII

ANOVA (Analysis of variance) for texture of prepared cake samples.

Source of variance	Degree of Freedom	Sum of squares	Mean square	F-value (Calculated)
Sample	4	61.947	15.487	16.132
Error	70	67.200	0.960	
Total	74	129.147		

DMRT (Duncan's Multiple Range Test) for texture of prepared cake samples.

Types of sample	Original order of means	Types of sample	Ranked order of means
T_1	8.20^{a}	T_1	8.20^{a}
T_2	7.73^{ab}	T_2	7.73^{ab}
T_3	7.47^{ab}	T_3	7.47^{ab}
T_4	7.20^{b}	T_4	7.20^{b}
T_5	5.53^{c}	T_5	5.53^{c}

Appendix IX

Rating score for overall acceptability of prepared cake samples.

No. of Panelists	Sample T1	Sample T2	Sample T3	Sample T4	Sample T5
1	8	8	9	6	6
2	9	6	8	6	6
3	9	8	7	6	5
4	8	6	8	8	6
5	8	8	8	7	5
6	6	6	9	7	6
7	9	8	8	7	5
8	9	6	8	7	5
9	8	7	8	7	5
10	8	6	8	7	4
11	8	8	7	8	5
12	9	6	8	6	5
13	8	6	9	7	6
14	7	7	7	8	5
15	9	8	9	6	5
Total	123	104	121	103	79
Mean	8.2	6.93	8.07	6.86	5.26

Appendix X

ANOVA (Analysis of variance) for overall acceptability of prepared cake samples.

Source of variance	Degree of Freedom	Sum of squares	Mean square	F-value (Calculated)
Sample	4	83.733	20.933	19.555
Error	70	74.933	1.070	
Total	74	158.667		

DMRT (Duncan's Multiple Range Test) for overall acceptability of prepared cake samples.

Types of sample	Original order of means	Types of sample	Ranked order of means
T_1	8.20^a	T_1	8.20^a
T_2	6.93^b	T_3	8.07^a
T_3	8.07^a	T_2	6.93^b
T_4	6.87^b	T_4	6.87^b
T_5	5.27^c	T_5	5.27^c