# EFFECTS OF PEELING METHODS ON MINERAL CONTENT OF POTATO AND DEVELOPMENT OF POTATO BASED BISCUIT



**A**

**THESIS**

**BY**

MD. ATIKUR RAHMAN
Student no. 1205040
Session: 2012-2013
Semester: January-June, 2013

**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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JUNE, 2013

DEDICATED TO
MY
BELOVED PARENTS

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*The Author*

**ABSTRACT**

An attempt was taken to select the effective methods of peeling of potatoes based on mineral contents and to formulate biscuits using potato flour together with wheat flour. Fresh potatoes, potatoes peeled before and after boiling were analyzed for their mineral content. Calcium (Ca), Magnesium (mg), Potassium (K), Phosphorus (P), Iron (Fe) and Zinc (Zn) contents were found 9.40 mg/100g, 21.6 mg/100g, 413.91 mg/100g, 60.57 mg/100g, 0.78 μg/100g and 0.29 μg/100g, respectively in fresh potatoes; 6.57 mg/100g, 13.09 mg/100g, 360.7 mg/100g, 46.65 mg/100g, 0.69 μg/100g and 0.25 μg/100g, respectively in potatoes peeled before boiling and 8.23 mg/100g, 19.89 mg/100g, 400.78 mg/100g, 59.52 mg/100g, 0.75 μg/100g and 0.25 μg/100g, respectively in potatoes peeled after boiling. On the basis of mineral content potato with peel was selected to produce potato flour to replace wheat flour partially in preparing nutritionally enriched biscuit. Potato flour was blended with wheat flour at levels of 15, 25 and 35 percent in preparation of biscuits with maintaining all other ingredients constant. The proximate composition of the developed biscuits ranged in the values with moisture from 5.0% to 7.30%, protein 9.70% to 15.20%, fat 11.0% to 12.67%, ash 0.99% to 3.13% and carbohydrate 67.0% to 67.81%, respectively. It was also observed that potato four had higher ash content than that of wheat flour which enhanced the ash level of the biscuits produced from the blends. The prepared biscuits were evaluated for sensory quality by Hedonic Rating Test. The sensory evaluation revealed that the biscuits prepared using 25% potato flour were almost equally acceptable as control biscuits and secured the score for colour (6.90), flavor (6.60), taste (6.90), texture (7.50) and overall acceptability (7.20) and ranked as 'like very much'. Biscuits prepared using 35% potato flour secured the lowest score (5.20) in terms of overall acceptability and was unacceptable to the panelist. Potato flour prepared from potato with peel and partial replacement of wheat flour by 25% potato flour produce biscuits of acceptable quality which will afford the consumer to have biscuits of high nutritional value.

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# ABBREVIATIONS AND SYMBOLS

| | |
|---|---|
| *et al.* | : Others |
| ANOVA | : Analysis of Variance |
| AOAC | : Association of Analytical Chemist |
| BBS | : Bangladesh Bureau of Statistics |
| FAO | : Food and Agriculture Organization |
| DMRT | : Duncan's Multiple Range Test |
| T | : ton |
| Kg | : Kilogram |
| G | : Gram |
| μg | : Microgram |
| % | : percent |
| $^0C$ | : Degree celcius |
| $H_2SO_4$ | : Sulphuric acid |
| HCl | : Hydrochloric acid |
| NaOH | : Sodium hydroxide |
| LSD | : Least Significant Difference |

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# CHAPTER I

# INTRODUCTION

# CHAPTER I

# INTRODUCTION

Potato (*Solanum Tuberosum)* belongs to the family Solanaceace or nightshade, occupies an important plant kingdom comprising a large and composition group of about 90 genera and 3000 to 4000 species (Marwaha, 2007). Among plants potato, which directly serve mankind, is so rich in starch that it is the world's most widely grown tuber crop and the fourth largest food crops in terms of fresh produce after rice, wheat and maize (corn), which is taken in our daily diet for the source of calories, vitamins and minerals. Potato is the edible tubers of Solanaceous plant (Wade, 2008). With increasing cropping intensity of Bangladesh, potato tubers are the second only to that of paddy rice. In 2006, Bangladeshi farmers harvested more than 4.1 million tones (12 times more than 1961) which placed 15$^{th}$ position among the world's potato producers and 5$^{th}$ in Asia (FAO, 2008). The per capita consumption of potato in Bangladesh is around 24 kg against the world average 33 kg and a European average of a 120 kg per capita (Khan, 2009).

In Bangladesh potato occupies about 8.5 lakh acres of the total cropped area (339,444,000 acres) and produced 51.67 lakh tons annually (BBS, 2011). Although area of potato under cultivation is 8.5 lakh acres annually still at present, there is an acute shortage of potato production in relation to their demand (Khan, 2009).

Among the carbohydrate rich food crops, potato plays an important role as alternative food materials instead of rice and numerous different types of food preparation (Khan, 2009). Potato is a staple food crop in many countries of the world and emerging as a truly global food. Potato has the highest food value on a dry matter basis and is most nutritious in proportion to its calorie content (Khurana, 1978). The value of this crop as a food security crop and as an insurance against cereal crop failure is recognized. The year 2008 has been declared by the United Nations to create awareness to world people as its value as a staple food, food security and eradicating poverty from the world, mainly from developing countries (Khan, 2009).

Now-a-days in Bangladesh, potato has become a valuable winter cash crop and an alternative food crop instead of rice. The slogan has started to promote it as "Bhater bodoley aloo". Potato has played an important role in meeting the cheap quantitative source as a wholesome food to the large part of humanity especially in the developing countries of Asia, Africa and latin America. In Bangladesh the major source of carbohydrate is rice and wheat of which both are costly and devoid of vitamin C and less micronutrient. Whereas potato supplies dietary energy (60-80 percent of dry matter is starch), vitamin C, $B_1$, $B_3$, $B_6$ and minerals such as potassium, calcium, Iron, phosphorus and magnesium and contain folate, pantothenic acid, riboflavin and also contain dietary antioxidants and on dry weight basis, the protein content is similar to that of cereals and little fat (FAO, 2008) . Poverty is a serious and persistent problem of Bangladesh. Nearly 60-65 percent people lives below poverty line. The malnutrition is widespread in the country due to lack of balanced diet (Hussain, 2008).

For balanced diet potato contains optimum quantity of carbohydrate, protein, fat, vitamins, minerals and some dietary fiber needs no elaboration. To improve the gloomy poverty and malnutrition situation of Bangladesh, more potatoes are to be taken in the daily diets (Khan, 2009).

The potato recipes are nutritious, no other food which is used in so many dishes as potato nearly 200 types. In Bangladesh and some other countries of this sub-continent mashed potatoes are used as 'Aloo Vorta' is very tasty and popular in urban or rural areas to all age group of peoples. The cooked, peeled, diced potato mixed with panchforan, ginger, onion, green chilli and finally keeping those in oval shaped chapaties and finally making triangular or semi-pyramid in shape and cooking it in 10-15 minutes in hot oil (140-160 $^0$C) called Aloo singara which is very popular in restaurants and hotels all over in Bangladesh and also in different parts of the world. Due to its versatile nature of food preparation the term versatility can be attributed to it (Khaliduzzaman, 2010).

Potato is a good food for invalids and infants. It can be used as vegetables and also as substitutes of rice and wheat. Boiled potato of an equal weight of boiled rice contains almost equal and superior protein than rice. The nutritious value is higher than rice. Potato contains significant amount of other vitamins and minerals like niacin, magnesium, zinc etc including other vitamins and minerals. It contains relatively low quantity of sodium. So combination of high potassium and low sodium makes potato an ideal food for people suffering from hypertension (Khan, 2009). Potato also contains assortment of phytochemicals such as carotinoids and polyphenols which provide bulk, offer protection against colon cancer, improve glucose tolerance and insulin sensitivity, lower plasma cholesterol and triglyceride concentration increases satiety and possibly even reduce fat storage (Cummings *et al.,* 1996 and Hylla *et al.,* 1998).

Despite the advantages associated with crop, the bulk of the crop produced has a short storage life (CIP, 1984). Moreover, due to inadequate cold storage capacity, the diversion of potatoes to processed potato products would benefit both growers and consumers, as it would help extend the storage life and serve as a means of increasing the supply in off-seasons (Misra and Kulshrestha, 2003).

Among several processed products, potato flour is the oldest commercial potato products, which can be stored safely and incorporated into various recipes. Potato flour has diversified uses in the home as well as in the food industry, especially, in the baking industry in preparation of bread and biscuits. In Bangladesh, biscuits are now gaining popularity and are no more limited in usage to higher income groups of the population only. Biscuits are more amenable to variation in the formulation to meet a wide spectrum of consumer demands with respect to taste and nutritional requirement. Biscuits wheat and potato flour from a popular carrier of nutrition to vulnerable groups like pregnant and nursing mothers and young children. For preparing biscuits, the flour should contain 8-9.5% gluten but normally wheat flour contain more gluten than the required, so a portion of potato flour can be used easily as a supplement. Potato flour with negligible fat content, high dietary fiber, high vitamins a good amount of minerals and 6-12 percent protein content (Gahlawat and Sehgal, 1998) can be substituted for wheat flour in the preparation of biscuits. This also helps in lowering the gluten level and prevent from Coeliac disease (Tilman *et al*., 2003). Addition of potato flour also enhances the sensory characteristics of biscuits and industries also find it economical to use in biscuits manufacture. Potato flour can be prepared by drying the peeled slices in a hot air dryer into flakes followed by grinding and sieving (Yadav *et al*., 2006).

Considering the information as accumulated the research was conducted to achieve the following objectives.

i) To find out the effective peeling method of potato regards to mineral content and

ii) To formulate biscuits using potato flour with wheat flour.

# CHAPTER II

# REVIEW OF LITERATURE

# CHAPTER II

# REVIEW OF LITERATURE

The literature was reviewed on the following aspects with respect to the proposed research work.

Potato (*Solanum tuberosum* L) is a nourishing food that has sustained civilizations for centuries in South America and Europe. To the inhabitants of Peru and Bolivia, potato was the 'bread of life' for centuries (Marwaha, 2007). Potato production has significantly increased in recent years in many countries, particularly Asia where it has become more important as a food and industrial crop. The per capita consumption of potatoes is very high in European countries; in Belarus it is 653 kg/year and in Poland it is 467 kg/year whereas in Bangladesh the per capita consumption of potato is only 24 kg/year. Thus, there is plenty of scope for increasing the potato consumption in Bangladesh although people are traditionally dependent upon cereals and are generally unaware of the nutritional value of potatoes (Ezekiel *et al.,* 2007)

## 2.1 Production of potato

Potato is one of the important food crops in Bangladesh. It is considered as a vegetable in this country, and contributes alone as much as 55% of the total annual vegetable production (Anonymous, 1996).

Potato is now- a-days commercially grown in almost all countries of the world. At present the crop is being cultivated in a total area of 19,455 thousand hectares of land producing 3,01,552 thousand tons of potato annually in the world (Anonymous, 1993).

**Table 2.1 Production of potatoes in Bangladesh per year (FAOSTAT, 2013)**

| Year | Production (M-tons) |
|---|---|
| 2012 | 8205470 |
| 2011 | 8326389 |
| 2010 | 7930000 |
| 2009 | 5268000 |
| 2008 | 6648000 |
| 2007 | 5167000 |
| 2006 | 5368400 |

## 2.2 Potato Varieties

Potatoes in Bangladesh are sometimes designated as deshi, a term often treated as "local varieties" or "indigenous," Most are relatively low yielding and have longer vegetative cycles than more recently introduced varieties, but are retained by farmers for other factors, such as storage properties and cooking and culinary qualities (Scott, 1985 and Mahfuz-ul-Hoque, 1985).

Following are local varities of potato with local name (Banglapedia: Potato)

- Sheel Bilatee: mostly cultivated in Rangpur, with oblong reddish tubers;
- Lal Sheel , also known as Lal Madda and Bogra*i*: grown primarily in Bogra with rounder and reddish tubers;
- Lal Pakri : widely grown in Dinajpur, Bogra, and Sirajganj districts with round, also reddish tubers;
- Du Hajari: mostly cultivated in the Chittagong area, with round and more pale tubers.

Several dozen of potentially higher yielding varieties (HYVs) have been introduced to Bangladesh. Most have proven unsuitable to local conditions, but several which have been retained have proven capable of much higher average yields.

Khairul and Harsha ( 2011) reported that Diamante is the most widely grown potato variety in most of the potato growing districts followed by Granola, Cardinal, Multa, Binella and Felsina. Other varieties grown in different potato growing zones are Asterix, Patronese, Provento, Ultra, Heera and Dheera. However, among them, mostly the Granola variety is currently being exported because of its appearance, taste and size. There are two different grades for exportable potato (Granola): Grade A: 4-6 tubers/kg and Grade B: 7-10 tubers/kg.

## 2.3 Major potato growing districts

Four districts in Bangladesh produce 60% of total national potato crop on 50% of the land planted for potato: Rangpur, Bogra, Dhaka and Comilla. The greater Dhaka district produces 29% of the potato crop on 19% of the area under potato. The average yield was

14.6 t/ha. Major producing areas are Munsiganj, Tongibari, Sirajdikhan and Joydehpur. The greater Comilla district produces 15% of the national potato crop on 12.7% of the land under potato. Average yield is about 11.2 t/ha. The major producing areas are Chandpur, Chandina and Debidwar.

The greater Bogra district contributes about 8% of the total potato crop on 10.7% of the land under potato. The average yield is about 7.2 t/ha and the main producing areas are Bogra, Sadar and Gabtoli. The greater Rangpur district produces 8.4% of the total potato crop on 9.6% of the land under potato. Its average yield is about 7.2 t/ha and the main producing area is Rangpur Sadar (BBS, 2011).

## 2.4 Composition and nutritive value of potato

Watt and Merrill (1963) reported that the proximate composition of potato as about water 77.5%, protein 2%, fat 0.10%, ash 1% and total carbohydrate 19.2%. Schwimmer and Burr (1967) reported that potato contains 77.5% water, 2% Protein, 0.02% fat, 19.2% carbohydrate, and 1% ash. It also contains ascorbic acid, niacin, thiamin ($B_1$), iron and riboflavin. Schwimmer and Burr (1967) reported the following proximate analysis of potato.

**Table 2.2 Proximate analysis of potato** (Schwimmer and Burr, 1967)

| **Components** | **Composition in average (%)** | **Range (%)** |
|---|---|---|
| Water | 77.5 | 63.2-86.9 |
| Total solid | 22.5 | 13.1-36.8 |
| Protein | 2.0 | 0.7-4.6 |
| Fat | 0.1 | 0.02-0.96 |
| Carbohydrate | 19.2 | 13.3-30.53 |
| Crude fibre | 0.6 | 0.17-3.48 |
| Ash | 1.0 | 0.44-1.9 |

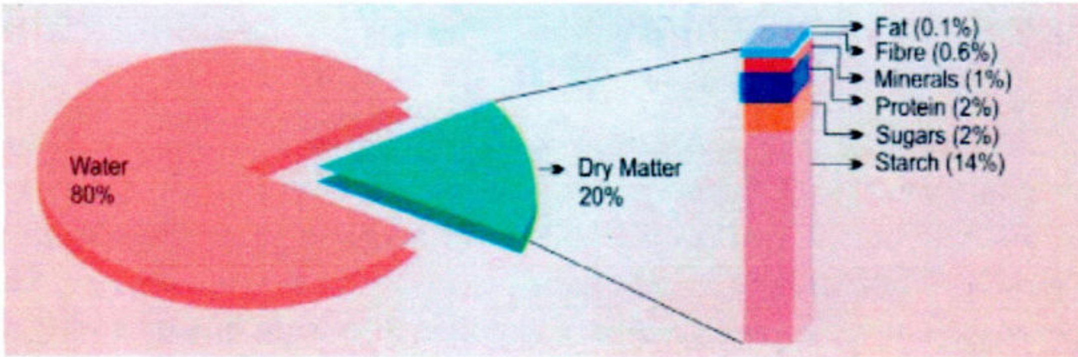


Fig 2.1 Composition of potato tuber (Ezekiel *et al., 2007*)

Potato produces more carbohydrate, fiber and vitamins per unit area and time than other major food crops. Potato is a low energy food. The dry matter content in potato is 47.6 kg/hectare/ day whereas in wheat and rice it is 18.1 kg/ha/day respectively (Fig 2.2). Similarly potato contains 3 kg/ha/day of edible protein as compared to 2.5 and 1.0 kg in wheat and rice, respectively. According to Ezekiel *et al.,* 2007 the mineral content (kg/ha/day) of potato is 3.7 times more than that of wheat and 11.0 times more than that of rice (Table 2.3).

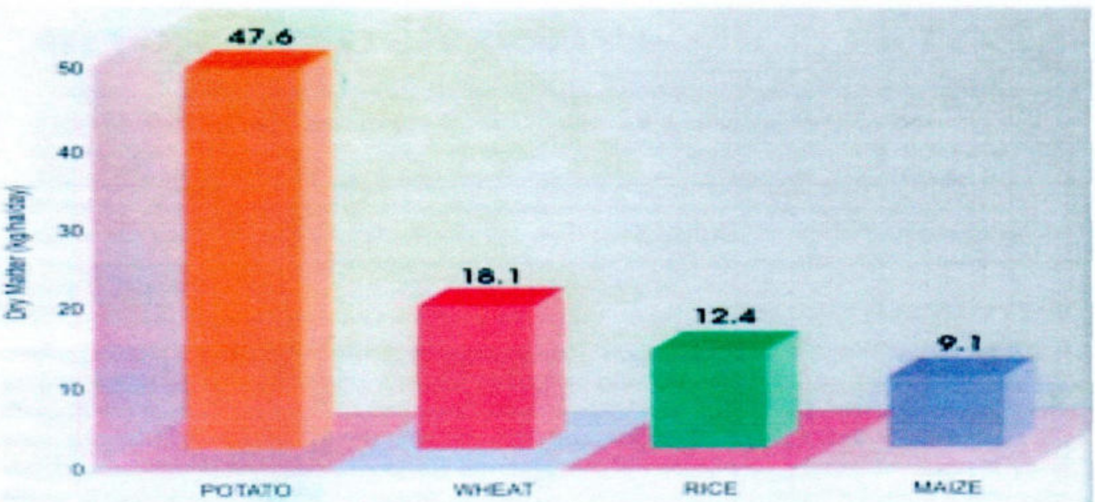


Fig 2.2 Dry matter content of potato and other major cereals

### 2.4.1 Starch

The dry matter content of potato tubers tends to increase from 16% at the time of flowering to 20% when the leaves begin to die. The dry matter is mainly starch and comprises two-thirds of the total solid or dry matter.

### 2.4.2 Sugar

In potato, sucrose is synthesized from carbohydrate in the foliage and transported to the tubers. The forms of sugar present in the tubers are sucrose, glucose and fructose. In mature tubers, these sugars remain in equilibrium with the starch. The sugar content of potato tubers is normally low, but varies greatly in storage under varying temperatures. In general, lower the temperature, the higher the sugar content.

### 2.4.3 Protein

Protein, free amino acids and basic nitrogen are the forms of nitrogen present in potato tubers. Protein exists in potato tubers in both soluble and insoluble forms. The soluble protein constitutes over 50% and insoluble protein about 10% of the total nitrogen content. Potato protein has high nutritional value. Schuphan and Postel (1957) mentioned index values as high as 72 as the biological value of the amino acids of potato protein samples measured against an index value of 100 for a complete protein. The high nutritional value of protein in potatoes is evident when its composition is compared with that of whole wheat (Smith 1968). Potato protein contains substantially greater amounts of all the essential amino acids except histidine, and the amount of lysene in potatoes is similar to that in most animal proteins.

**Table 2.3 Nutritional value of raw potato per 100g** (Anonymous, 2008)

| | |
|---|---|
| Energy | 320KJ |
| Carbohydrate | 19 g |
| Starch | 15 g |
| Dietary fibre | 2.2 g |
| Fat | 0.1 g |
| Protein | 2.0 g |
| Water | 75 g |
| Vitamin | |
| Thiamin | 0.08 mg |
| Riboflavin | 0.03 mg |
| Niacin | 1.1 mg |

| | |
|---|---|
| Vitamin $B_6$ | 0.25 mg |
| Vitamin C | 20 mg |
| Minerals | |
| Calcium | 12 mg |
| Iron | 18 mg |
| Magnesium | 23 mg |
| Phosphorus | 57 mg |
| Potassium | 421 mg |
| Sodium | 6 mg |

### 2.4.4 Enzymes

Enzymes are proteins of high molecular weight. Enzymes present in potato include hydrolase, lyase, transferase, isomerase, synthetase and polyphenoloxidase. The activity of polyphenoloxidase is important in potato.

### 2.4.5 Fats

The fat content in potato tubers is low; it varies from 0.02 to 0.19% of fresh weight (Lampitt and Goldenberg 1940).

### 2.4.6 Minerals

According to Ayesha, 2012 that the minerals present in potato are potassium, phosphorus, magnesium, sulphur, chlorine, calcium, iron, silicon, zinc, boron, bromine, aluminium, sodium, manganese, iodine, fluorine, copper, cobalt, arsenic, lithium, molybdenum and nickel. Some of these minerals are essential elements, or are catalytic agents in metabolic processes, while others happen to be present in the soil in which the crop has been grown. Elements that may be found in larger quantities are potassium, phosphorus, magnesium, sulphur, chlorine, iron and zinc. calcium, phosphorus and iron are considered most important to the nutritional value of potato tubers. It has been reported that soil type and fertilizer content of soil can cause variations in the mineral content of potato tubers. The variation of some of these elements in potato tubers is shown in Table 2.4.

**Table 2.4 Variations in the mineral contents of potatoes** (Lampit and Goldenberg, 1940)

| Element | Maximum variation in100 gram dry matter of potato tuber |
|---|---|
| Potassium | 1394 - 2825 mg |
| Calcium Chlorine | 44.7 - 805 mg |
| Phosphorus | 119 - 605 mg |
| Magnesium | 45.9 - 216.5 mg |
| Sulphur | 42.7 - 423 mg |
| Silicon | 5.1 - 17.3 mg |
| Iron | 2.61 - 71.5 mg |
| Zinc | 1.74 - 2.17 mg |

### 2.4.7 Acids

The pH value of potato tubers ranges from 5.7 to 6.1 (i.e., slightly acidic). The acidity varies from variety to variety. Citric acid is the most important acid. Oxalic, malic and tartaric acids, and some vitamins such as ascorbic and nicotinic acids have also been found in potato tubers.

### 2.4.8 Vitamins

According to Ayesha, 2012 potato tubers contain the vitamin groups A, B and C, and therefore are considered to be good sources of vitamins compared with cereals and other vegetables. B vitamins are water soluble and may be lost if the tuber is boiled. Growing tubers have high thiamin content. Riboflavin (vitamin B,) is usually present in much smaller amounts. Vitamin C is an important constituent of potato tubers and is present in large quantities.

## 2.5 IMPORTANCE OF THE MINERAL ELEMENTS

### 2.5.1 Calcium

Calcium acts as a constituent of bones and teeth, regulation of nerve and muscle function. In blood coagulation, calcium activates the conversion of prothrombin to thrombin and also takes part in milk clotting. It plays a vital role in enzyme activation. Calcium activates large number of enzymes such as adenosine triphosphatase (ATPase), succinic dehydrogenase, lipase etc. It is also required for membrane permeability, involved in muscle contraction, normal transmission of nerve impulses and in neuromuscular excitability. A reduced extracellular blood calcium increases the irritability of nerve tissue, and very low levels may cause spontaneous discharges of nerve impulses leading to tetany and convulsions (Hays and Swenson, 1985; Malhotra, 1998; Murray *et al*., 2000).

In children, calcium deficiency causes rickets due to insufficient calcification by calcium phosphate of the bones in growing children. The bones therefore remain soft and deformed by the body weight. In adults, it causes osteomalacia, a generalized demineralization of bones. It may also contribute to osteoporosis, a metabolic disorder resulting in decalcification of bone with a high incidence of fracture, that is, a condition where calcium is withdrawn from the bones and the bones become weak and porous and then breaks (Hays and Swenson, 1985; Malhotra, 1998 and Murray *et al*., 2000).

Calcium deficiency also affects the dentition of both children and adult. Toxicity symptoms occur with excess absorption due to hypervitaminosis D or hypercalcaemia due to hyperparathyroidism, or idiopathic hypercalcaemia. Excess calcium depresses cardiac activity and leads to respiratory and cardiac failure; it may cause the heart to stop in systole, although, normally, calcium ions increase the strength and duration of cardiac muscle contraction. Excess calcium and phosphorus are excreted by the kidney. Ca and P excreted in faeces are largely the unabsorbed dietary minerals; some comes from the digestive juices, including bile (Hays and Swenson, 1985).

Sources of calcium include Beans, lentils, nuts, leafy vegetables, dairy products, small fishes including sardines, bones, etc.

### 2.5.2 Phosphorus

Phosphorus is located in every cell of the body and is vitally concerned with many metabolic processes, including those involving the buffers in body fluids (Hays and Swenson, 1985).

Phosphorus is essential for bones, teeth, adenosine triphosphate (ATP), phosphorylated metabolic intermediates and nucleic acids. It serves buffering action, that is, phosphate buffers, functions in the formation of high energy compounds, that is, adenosine triphosphate (ATP) and is involved in the synthesis of phospholipids and phosphoproteins. Practically, every form of energy exchange inside living cells involve the forming or breaking of high-energy bonds that link oxides of phosphorus to carbon or to carbon-nitrogen com-pounds (Hays and Swenson, 1985; Malhotra, 1998; Murray *et al.*, 2000).

Decrease in serum phosphorus is found in rickets, hyperparathyroidism. Deficiency disease or symptoms in children causes rickets and in adults, it causes osteomalacia. Increase in serum phosphorus is found in chronic nephritis and hypoparathyroidism. Toxicity disease or symptoms include low serum Ca2+: P ratio. It may also lead to bone loss (Malhotra, 1998; Murray *et al.*, 2000).

Sources of phosphorus include phosphate food additives, green leafy vegetables and fruits, especially banana.

### 2.5.3 Potassium

Potassium is the principal cation in intracellular fluid and functions in acid-base balance, regulation of osmotic pressure, conduction of nerve impulse, muscle contraction particularly the cardiac muscle, cell membrane function and Na+/K+-ATPase. Potassium is also required during glycogenesis. It also helps in the transfer of phosphate from ATP to pyruvic acid and probably has a Deficiency disease or symptoms occurs secondary to illness, functional and structural abnormalities including impaired neuromuscular functions of skeletal, smooth, and cardiac muscle, muscular weakness, paralysis, mental confusion (Hays and Swenson, 1985; Malhotra, 1998; Murray *et al.*, 2000).

The kidney, resulting in the inability to concentrate urine, and also causes alterations of gastric secretions and intestinal motility (Streeten and Williams, 1952).

The rapidly growing animals apparently have a higher requirement for potassium, and increasing the protein level increases the requirement. Plant products contain many times as much potassium as sodium. Sources include vegetables, fruits, nuts.

### 2.5.4 Magnesium

According to Theodore and Labuza (1977) magnesium is the last major minerals found in the body. Its distribution is similar to that of phosphorus, about 70 percent in the skeleton and 30 percent in the tissues. The RDA for magnesium is 350 milligrams per day. It is present in all foods. It is highest in cereals and vegetables. The magnesium has a demand for muscle contraction act as a cofactor for some of the enzyme system that takes part in the Krebs Cycle. Magnesium is also involved in nerve transmission.

### 2.5.5 Zinc

Theodore and Labuza (1977) mentioned that zinc is associated with many enzymes that help to manufacture stomach acid leading to breakdown of alcohol in the body which helps in the metabolism of the nucleic acids. The RDA of zinc for children is 10 milligrams and 15 milligrams for adults. At lower levels of zinc leading to delay in puberty in males. Zinc is found in meats, liver, eggs and shellfish at about two to six milligrams per 100 grams. Cereals contain about 0.5 milligrams per 100 grams. Theodore and Labuza (1977)

### 2.5.6 Iron

According to Theodore and Labuza (1977) iron is the most important trace elements for man. It is important part of the haemoglobin molecule, which picks up the oxygen in the lungs. Iron is also part of some enzyme systems and myoglobin. Myoglobin is the chemical that gives meat and muscles a red colour. As the iron reacts with oxygen it slowly turns the meat brown which is the colour associated with meat. The iron requirement is affected by various factors as blood cells break down, iron can be lost into the urine and excreted. Women also lose considerable iron as a result of blood loss in menstruation. The RDA of iron for males is 10 milligrams and 18 milligrams for women. Iron deficiency anemia may be one of the most prevalent forms of nutritional disease. If iron consumption is inadequate, the number of red blood cells, which contain the hemoglobin, is reduced, and the levels of hemoglobin may also go down. Thus, not enough oxygen can be brought to the cells.

## 2.6 Composition and nutritive value of potato flour and wheat flour

Mollik and Shams-Ud-Din (2007) analyzed the meal flour for chapatti making for moisture, protein, fat, ash, carbohydrate contents and the results are presented in table 2.6 shown below. The authors found the whole meal flour contained moisture 13.63%, protein 11.44%, fat 0.88%, ash 1.15% and total carbohydrate 72.9%. The analysis for proximate composition of potato flour reported by Schwimmer and Barr (1967) shown in table 2.6 showed that the potato flour contained moisture 11.5%, protein 5.5%, fat 0.87%, ash .40%, crude fibre 4.30% and total carbohydrate 75.43%.

**Table 2.5 Composition of whole meal flour and potato flour** (Schwimmer and Barr, 1967)

| Components | Whole meal flour (%) | Potato flour (%) |
|---|---|---|
| Moisture | 13.63 | 11.5 |
| Protein | 11.44 | 5.50 |
| Fat | 0.88 | 0.87 |
| Ash | 1.15 | 2.40 |
| Gluten | 12.55 | -- |
| Crude fibre | 1.8 | 4.30 |
| Total carbohydrate (by difference) | 72.9 | 75.43 |

**Table 2.6 Nutrient value per 100 g of potato flour** (Ayesha, 2012)

| Nutrient factor | Content | Unit |
|---|---|---|
| Energy, calculated | 1535 | KJ |
| Carbohydrate, available | 73.5 | G |
| Fat, total | 4.3 | G |
| Protein, total | 5.7 | g |
| Alcohol | 0 | g |

**Table 2.6.1 Carbohydrate components per 100g of potato flour** (Ayesha, 2012)

| **Carbohydrate component** | **Content** | **Unit** |
|---|---|---|
| Organic acid, total | 2.3 | G |
| Starch, total | 67.4 | g |
| Sugars, total | 6.1 | g |
| Sucrose | 0.5 | g |
| Lactose | 4.2 | g |
| Fructose | 0.70 | g |
| Sugar alcohol | 0 | g |
| Fiber, total | 6.7 | g |
| Fiber, water soluble | 4.8 | g |
| Poilysaccharides, non-cellulosic, water soluble | 1.9 | g |
| Glucose | 0.7 | g |
| Maltose | 0 | g |

**Table 2.6.2 Fats found in per 100g of potato flour** (Ayesha, 2012)

| Fats | Content | Unit |
|---|---|---|
| Fatty acid, total calculated as TAG | 2.9 | g |
| Fatty acid, total | 2.8 | g |
| Fatty acid, saturated | 1.0 | g |
| Fatty acid, monosaturated cis | 1.3 | g |
| Fatty acid, polyunsaturated | 0.1 | g |
| Fatty acid, totaltrans | 0.4 | g |
| Linoleic acid | 80 | mg |
| Alpha-linolenic acid | 22 | mg |

| | | |
|---|---|---|
| Ecosa Pentanoic acid (EPA) | 0 | g |
| Docusa hexanoic acid(DHA) | 0 | g |
| Cholesterol (GC) | 2.6 | g |
| Sterol, total | 21.6 | g |

## 2.7 Potato products

Woolfe (1987), and Gopal and Khurana (2006) reported that Potatoes are prepared by consumers in an overwhelming variety of means. Baking, boiling, dehydrating, and frying are employed world-wide. Examples of commercial potato products are listed below

## 2.8 Drying method for making potato flour

Kamal *et al.* (2002) studied the physicochemical properties of potato flour made from boiled and raw tubers of the variety Kufri Jyoti. Tubers were steam-cooked, peeled, hand sliced and sun-dried in the first method while 1.5-3 mm thick slices from raw potatoes were dipped in 0.5% acetic acid solution for 15 minutes and then sun-dried in the second. The dried slices in

**Table 2.7 Processed potato products** (Woolfe 1987, and Gopal and Khurana , 2006)

| Category | Products |
|---|---|
| Fresh /Refrigerated | hash browns |
| | cake |
| | steamed or baked whole, halved, cubed |
| | steamed and mashed |
| | pancakes and latkes |
| Frozen | cakes |
| | French fries, home fries |
| | hashed browns |

| | |
|---|---|
| Dried | cakes |
| | French fries, home fries |
| | hashed browns |
| | cakes |
| | French fries, home fries |
| | hashed browns |
| Shelf stable | cakes |
| | French fries, home fries |
| | hashed browns |
| | cakes |
| Beverages | vodka |
| | wine |

both cases were ground to flour and then analyzed. The values of water absorption, moisture content, total sugars and reducing sugars were higher in the flour made from boiled potatoes, while starch content was higher in flour made from raw slices. There was not much of difference in quality of the flour prepared from boiled and raw potatoes.

Oliveira *et al.* (2006) studied on the production of potato flour by sun drying. A study was conducted to evaluate the sun-dried and stove-dried grated potatoes to determine their flour quality and to verify the effect of sodium bisulfate addition on the final production. The potato flour samples according to observations showed visco-amylographic properties, good enough to be used on bakery products. The average input from solar drying prevents oxidation.

The potato flour production process and technology reported by Ritika (2009) consists of the following steps: Cooking, Washing, Pulping, Drum drying, Potato flour, Packaging etc.

## 2.9 Application of potato or potato flour in baked products

Mckee *et al.* (2001) conducted an experiment on extrude, puffed products prepared from potato flour combined with either partially defatted chopped beef (PDCB), mechanically deboned chicken (MDC) or chicken thigh meat (C) and coated with cheese seasoning containing 3 levels of chile were evaluated by instrumental and sensory methods. Expansion ratio, shear, compression and bulk density measurements indicated that products prepared with C were less expanded and slightly harder than those made with MDC or PDCB. C products tended to have the lightest color. Chile pepper was the dominant flavor and aroma detected by trained sensory panelists. C puffs were generally rated more gritty/cohesive/grainy than MDC puffs by panelists. Results indicate that acceptable extruded, puffed products could be successfully made using a combination of meat and potato flour.

Greene *et al.* (2004) studied on the macroscopic and sensory properties of breads supplemented with 50%, 55%, 60%, and 65% sweet-potato flour. Moisture contents of the breads fluctuated during storage. Protein value was highest for the bread supplemented with 50% sweet-potato flour. Carbohydrate contents ranged from 18.2 to 24.4%. Beta-carotene contents and loaf volumes were highest in the breads supplemented with 65% and 50% sweet-potato flour, respectively. The breads were similarly firm, with comparable vitamin C contents at the end of storage. The breads with 65% sweet-potato flour had the most intense yellow-orange colour. Twelve perceived sensory attributes, which could be used to differentiate the appearance, texture, and flavor of sweet-potato breads, were generated.

Zhang *et al.* (2006) studied on the preparation of textured starch chips made from potato flour in order to improve the utilization rate of potato and enrich the types of textured starch chips. The results showed that the optimum technology parameters were: potato starch to potato flour ratio, 65:35 (w/w); water content of dough, 40%; aging time, 16 hr; drying time, 4.5 hr; dry*ing* temperature , 50 $^{0}$C ; semi-product's moisture content, 9%; and frying temperature, 190-200 $^{0}$C. Using the optimum parameters, the forming and steaming processes were easily controlled, the flavor and taste of the product were better, and the product's expansion rate was 362%.

Bamidele *et al.* (2001) conducted rheological and baking tests carried out on wheat-cocoyam composite flour mixed in different proportions. The results of the farinograms and extensograms showed that replacement of wheat flour up to 20% level gave bread of acceptable quality. The proportion of extensibility and resistance to force decreased with the increase of cocoyam flour in the composite mix. Mixing tolerance index also indicated the poor quality of the composite flour beyond 20% replacement. Bread making properties, as indicated by internal and external scores, also showed that beyond 20% replacement level the bread was unattractive and lacking in the required quality attributes.

Okorie *et al*. (2002) conducted an experiment on composite bread using wheat, potato and cocoyam (Colocasia esculenta) flours at substition levels of 80:15:5; 60:25:15; and 50:30:20, respectively, was produced. The proximate analysis showed that increasing the proportion of non-wheat flours decreased the food nutrients in the mix. The main visible quality defects produced in the bread were the decreased loaf volume, specific volume and the gradual darkening of the crumb colour as substitution was increased. Seneory evalution showed that the control (wheat bread) compared favourably with 20% (15:5) and 30% (20:10) substitution bread in appearance, texture, taste, crust colour and overall acceptability, but differed significantly from 40% (25:15) in appearance and taste. Amongst all, 50% (30:20) substitution bread was inferior in quality attributes except crust colour.

## 2.10 Composition and nutritive value of biscuit

Analysis of the nutrient content of some Bangladeshi biscuits, namely glucose type and cracker type biscuits have been reported by Kabiraullah *et al.* (1995). The authors reported that the sweet biscuit contain moisture 4.06- 4.97%, ash 0.74-1.01%, fat 8.98-19.33%,protein 6.88-9.38%; carbohydrate 65.57-79.1%, total sugar 5.90-6.21% respectively.

Niola *et al.* (1992) reported that the composition of 15% soya containing biscuits were moisture 4.03-5.60%; ash 0.74-1.01%, crude protein 11.43-17.14%, lipids 9.43-10.45%, starch 0.53-0.63%, sugar 3.35-6.46% and acidity 0.95-1.24%.

The biscuit made from low fat soy flour mixed with wheat flour contains moisture 2.24-6.97%; fat 9.43- 10.45%; protein 11.43-17.4%; and ash 0.49-1.9%.They also assessed the freshness and shelf-life of biscuits. They found that soya contents in biscuits ranged from 3 to 25 % with most samples being in the range 10-15%. Composition of the biscuits varied widely. The samples with highest soy content tended to have highest crude protein content.

Kabirullah *et al.* (1996) analyzed crackers and salted biscuits for protein, fat and some other nutrient content. They reported that nutrient content was poor. Proteins were several denatured and fats were mainly saturated and rancid. Acid values exceeded permitted amounts and peroxide values were also high.

## 2.11 Preparation of biscuits

Kumari *et al.* (1996) formulated a supplementary food in the form of biscuits using wheat, soy and sugar at a proportion of (70:10:20). The find out proximate composition, viscosity and protein quality of the biscuit energy contents of 100 gm biscuits were 37 and 456 kcal, respectively, while protein contents were 13.0 and 9.0gm respectively.

Krishna *et al.* (1996) suggested supplementary food developed from wheat, sugar and defatted soy flour. They analyzed the food for proximate composition, viscosity and protein quality. A biscuit form of the food was also prepared and biscuits contained 4.6% moisture, 9% protein, 17.45 fat, 2.8% ash, 0.09% fibre and 64.9% carbohydrates.

Hozova *et al.* (1995) studied the biscuits prepared from amaranth flour and tested for microbiological quality and sensory characteristics during 6 month storage at 20 $^0$C and 62% RH. They found that biscuits were satisfactory and the presence of micro-organisms was not detected in biscuits during first 4 month of storage.

Ranjana *et al.* (1998) studied on physical, chemical and sensory properties of biscuits prepared from wheat flour with 0-50% replacement by defatted soybean flour. They observed that thickness of biscuits were increased, soya flour increased. Sensory properties dictated that there was no substantial adverse effect on overall quality that the replacement of 20% defatted soya flour in biscuits formulation.

Foda *et al.* (1984) conducted an experiment on low fat soy flour (LFSF) mixed with wheat flour and prepared biscuits. Dough and prepared biscuits were analyzed for several characteristics (farinograph data of dough, chemical composition and organoleptic quality of biscuits). Farinograph data were observed as absorption ratio, dough stability, arrival time, dough development time, mixing tolerance index. Organoleptic parameters examined were appearance, tenderness, color, flavor, chemical composition. The chemical composition was moisture 2.24-6.97%, fat 9.43-10.45%, protein 11.43-17.4%

and ash 0.49-1.9% LFSF markedly increased the nutritional value without adversely affecting quality.

Bottcher *et al.* (1995) studied the possibility of developing flour suitable for biscuits manufacture. Baking trials were carried out in which rye, corn flour were substituted for wheat flour at 10-30%, thus reducing protein content. Addition of rye flour to wheat flour did not produce biscuits of acceptable quality. Addition of rice corn flour to wheat flour resulted is a suitable flour for biscuits manufacture. Granulation had an important influence on dough and baking properties. Prediction of mixed flour quality by instrumental analysis showed only limited success.

## 2.12 Quality evaluation of biscuits

Quantifying the quality of biscuits has been a challenge to researchers. Two primary sensory characteristics, i.e. colour and texture of products have been measured by a number of laboratory instruments, such as the Instron, Universal Testing Machine (Ebeler and Walker, 1983). Kannur *et al.* (1973) quantitatively determined the colour of biscuits by a colorimetric method. Also, measurements of texture indicators by a number of test conducted with the Instrument have been investigated, and significant correlation between panel scores, hardness and yield point measurements were found for biscuits.

# CHAPTER III
# MATERIALS AND METHODS

## CHAPTER III

# MATERIALS AND METHODS

The study was conducted in the laboratory of the Department of Food Engineering and Technology, Food Processing and Preservation, Food Science and Nutrition under the Faculty of Agro-industrial and Food Process Engineering, Hajee Mohammad Danesh Science and Technology University and Soil Research and Development Institute (SRDI), Dinajpur.

## 3.1 Materials

### 3.1.1 Chemicals

The chemical and reagents used during the present research work are listed below:

i. Sodium hydroxide (NaOH)
ii. Disodium ethylene diamine tetra acetate, AR grade ($Na_2EDTA$)
iii. Masking agent:
   a) Hydroxylamine hydrogen chloride ($NH_2OH.HCL$)
   b) Potassium ferocyanide ($K_4Fe\ (CN)_63H_2O$)
   c) Triethanolamine ($C_6H_{15}NO_3$)
iv. Selinium Powder
v. Petroleum ether
vi. Copper sulphate($CuSO_4.5H_2O$).
vii. Boric acid
viii. Hydrochloric acid (HCl
ix. Sulphuric acid ($H_2SO_4$)
x. Methyl red
xi. Calcon indicator powder (C20H13N2NaO5S
xii. Methanol ($CH_3OH$)/Ethanol ($C_2H_5OH$)
xiii. Masking agent:
   a) Sodium tungstate ($Na_2WO_42H_2O$)
   b) Hydroxylamine hydrogen chloride ($NH_2OH.HCL$)
   c) Potassium ferocyanide ($K_4Fe\ (CN)_63H$

d) Triethanolamine ($C_6H_{15}NO_3$)

xiv. EBT indicator powder ($C_{20}H_{13}N_2NaO_5S$)

xv. Potassium difydrogen phosphate ($KH_2PO_4$)-AR grade

xvi. Stannous chloride ($SnCl_2.2H_2O$) -AR grade

xvii. Sulfuric acid ($H_2SO4$) -AR grade

xviii. Hydrochloric acid (HCl) -AR grade

xix. Ammonium molybdate tetrahydrate ($NH_4Mo_7O_{24}.4H_2O$) -AR grade

### 3.1.2 Apparatus

i. Muffle furnace,

ii. Electrical balance, (Mettler, Toledo AB 104).

iii. Triple beam balance, (Ohaus, U.S.A.)

iv. Oven, IH-150, (Gallenkamp, England)

v. Spectrophotometer (JASCO V-630)

vi. Electri hot plate

vii. Flame photometer

viii. Atomoc Absorption photometer (AAS)

ix. Blendar Machine

x. Pipette

xi. Containers

xii. Measuring Cylinder

xiii. Volumetric Flask

Good quality Potatoes of local varieties 'Granola' without any bruises, wheat flour and other raw materials were procured from local market of Dinajpur. The high density polyethylene bags and required chemicals were used from the laboratory stock and /or procured from the local market.

## 3.2 Methods

### 3.2.1 Collection of Potatoes

Good quality Potatoes of local varieties 'Granola' were collected from local market. The potatoes were cleaned with water to remove adhering dirt, soil and stone. The cleaned and washed potatoes were then divided into three categories for selecting the best type for culinary uses. For mineral analysis potatoes were categorized into potato which was neither peeled nor boiled. Second sample was prepared by peeling the potato. Peeling was done by using knife. Finally the third sample was boiled and peeled immediately after boiling. Boiling was carried out by heating the potatoes with water at 90-95$^0$ C for 30-35 minutes.

## 3.3 Mineral Contents in Potatoes

### 3.3.1 Methods

The study was concerned with the analysis of essential minerals i.e. calcium, magnesium, phosphorus, potassium, Iron and Zinc in raw potato, Peeled potato before boiling and peeled potato immediately after boiling. Ca, Mg, P, K, Fe and Zn in raw and treated potatoes were determined by Hunter Method (Pearson, 1976).

### 3.3.2 Reagents preparation

**a) 0.01 M Disodium salt ethylene diamine tetra acetic acid solution preparation:** About 0.372 g $Na_2EDTA$ (Disodium salt ethylene diamine tetra acetic acid) was taken in 1000 ml volumetric flask containing about 400 ml distilled water. The flask was shaken thoroughly until the salt completely dissolved. Then volume was made up to the mark with distilled water and mixed well. The solution was kept fpr subsequent use.

**b) Calcon indicator solution:** 400 mg calcon powder along with approximately 30 ml methanol was taken in a 100 ml volumetric flask. The flask was shaken thoroughly until the solid dissolve and the volume was made up to the mark with same solvent.

**c) Ammonium molybdate [$(NH_4)_6Mo_7O_{24}.4H_2O$] solution:** 25 g ammonium molybdate was taken in a beaker containing 200 ml distilled water and dissolved by warming at 60°C. The solution was filtered to remove any sediment present. The 275 ml concentrated $H_2SO_4$ was added to it with constant stirring at room temperature. Final volume was kept in amber colored bottle to protect from light and left for subsequent use.

**d) Potassium Ferro cyanide solution:** Four g $K_4Fe\ (CN)_6$ with approximately 30 ml distilled water was taken in a 100 ml volumetric flask. The flask was shaken thoroughly until the reagent dissolve. The volume was made up to the mark with distilled water.

**e) Stannous chloride ($SnCl_2$) solution:** 25 g of $SnCl_2$ were dissolved in 500 ml concentrated HCl at warmed state. The solution was diluted with boiled distilled water. A fresh $SnCl_2$ solution was prepared every day.

**f) Calcium stock solution:** Exactly 12.485 g /litre $CaCO_3$ of (AR grade) previously dried in an oven at 60°C for about 2 hours was taken in a beaker covered a watch glass containing approximately 300 ml of distilled water. The content was then stirred and dilute HCl (1:1) was added drop by drop in a minimum cases excess until $CaCO_3$ completely dissolved. The solution was then boiled about 3 minutes to extend $CO_2$ and then allowed to cool. The solution then was transferred into a 100 ml volumetric flkask and the solution was diluted to 1 litre with distilled water. This solution would contain 5mg Ca/ml. 10 ml of this solution was then pipetted into 100 ml volumetric flask and the volume was made to 100 ml with distilled water. This solution would contain 0.5 mg Ca/ml.

**g) 10% NaoH solution**: 50 g of NaOH of AR grade was dissolved in approximately 200 ml of distilled water contained in a 500 ml volumetric flask. The flask with its content was shaken throughly to dissolve NaOH and the volume was made up to the mark with distilled water.

**h) Mg stock solution:** Exactly 8.33 g MgO of AR grade previously dried in an oven at 60°C for about 2 hours was taken in a water glass containing approximately 300 ml of distilled water. The content was then stirred and dilute HCl (1:1) was added drop by drop to a minimum excess until MgO completely dissolved. The solution was then transferred into 100 ml volumetric flask and the solution was diluted to 1 litre with distilled water. The solution would contain 5 mg/ml. 10 ml of this solution was then pipetted into a 100 ml volumetric flask and the volume was made up to 100 ml with distilled water. This solution would contain 0.5 mg Mg/ml.

**i) EBT indicator solution**: 400 mg EBT indicator powder was weighed and poured into 100 ml volumetric flask containing about 30 ml of $CH_3OH$. The flask was shaken thoroughly to dissolve the indicator powder and the volume was made to 100 ml with methanol.

**j) $NH_3$-$NH_4$ buffer:** 67.5 g $NH_4Cl$ of AR grade was taken into a 1 liter volumetric flask containing about 200 ml of distilled water. The flask was shaken until $NH_4Cl$ completely dissolved. Then 570 ml of $NH_4OH$ was added into the flask and the volume was made up to the mark with distilled water.

**k) Hydroxylamine hydrochloride ($NH_2$-OH.HCl):** 25 g $NH_2$-OH.HCl with approximately 30 ml distilled water was taken in a 100 ml volumetric flask. The flask was shaken thoroughly until the reagent dissolve. The volume was made up to the mark with distilled water.

**l) Na-Tunstate ($Na_2WO_4.2H_2O$) 20% solution:** 20% of Na-Tunstate solution was prepared by dissolving 20 g of Na-Tunstate of analytical grade and volume was made to 100 ml with distilled water.

**m) Diacid mixture:** Nitric acid and perchloric acid in the ratio of 2:1 by volume was mixed and was allowed to cool before use.

**n) Triethanol amine**

**o) Standard phosphate solution:** 0.438 g potassium dihydrogen phosphate was dissolved in distilled water and diluted to 1 litre. Then 10 ml of this solution was made up to 100 ml with distilled water (1 ml=0.01 mg phosphorus).

### 3.3.3 Working procedure

#### 3.3.3.1 Sample digestion

1.0 g sample was taken into a 50 ml boiling flask. Five ml of diacid mixture (500 ml conc. $HNO_3$ and 100 ml perchloric acid) was added to it. The flask was then placed on cool hot plate and digested at $195^0C$ and allowed to digest for 1 hour and 30 minutes while fume evolved and the solution become clear. Distilled water was added to the clear residue and the contents were shaken thoroughly. The mixture was then filtered through Whatman no. 42 filter paper and the volume was made up to 100 ml with distilled water. The solution was then ready for the estimation of minerals (Ca, Mg P, K, Fe and Zn).

#### 3.3.3.2 Estimation of Calcium

5 ml digestion mixture was taken in a 250 ml conical flask and then 50 ml distilled water was added. 2-5 ml of 10% NaOH solution was added to the flask. Masking reagent (10 drops potassium ferocyanide, 10 drops hydroxylamine hydrochloride, 10 drops

triethanolamine) was added to the flask and 6 drops calcon indicator was added. The flask was shaken vigorously and titrated against 0.01M of $Na_2EDTA$. The solution turned into blue. A blank was run following the same procedure as describe above. The data were recorded and the amount of calcium present in the sample was calculated. The percent of calcium was calculated according to the formula:

1 ml of 0.01M EDTA solution = 0.2004 mg of Ca

$$\text{mg of calcium} = \frac{\text{mg of calcium obtained}}{\text{weight of sample}} \times 100$$

#### 3.3.3.3 Estimation of magnesium

5 ml digestion mixture was taken in a 250 ml conical flask and then 50 ml distilled water was added. 5 ml $NH_3$-$NH_4$ buffer solution was added to the flask. Masking reagent (10 drops potassium ferocyanide, 10 drops hydroxylamine hydrochloride, 10 drops triethanolamine and 10 drops sodium tunstate solution) was added to the flask and 6 drops EBT indicator was added. The flask was shaken vigorously and titrated against 0.01M of $Na_2EDTA$. The solution turned into blue. A blank was run following the same procedure as describe above. The data were recorded and the amount of calcium present in the sample was calculated. The percent of calcium was calculated according to the formula:

1 ml of 0.01M EDTA solution = 0.2432 mg of Mg

$$\text{mg of magnesium} = \frac{\text{mg of magnesium obtained}}{\text{weight of sample}} \times 100$$

#### 3.3.3.4 Estimation of Phosphorus

**Series solution of Phosphorus**

2.5 ml, 5 ml, 10 ml, 15 ml, 20ml, 25 ml and 30 ml of 2 ppm Phosphorus solution was taken in several 500 ml volumetric flask and made volume upto 20 ml to 500 ml with distilled water. For unknown sample a blank solution was made which contained 5 ml of 2 ppm solution.

**Procedure**

5 ml digestion mixture of the formulated food was taken in 100 ml volumetric flask. 60 ml of distilled water was poured into the flask and shaken thoroughly. 4 ml of ammonium

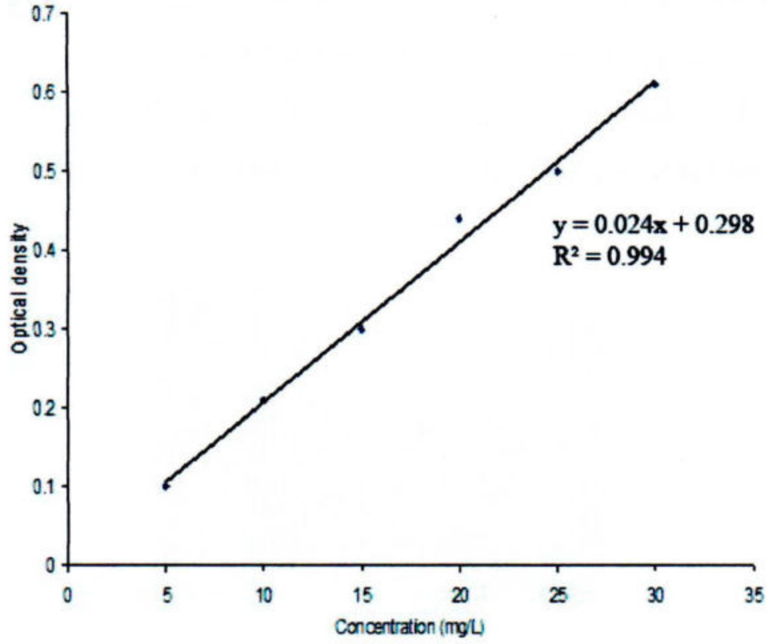


Fig 3.2 Standard curve of Potassium

### 3.3.3.6 Estimation of Zinc and Iron

The contents of these elements were measured by atomic absorption spectrometer (AAS) directly in the undiluted filtrate.

**Calculations for Zn and Fe:**

$$\text{mg of Zn or Fe} = \frac{d \times 100}{c}$$

Where,

d = mg/l Zn or Fe measured on atomic absorption spectrometer or spectrophotometer.

c = weight of sample

## 3.4 Preparation of potato flour

Uniform sized potatoes having no signs of infection or infestation were thoroughly washed in running tap water to remove adhering dirt, soil and dust. The washed and cleaned potatoes were sliced (about 3 mm thickness) with hand knife. The slices were then soaked

## 3.5 Procedure for preparation of Biscuit

The basic formulations used for preparation of biscuits using potato flour as a supplement of wheat flour are outlined in Table 3.1. The basic formulations of biscuit have been adapted from the recipe reported by Hoseney (1986) and Kent (1984). Wheat flour, potato flour, sugar and fat constitute the major portion of the biscuits. Starch rich potato flour was incorporated at 0.0, 15, 25 and 35% levels with 100, 85, 75 and 65% of wheat flour indicated as $T_1$, $T_2$, $T_3$, $T_4$, respectively to provide extra energy and taste in biscuits. The fat (shortening) was usually hydrogenated fat and with good keeping quality. Baking powder was used as leavening agents.

Wheat flour, potato flour, powdered sugar, shortening (Dalda) and baking powder weighed accurately as indicated in Table 3.1. The dalda was kneaded until paste form and powder sugar was mixed with dalda paste. After complete mixing of shortening and powder sugar, wheat flour, potato flour, milk powder and baking powder were mixed thoroughly to make adequate dough and kept for a while. Then the dough was rolled to a uniform sheet of thickness. The sheet was cut according to the desired shape and size of biscuits with a cutter and baked in the oven at 210 $^0$C for 8 min, cooled to ambient temperature and packed in plastic bags. The prepared biscuits were packed in high density polythene bag, sealed and stored at room temperature (25-30 $^0$C).

**Table 3.1 Basic formulation of biscuit for each treatment of potato flour**

| Ingredients | Samples | | | |
|---|---|---|---|---|
| | $T_1$ | $T_2$ | $T_3$ | $T_4$ |
| Wheat flour (g) | 100 | 85 | 75 | 65 |
| Potato flour (g) | 0 | 15 | 25 | 35 |
| Sugar (g) | 20 | 20 | 20 | 20 |
| Shortening (g) | 15 | 15 | 15 | 15 |
| Skim Milk powder (g) | 05 | 05 | 05 | 05 |
| Soyabean oil (g) | 10 | 10 | 10 | 10 |
| Baking powder (g) | 1.5 | 1.5 | 1.5 | 1.5 |

Preparation of composite flour (Potato flour : whole wheat flour)

(0:100, 15:85,25:75, 35:65)

↓

Premixing (Fat and sugar)

↓

Mixing (Cream, flour, milk powder and baking powder)

↓

Molding

↓

Baking

↓

Cooling to room temperature

↓

Packaging (HDPE)

↓

Storage (at ambient temperature)

Fig 3.5 Flowchart for the Preparation of Biscuits

## 3.6 Proximate analysis

The raw potato, potato flour, wheat flour and biscuits were analyzed for their moisture, ash, fat and protein. All the determinations were done in triplicate and the results were expressed as average value.

### 3.6.1 Moisture content

Moisture content was determined by the Association of Official Analytical Chemists (AOAC, 2005) method as described below.

**Procedure**

First of all, weight of empty previously dried (1hr at $100^0C$) crucible with cover was taken and 5 g of sample was placed on it. Then the crucible was placed in an air oven into the extraction tube attached to a Soxhlet flask. Approximately 75 ml or more of anhydrous ether was poured in the tube into the flask. The top of the fat extraction tube was attached to the condenser. The sample was extracted for 16 hr or longer on water bath at 70-80$^0$ C. At the end of the extraction period, the thimble was removed from the apparatus and distilled off most of the ether by allowing it or collected in soxhlet tube. The ether was poured off when the tube was nearly full. When the ether reached a small volume, it was poured into a small, dry (previously weighed) beaker through a small funnel containing a plug on cotton.

The flask was rinsed and filtered thoroughly, using ether. The ether was evaporated on a steam bath at low heat, it was then dried at 100$^0$ 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:

$$\text{Percent of Fat} = \frac{\text{Weight of ether extracts}}{\text{Sample weight}} \times 100$$

### 3.6.4 Protein content

AOAC (2005) method was used to determine protein content of the sample as described below;

**Principle**

Protein content can be measured by estimating the nitrogen content of the material and then multiplying the nitrogen value by 5.5. This is referred to as crude protein content, since the non-protein (NPN) present in the materials was taken into consideration in the present investigation.

The estimation of nitrogen was made by modified Kjeldahl method, which depends on the fact that organic nitrogen, when digested with concentrated sulphuric acid ($H_2SO_4$). In the presence of a catalyst, is converted into ammonium sulphate $(NH_4)_2SO_4$. Alkali is added to the sample to convert ammonium ($NH_4^+$) to ammonia ($NH_3$). The ammonia is steam distilled into a receiver flask containing boric acid and titrated with a standard acid solution. This determines % of N that is multiplied by 5.5 to give the value of crude protein.

**Digestion Mixture**

Potassium sulphate ($K_2SO_4$) and dehydrated copper sulphate ($CuSO_4.5H_2O$) in a ratio of 5g: 1g were powdered with mortar and pestle and mixed well.

Concentrated HCl was used for titration.

**Sodium hydroxide (40%)**

Sodium hydroxide (NaOH) 40 gm was dissolved in distilled water and the volume was made up to 100 ml.

**Receiver Solution**

10g of boric acid was added in 500 ml deionized water in a one liter volumetric flask, heated it gently until the boric acid was dissolved. An amount of 0.02 g bromo cresol green was dissolved with 4ml ethanol ($C_2H_5OH$) in a separate beaker. An amount of 0.014g methyl red was dissolved with 4 ml ethanol ($C_2H_5OH$) in another beaker. Some bromo cresol green and methyl red solution mixture was than transferred into that volumetric flask and 0.5 ml 1N NaOH was added when the total volume was made 1000 ml with deionized water.

**Procedure**

The Kjeldahl method consists of the following steps:

- Digestion of the sample
- Distillation
- Titration

**Digestion of the sample**

Two grams of raw potato or one gram of flour or biscuit sample was taken in weighing paper and measured accurately. This sample was poured into a 100 ml clean and dry Kjeldahl flask, to which 10 gm of Digestion Mixture and 25 ml of concentrated HCl were added. To avoid frothing and bumping 2-5 glass beads was placed inside the flask. A blank sample was carried with all reagents except sample material for the comparison.

The flask was then heated in a Fume hood Digestion chamber at $400^0C$ until the solution became colorless. At the end of digestion period, the flasks were cooled and diluted with 100 ml distilled water. A small piece of litmus paper was placed in the solution and the reaction was found to be acidic.

**Distillation**

The distilling set of Kjeldahl apparatus was thoroughly washed with distilled water before starting the distillation. In a measuring cylinder 60 ml of 40% NaOH was taken and it was carefully poured down the side of the Kjeldahl flask. The mouth of the flask was closed with a stopper containing connective tube, which was ultimately connected to the ammonia-receiving flask containing 25 ml receiver solution.

The mixture was boiled at such a rate that water and ammonia distilled over at a steady moderate rate. The heating was not too slow so that the receiver solution might be sucked into the Kjeldahl flask and not to fast so that the distilling ammonia did not escape the receiver solution without absorption.

**Titration**

The ammonia absorbed in the receiving flask containing receiver solution was titrated with 0.1 N HCl. Similarly a reagent blank was distilled and titrated.

**Calculation**

Crude protein content of the sample on the percentage basis was calculated by using the following formula:

$$\text{Percentageof nitrogen} = \frac{\{c - b \times p \times 0.014 \times d\}}{\text{weight of sample}} \times 100$$

Where, c = reading of the sample

b = blank reading

p = strength of the HCl solution

d = a factor (6.25 for tomatoes)

Nitrogen percentage was converted into protein by multiplying with a factor 5.95 for potato.

### 3.6.5Total carbohydrate

Total carbohydrate content of the sample were determined as total carbohydrate by difference, that is by subtracting the measured protein, fat, ash and moisture from 100 (Pearson, 1976).

## 3.7 Sensory evaluation of biscuit

The symmetry and the characteristics of crust and crumb of the biscuits supplemented with potato flour were evaluated and recorded. Biscuits were evaluated organoleptically for color, flavor, texture, and overall acceptability. A 1-9 point hedonic rating test was also performed to assess the degree of acceptability of biscuit containing sweet potato flour in different level. Biscuits using various ratio flour were presented to 10 panelists as randomly coded samples. The taste panelists were asked to rate the sample for color, flavor, texture, and overall acceptability on a 1-9 point scale, where 9=Like extremely; 8=Like very much; 7= Like moderately; 6=Like slightly; 5= Neither like nor dislike; 4=Dislike slightly; 3= Dislike moderately; 2= Dislike very much; 1=Dislike extremely.

The results were evaluated by Analysis of variance and Duncan's New Multiple Range Test Procedures of the Statistical Analysis System (SAS, 1985).

# CHAPTER IV

# RESULTS AND DISCUSSION

# CHAPTER IV

# RESULTS AND DISCUSSIONS

## 4.1 Composition of raw potato, potato flour and wheat flour

The results of the proximate composition analysis of potato, potato flour and wheat flour are presented in Table 4.1.

**Table 4.1 Composition of raw potato, potato flour and wheat flour**

| Composition | Raw potato | | Potato flour | | Wheat flour | |
|---|---|---|---|---|---|---|
| | wb | db | wb | db | wb | db |
| Moisture (%) | 79.0 | 376.19 | 7.67 | 8.24 | 12.48 | 14.26 |
| Protein (%) | 1.8 | 8.57 | 5.3 | 5.69 | 10.63 | 12.07 |
| Fat (%) | 0.25 | 1.19 | 0.95 | 1.02 | 1.06 | 1.2 |
| Ash (%) | 2.13 | 10.14 | 3.59 | 3.86 | 0.53 | 0.6 |
| Total carbohydrate (% by difference) | 16.82 | 80.09 | 81.08 | 87.18 | 75.3 | 85.56 |

### 4.1.1 Moisture content

The moisture contents of raw potato, potato flour and wheat flour are presented in Table 4.1. Moisture content of raw potato and potato flour were 79.0% and 7.67%, respectively while the moisture content of wheat flour was 12.48%. The value was higher than those found for high yielding variety by Islam (2004), FAO (2008) and Kroner and Volksen (1950), who reported 78%, 77% and 77.5% moisture content respectively. The moisture content of potato flour was much lower than that of raw potato. The drying process significantly reduced the moisture content in potato slices and hence potato flour. The potato flour has slightly less moisture content than that of the wheat flour and which might be due to compositional difference and extent of drying.

### 4.1.2 Protein Content

Table 4.1 showed that the protein contents of raw potato and potato flour were 1.8% and 5.3%, respectively whereas protein content of wheat flour was 10.63%. Protein content in potato was much lower than those found by Islam (2004), FAO (2008) and Kroner and Volksen (1950), who reported 2.02%, 1.87% and 2%, respectively. The variation might be due to varietal differences, different maturity, storage time and time elapsed between harvesting and analysis and the growing conditions of the crop. Due to the drying process, the protein content increased proportionally along with other components in potato flour. Potato flour contained lower protein and higher starch or carbohydrate than wheat flour.

### 4.1.3 Fat content

The fat content of raw potato was very low (0.25%) and the fat content of potato flour was 0.95%, which was slightly lower than that of the wheat flour sample (1.06%). The value of fat content in raw potato was higher than results found by Schwimmer and Burr (1967) who mentioned 0.1% fat content in raw potato, and the fat content of wheat flour was higher than results found by Mollik and Shams-Ud-Din (2007) who mentioned 0.88% fat in wheat flour. This variation in fat content may result from varietals difference, chemicals used for fat extraction and milling process differences.

### 4.1.4 Ash content

The ash content of raw potato, potato flour and wheat flour are presented in Table 4.1 which were 2.13%, 3.59% and 0.53%, respectively, and it was found that the potato flour contained substantially higher ash than wheat flour. The value was higher than those found by Islam (2004) and Kroner and Volksen (1950), who reported 1.1% and 1% respectively.

### 4.1.5 Total carbohydrate content

Data corresponding to the total carbohydrate contents of raw potato, potato flour and wheat flour are shown in Table 4.1. The raw potato contained 16.82% carbohydrate. Potato flour was rich in total carbohydrate 81.08% than that of wheat flour 75.3% due to higher starch content of potato as a tuber crop. The value of total carbohydrate content in potato was lower than those found by Islam (2004), FAO (2008) and Kroner and Volksen (1950), who reported 18.78%, 20.13% and 19.4%, respectively. The variation might be due to varietal differences, different maturity periods, storage time and time elapsed between harvesting and analysis, harvesting periods etc. These variations may also from the differences in the level of moisture, protein, fat and ash content. The total carbohydrate content, in fact, represents mostly the dietary fibre level in the potato samples. Dietary fibre encompasses cellulose, hemicelluloses, lignins, gums, pectic substances, mucilages etc. However, potato contains polyphenols, which is considered as anti-nutritional factor for certain proteins and enzymes (Salunkhe *et al.*, 1985).

## 4.2 Mineral contents in potato tuber

Significant effects of peeling treatment on concentration of Phosphorus (P), Potassium (K), Calcium (Ca), Magnesium (Mg), Iron (Fe) and Zinc (Zn) in potato tubers are recorded (Table 4.2). The concentration of Phosphorus ranged from 59.52 to 60.57 mg/100 g in potatoes peeled after boiling ($T_3$) and in potatoes without peeling ($T_1$) on the other hand lower phosphorus content is observed in potatoes peeled before boiling ($T_2$) (45.65 mg/100g). Woolfe (1987) reported a range of 27-89 mg/100g (fresh weight basis) while Burton (1989) reported range of 150-300 mg/100g (dry weight basis). The range in present study compares more closely to the values reported by Woolfe (1987). On boiling potato, phosphorus content significantly losses and the losses due to leaching on boiling can be reduced by retaining the skin (True *et al.*, 1979).

The concentration of potassium ranged from 413.91 and 400.78 (mg/100 g) in potatoes without peeling ($T_1$) and in potatoes peeled after boiling ($T_3$) to 360.17 mg/100 g in potatoes before boiling ($T_2$). George *et al.*, 2009 reported that the raw tubers had high amounts of potassium ranging from 697 mg to 2082 mg per 100g of dry weight basis. Significant losses of potassium occurred in potatoes peeled immediately before boiling. There was no much variation on concentration of Iron and Zinc among the treatment. This is because the potato peel contains negligible amount of Iron and Zinc. The levels of Zinc in the study compares well with those reported by Woolfe (1987) and Burton (1989). Levels of Zinc did not significantly differ for treated potato compared to the raw potato.

The concentration of calcium ranged from 8.23 and 6.57 mg/100 g potatoes peeled after boiling ($T_3$) and in potatoes without peeling ($T_1$) to 9.40 mg/100 g in potatoes without peeling ($T_1$). According to George *et al.*, 2009 potato tuber contains calcium in the range of 37-92 mg per 100g.

**Table 4.2 Effect of peeling on mineral content of potato**

| Sample | Phosphorus (mg/100 g) | Potassium (mg/100 g) | Calcium (mg/100 g) | Magnesium (mg/100 g) | Iron (µg/100 g) | Zinc (µg/100 g) |
|---|---|---|---|---|---|---|
| **$T_1$** | 60.57 | 413.91 | 9.40 | 21.65 | 0.78 | 0.29 |
| **$T_2$** | 45.65 | 360.17 | 6.57 | 13.09 | 0.69 | 0.25 |
| **$T_3$** | 59.52 | 400.78 | 8.23 | 19.89 | 0.75 | 0.25 |

N.B: $T_1$ = Potato without peeling, $T_2$ = peeled potato before boiling, $T_3$ = peeled potato after boiling

The higher Magnesium content 21.65 mg/100 g was observed in fresh potato ($T_1$) and the lower Magnesium content was observed in potatoes before boiling ($T_2$) which was peeled before boiling 13.09 mg/100 g. Ahmed (2010) reported that unpeeled potato contains higher mineral content than peeled potato. This may be due to higher solute content in unpeeled potatoes compared to the peeled ones.

Camire *et al.*, 2009 investigated that most of the minerals reside just beneath the skin of the potato. Hence there is always a significant loss in minerals as a result of peeling before boiling. It was also observed that the potatoes peeled immediately after boiling contained more P, K, Ca, Mg, Fe and Zn in comparison with potatoes peeled before boiling. Nassar *et al.*, 2012 reported in their study that most of the mineral migrates to the centre from the outer surface during boiling.

Based on the above study, it can be reported that the fresh potato with skin contained the highest mineral compared to any kind of peeled potato. So, potato with peel is always recommended for further processing to make any value added food products with potato.

## 4.3 Mineral content of potato flour and wheat flour

Variation in mineral content between potato powder and wheat flour is presented in table 4.3. From the Table it was found that potato flour secured the higher Phosphorus and Potassium content 60.57 mg/100 g and 413.91 mg/100g respectively compared to wheat flour 25 mg/100 g phosphorus and 12.5 mg/100 g potassium. But Calcium 9 mg/100 g and Magnesium 21 mg/100 g was much lower whereas wheat flour showed much higher Calcium and Magnesium content 160.31 mg/100g and 364.50 mg/100 g respectively. Considering the above findings potato flour can easily be suggested as a good source of Phosphorus and Potassium and can be used with wheat flour to enrich the nutritive value. Adrogue and Madias (2007) reported that potassium is required in relatively large amounts because it functions as an important electrolyte in the nervous system. Potassium also plays a role in osmoregulation. High levels of potassium can help to control high blood pressure.

**Table 4.3 Mineral content of potato flour and wheat flour**

| Sample | Phosphorus (mg/100 g) | Potassium (mg/100 g) | Calcium (mg/100 g) | Magnesium (mg/100 g) | Iron (µg/100 g) |
|---|---|---|---|---|---|
| **Potato flour** | 60.57 | 413.91 | 9 | 21 | 0.78 |
| **Wheat flour** | 25 | 12.5 | 160.32 | 364.50 | - |

## 4.4 Nutrient content in the finished product (Potato Biscuit)

Biscuit was prepared using potato powder at 15%, 25% and 35% substitution respectively. Biscuits were analyzed for different parameters like moisture content, ash, protein, fat and carbohydrates. Table 4.5 shows the effect of treatment on moisture, protein, ash, carbohydrates and fat content of fortified biscuit.

Table 4.5 indicates that among the different treatments in biscuit, moisture content ranged from 5.0% to 7.30%. Moisture content of the prepared biscuits was the lowest in control (5.0%) and the highest (7.30%) in treatment $T_4$ (biscuit with 35% potato powder). Moisture content was increased with the increase of addition of potato powder. Since potato powder contains higher amount of carbohydrate which has higher water holding capacity, hence, the moisture content was higher. The value was nearly same as those found by Khaliduzzaman *et al.* (2010), who reported that moisture content of biscuits prepared by potato powder (20% substitution) was 5.48%.

The ash content of the prepared biscuits ranged from 0.99% to 3.33%. Ash content is also increased with the increase of addition of potato powder. This value is higher than those found by Khaliduzzaman *et al.* (2010) who reported that the ash percentage of biscuits was 1.7%.This is because of formulation of biscuit with the potato powder with peel.

**Table 4.4 proximate composition of prepared biscuits**

| Nutrient contents | $T_1$ | | $T_2$ | | $T_3$ | | $T_4$ | |
|---|---|---|---|---|---|---|---|---|
| | wb | db | wb | db | wb | db | wb | db |
| Moisture(g/100 g) | 5.00 | 5.26 | 5.80 | 6.10 | 6.50 | 6.95 | 7.30 | 7.87 |
| Protein (g/100 g) | 15.20 | 16 | 13.90 | 14.75 | 11.00 | 11.76 | 9.70 | 10.46 |
| Fat (g/100 g) | 11.0 | 11.57 | 11.2 | 11.88 | 12.30 | 13.15 | 12.67 | 13.45 |
| Ash (g/100 g) | 0.99 | 1.04 | 2.10 | 2.22 | 2.50 | 2.67 | 3.13 | 3.37 |
| Carbohydrate (g/100 g) | 67.81 | 71.37 | 67.00 | 71.12 | 67.70 | 72.4 | 67.20 | 72.49 |

N.B. $T_1$ = 100% wheat flour; $T_2$ = 85% wheat flour + 15 % potato flour; $T_3$ = 75% wheat flour + 25% potato flour; $T_4$ = 65% wheat flour + 35% potato flour

Fat content of the prepared biscuits increased from 11.0 to 12.67%. Khaliduzzaman *et al.* (2010) reported that the fat percentage of biscuits prepared from potato powder ranged from 25.8% to 27.6%. The slight variation between the ranges might be due to the use of shortening agents.

Protein content of biscuits ranged from 9.70% to 15.20%, the highest in control (15.20%) and the lowest in the biscuit with 35% potato powder (9.70%). The biscuits showed decrease in protein content when potato powder substitution was increased. This decreasing trend might be due to increasing the incorporation level of low protein potato flour.These results are in close agreement with findings of Khaliduzzaman *et al.* (2010) who have reported 8.5% to 13.67% protein content respectively.

The carbohydrate content of biscuits ranged from 67.0% to 67.81%. There was no significant difference in carbohydrate content among the treatment. Khaliduzzaman *et al.* (2010) reported 64.0% in control and 63.9% carbohydrate in 20% potato powder incorporated biscuits. According to Messiaen (1992) the higher the protein, fat, ash content, the lower the carbohydrate content.

It was found that potato contains a limited amount of protein although rich in dietary fiber content and carbohydrate, so a successful combination with wheat flour for biscuit production would be nutritionally advantageous.

## 4.5 Sensory evaluation of the prepared biscuit

The colour, texture, taste, flavor and overall acceptability of the potato flour incorporated biscuits were evaluated by a panel consisting of 10 judges. The members scored for preference of colour, flavor, texture, taste and overall acceptability. The score was tabulated and analyzed (Table 4.4.1-4.4.15) (Appendix -II).

The analysis of variance (ANOVA) (Appendix-II ) showed that there was a significant differences among the samples in respect of colour, texture, taste, flavor and overall acceptability at 5% level of significance ($p<0.05$). The degree of differences among the samples were evaluated found by Duncan's Multiple Range Test (DMRT) shown in table 4.4.3, 4.4.6, 4.4.9, 4.4.12 and 4.4.15 (Appendix-II)

**Table 4.5 Mean sensory scores secured by different formulation of biscuit**

| Sensory attributes | Color | Flavor | Taste | Texture | Overall acceptability |
|---|---|---|---|---|---|
| Sample $T_1$ | $7.800^{a}$ | $7.200^{a}$ | $7.400^{a}$ | $7.200^{a}$ | $6.900^{a}$ |
| Sample $T_2$ | $5.900^{b}$ | $6.100^{b}$ | $6.500^{b}$ | $6.400^{b}$ | $6.200^{b}$ |
| Sample $T_3$ | $6.900^{ab}$ | $6.600^{ab}$ | $6.900^{ab}$ | $7.500^{a}$ | $7.200^{a}$ |
| Sample $T_4$ | $6.100^{b}$ | $5.400^{c}$ | $5.200^{c}$ | $5.500^{c}$ | $5.200^{c}$ |
| LSD | 0.9715 | 0.6190 | 0.7878 | 0.6818 | 0.6623 |

N.B. Means with different superscript within the same column differ significantly ($p<0.05$) using Duncan's Multiple Range Test; $T_1$ = 100 % wheat flour; $T_2$ = 85 % wheat flour + 15 % potato flour; $T_3$ = 75 % wheat flour + 25% potato flour; $T_4$ = 65 % wheat flour + 35 % potato flour.

A two way analysis of variance (ANOVA) (Appendix-II Table 4.4.2) was carried out for color preference and the result showed that, there were significant differences in color acceptability of potato biscuit. As shown in Table 4.4 (DMRT) 15% potato flour incorporation biscuit ($T_2$) secured the lowest score (5.90) for the color preference among the samples. Control biscuits ($T_1$) secured the highest score (7.80)

A two way analysis of variance (ANOVA) (Appendix-II Table 4.4.5) was carried out for flavor preference and the result revealed that, there were significant ($p<0.05$) differences in flavor acceptability of potato biscuit. As shown in Table 4.4 (DMRT) 35% potato flour incorporation biscuit ($T_4$) secured the lowest score (5.40) for the flavor preference among the samples. Control biscuits ($T_1$) secured the highest score (7.20). Table 4.5 also showed that 25% potato powder incorporated biscuit is securing 6.6 equally acceptable as control biscuit.

A two way analysis of variance (ANOVA) (Appendix-II Table 4.4.8) was carried out for texture preference and the result revealed that, there were significant ($p<0.05$) differences in texture acceptability of potato biscuit. As shown in Table 4.4 (DMRT) 35% potato flour incorporation biscuit ($T_4$) secured the lowest score (5.50) for the texture preference among the samples. Control biscuits ($T_1$) secured the highest score (7.40). Table 4.5 also showed that 25% potato powder incorporated biscuit is securing 7.5 equally acceptable as control biscuit.

A two way analysis of variance (ANOVA) (Appendix-II Table 4.4.11) was carried out for taste preference and the results revealed that, there were significant ($p<0.05$) differences in taste acceptability of potato biscuit. As shown in Table 4.4 (DMRT) 35% potato flour incorporation biscuit ($T_4$) secured the lowest score (5.20) for the taste preference among the samples. Control biscuits ($T_1$) secured the highest score (7.40). Table 4.5 also showed that 25% potato powder incorporated biscuit is securing 6.90 equally acceptable as control biscuit.

A two way analysis of variance (ANOVA) (Appendix-II Table 4.4.8) was carried out for overall acceptability preference and the result revealed that, there were no significant ($p<0.05$) differences in overall acceptability between 25% potato flour biscuit and control one. This indicates that the overall acceptability of 25% potato flour biscuit equally acceptable as control biscuit. As shown in Table 4.4 (DMRT) 25% potato flour incorporation biscuit ($T_4$) is secured the highest score (7.20) for the overall acceptability preference than other samples. Control biscuits ($T_1$) also secured the highest score (6.90). Table 4.5 showed that 35% potato powder incorporated biscuit were not overall accepted by the panelist as control biscuit and secured the score (5.20). Similar study as Khaliduzzaman *et al.* (2010) biscuits containing 25 % potato flour as a supplement secured the highest score in terms of all sensory attributes among others, though all samples are acceptable.

Misra and Kulshretha (2003) formulated biscuits by incorporating potato flour in 6 different proportions to replace wheat flour at levels of 0, 10, 20, 30, 40 and 50 percent. Results of the sensory evaluation revealed that until the 20 % level, there was no significant difference observed in acceptability of the product and all three levels had similar sensory scores. According to a study conducted by Nazni *et al.* (2009) potato flour incorporated biscuits have obtained highest scores for overall acceptability compared to maize and green gram flour incorporated biscuits.

# CHAPTER V

# SUMMARY AND CONCLUSION

# CHAPTER V

# SUMMARY AND CONCLUSION

The study was conducted in the Laboratory of the Department of Food Processing and preservation, Food Science and Nutrition, Hajee Mohammad Danesh Science and Technology University, Dinajpur. The purpose of this investigation was to observe the peeling effect on mineral content of potato before and after boiling and also suitable formulation of potato based biscuits. Moreover, the nutritional compositions of fresh potato and potato based biscuits were also analyzed.

After collecting the potato samples, the proximate composition of fresh potato was found 79.0%, 1.8%, 0.25%, 2.13% and 16.82% of moisture, protein, fat, ash and total carbohydrate, respectively on wet weight basis. Calcium content (9.40 mg/100g, 6.57 mg/100g & 8.23 mg/100g), Magnesium (21.6 mg/100g, 13.09 mg/100g & 19.89 mg/100g), Potassium (413.91 mg/100g, 360.7 mg/100g & 400.78 mg/100g), Phosphorus (60.57 mg/100g, 46.65 mg/100g & 59.52 mg/100g), Iron (0.78 μg μg/100g, 0.69 μg/100g & 0.75 μg/100g) and Zinc content (0.29 μg/100g, 0.25 μg/100g & 0.25 μg/100g), respectively were found in fresh potatoes ($T_1$), peeled potatoes before boiling ($T_2$) and peeled potatoes after boiling ($T_3$).

In the past, prior to cooking potato skins were peeled with the idea that the potato would be cleaner, and therefore healthier. However it has been discovered that leaving the potato skins intact can add nutrients to a meal. The potato, as well as the skin, are great sources of vitamin C, vitamin $B_6$, copper, potassium, zinc and protein, but neither naturally contain any fat, cholesterol or sodium. Leaving the skin intact can also help preserve the nutrients in the flesh of the potato, which have a tendency to escape during cooking.

Potatoes are a very common food in the diets of most people, but sometimes the nutritional contribution of this staple crop is overlooked. To start with, there are considerable nutritional differences between potato dishes depending on how they are prepared or cooked for consumption. The nutritional contribution of potatoes towards a healthy balanced diet as when boiled or baked, potatoes are virtually fat-free food. The main energy providing nutrient in potatoes is carbohydrate in the form of starch. Carbohydrates are the primary source of energy for the body, and should supply at least half of our calories for the day (Burgos *et al.*, 2007).

Potatoes are a significant source of the mineral potassium, and also contain small amounts of magnesium and iron. Potassium has many functions in the body including muscle function and contraction, the transmission of nerve impulses, and the regulation of blood pressure. Potatoes naturally contain almost no sodium (which together with chloride form salt). Consumption of too much salt associated with the risk of high blood pressure (hypertension). The combination of high potassium and low sodium content makes potatoes a healthy food for people trying to manage their blood pressure (Adrogue and Madias, 2007).

Because of the diversity of ways in which potatoes are prepared, the nutritional content of potato meals is very variable. Nutrient losses through cooking depend on the temperature and the length of cooking time. Water soluble vitamins and minerals such as B vitamins, vitamin C and potassium leech out from the potatoes into cooking water when boiled. Hence it is recommended that boiling potatoes with their skins on greatly reduces these nutrient losses (Anonymous, 2005).

In conclusion, potato mineral levels can be easily manipulated to meet the needs of consumers. If the goal is to add minerals to the diet through the consumption of potatoes, then this can be done by boiling whole potatoes.

Biscuit was prepared using potato powder at 15%, 25% and 35% concentrations respectively. The nutrient composition was analyzed for different parameters like moisture, ash fat, protein and carbohydrates. Among the different treatments in biscuit, moisture content ranged from 5.0% to 7.30%. The lowest (5.0%) was recorded in the control ($T_0$). Potato flour incorporation showed more moisture percentage in biscuit 7.30% in $T_4$. Protein content was gradually reduced. Potato powder incorporation minimizes the protein content. The fat content in biscuit ranged from 11.0% ($T_1$) to 12.67% ($T_4$) among the treatments. There was no significant difference on carbohydrate content.

It was found that potato contains a limited amount of protein although rich in dietary fiber content and carbohydrate, so a successful combination with wheat flour for biscuit production would be nutritionally advantageous.

The study was also conducted to find out the best proportion of wheat and potato flour to formulate the biscuit. Biscuit containing 25 percent potato flour showed the best performance compared to other proportion of flour used. For the large scale biscuit manufacture, potato flour can be incorporated up to 25 percent level, without affecting the sensory characteristics of biscuits as was accepted by the panelists. Moreover, nutritional value of potato flour incorporated biscuits was similar to the control (Wheat flour) biscuits, thus not affecting its nutritional quality. Hence, potato flour may prove to be quite economical and acceptable to replace wheat flour in biscuit preparation.

A significant amount of potato is spoiled and wasted due to inadequate cold storage facilities and insufficient post harvest handling facilities. Potatoes can also be utilized for the preparation of value added products. Thus minimization of post harvest losses of potatoes might be possible through proper handling and processing them into value-added products, which would contribute to ensure the food security to some extent in Bangladesh as well as the overall world.

The results suggested that potato flour could economically be used to replace wheat flour in biscuit production and could yield products of highly acceptable quality. Biscuits with potato flour were mostly higher in ash content resulting supplementation of wheat flour with potato flour for biscuit production is advantageous.

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# REFERENCES


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# APPENDICES

## APPENDIX –I

### SENSORY EVALUATION DATA OF BISCUITS MADE FROM POTATO FLOUR

**Name of the tester....................** **Date:....................**

Please taste these samples and check how much you like or dislike each one on four sensory attributes such as Color, Flavor, Taste, texture and Overall Acceptability. Use the appropriate scale to show your attitude by checking at the point that best describe your feeling about the sample. Please give a reason for this attitude. Remember you are the only one who can tell what you like. An honest expression of your personal feeling will help me.

| Sample | Sensory attributes | | | | |
|---|---|---|---|---|---|
| | Color | Flavor | Texture | Taste | Overall Acceptability |
| T1 | | | | | |
| T2 | | | | | |
| T3 | | | | | |
| T4 | | | | | |

Extra comments on each sample if any:

N.B. Overall Evaluation:

Hedonic scale used: 9=Like extremely; 8=Like very much; 7= Like moderately; 6=Like slightly; 5= Neither like nor dislike; 4=Dislike slightly; 3= Dislike moderately; 2= Dislike very much; 1=Dislike extremely

# APPENDIX –II

**4.4 Sensory evaluation data of biscuits made from potato flour**

**Table 4.4.1 Rating score for Color of Potato flour incorporated biscuit**

| Panelist No. | Sample No. | | | | Total |
|---|---|---|---|---|---|
| | $T_1$ | $T_2$ | $T_3$ | $T_4$ | |
| 1 | 8 | 6 | 6 | 4 | 24 |
| 2 | 8 | 6 | 5 | 6 | 25 |
| 3 | 9 | 5 | 7 | 7 | 28 |
| 4 | 9 | 4 | 7 | 5 | 25 |
| 5 | 8 | 6 | 6 | 7 | 27 |
| 6 | 7 | 6 | 7 | 7 | 27 |
| 7 | 7 | 7 | 6 | 6 | 26 |
| 8 | 7 | 7 | 7 | 7 | 28 |
| 9 | 8 | 6 | 9 | 6 | 29 |
| 10 | 7 | 6 | 9 | 6 | 28 |
| Total | 78 | 59 | 69 | 61 | 267 |
| Mean | 7.8 | 5.9 | 6.9 | 6.1 | |

Hedonic scale used: 9 = Like extremely; 8 = Like very much; 7 = Like moderately; 6 = Like slightly; 5 = Neither like nor dislike; 4 = Dislike slightly; 3 = Dislike moderately; 2 = Dislike very much; 1 = Dislike extremely.

**Table 4.4.2 Analysis of variance (ANOVA) for color**

| Source | Degree of freedom | Sum of squares | Mean squares | F- value | |
|---|---|---|---|---|---|
| | | | | Calculated | Tabulated |
| Judges | 9 | 6.025 | 0.669 | 0.5970 | 2.250 |
| Products | 3 | 22.475 | 7.492 | 6.6813 | 2.960 |
| Error | 27 | 30.275 | 1.121 | | |
| Total | 39 | 58.775 | | | |

**Table 4.4.3 Duncan's Multiple Range Test (DMRT) for Color**

**LSD value =0.9715, P<0.05**

| Sample Code | Original order of means | Sample Code | Ranked order of means |
|---|---|---|---|
| $T_1$ | $7.800^{a}$ | $T_1$ | $7.800^{a}$ |
| $T_2$ | $5.900^{b}$ | $T_3$ | $6.900^{ab}$ |
| $T_3$ | $6.900^{ab}$ | $T_4$ | $6.100^{b}$ |
| $T_4$ | $6.100^{b}$ | $T_2$ | $5.900^{b}$ |

**Table 4.4.4 Rating score for Flavor of Potato flour incorporated biscuit**

| Panelist No. | Sample No. | | | | Total |
|---|---|---|---|---|---|
| | $T_1$ | $T_2$ | $T_3$ | $T_4$ | |
| 1 | 7 | 6 | 6 | 5 | 23 |
| 2 | 8 | 6 | 7 | 5 | 26 |
| 3 | 7 | 5 | 6 | 6 | 24 |
| 4 | 7 | 6 | 7 | 5 | 25 |
| 5 | 6 | 7 | 7 | 6 | 26 |

| | | | | | |
|---|---|---|---|---|---|
| 6 | 8 | 6 | 6 | 5 | 25 |
| 7 | 8 | 6 | 7 | 6 | 27 |
| 8 | 7 | 7 | 8 | 5 | 27 |
| 9 | 7 | 7 | 6 | 5 | 25 |
| 10 | 7 | 5 | 6 | 6 | 24 |
| Total | 72 | 61 | 66 | 54 | 253 |
| Mean | 7.2 | 6.1 | 6.6 | 5.4 | |

Hedonic scale used: 9 = Like extremely; 8 = Like very much; 7 = Like moderately; 6 = Like slightly; 5 = Neither like nor dislike; 4 = Dislike slightly; 3 = Dislike moderately; 2 = Dislike very much; 1 = Dislike extremely.

**Table 4.4.5 Analysis of variance (ANOVA) for flavor**

| Source | Degree of freedom | Sum of squares | Mean squares | F- value | |
|---|---|---|---|---|---|
| | | | | Calculated | Tabulated |
| Judges | 9 | 3.025 | 0.336 | 0.7393 | 2.250 |
| Products | 3 | 17.475 | 5.825 | 12.8126 | 2.960 |
| Error | 27 | 12.275 | 0.455 | | |
| Total | 39 | 32.775 | | | |

**Table 4.4.6 Duncan's Multiple Range Test (DMRT) for flavor**
**LSD value =0.6190, $P<0.05$**

| Sample Code | Original order of means | Sample Code | Ranked order of means |
|---|---|---|---|
| $T_1$ | $7.200^a$ | $T_1$ | $7.200^a$ |
| $T_2$ | $6.100^b$ | $T_3$ | $6.600^{ab}$ |
| $T_3$ | $6.600^{ab}$ | $T_2$ | $6.100^b$ |
| $T_4$ | $5.400^c$ | $T_4$ | $5.400^c$ |

**Table 4.4.7 Rating score for Texture of Potato flour incorporated biscuit**

| Panelist No. | Sample No. | | | | Total |
|---|---|---|---|---|---|
| | $T_1$ | $T_2$ | $T_3$ | $T_4$ | |
| 1 | 8 | 6 | 6 | 4 | 24 |
| 2 | 7 | 7 | 7 | 5 | 26 |
| 3 | 6 | 6 | 8 | 6 | 26 |
| 4 | 7 | 6 | 8 | 6 | 27 |
| 5 | 6 | 7 | 7 | 5 | 25 |
| 6 | 7 | 6 | 8 | 6 | 27 |
| 7 | 8 | 7 | 8 | 7 | 30 |
| 8 | 7 | 7 | 7 | 6 | 27 |
| 9 | 8 | 6 | 8 | 6 | 28 |
| 10 | 8 | 6 | 8 | 4 | 26 |
| Total | 72 | 64 | 75 | 55 | 266 |
| Mean | 7.2 | 6.4 | 7.5 | 5.5 | |

Hedonic scale used: 9 = Like extremely; 8 = Like very much; 7 = Like moderately; 6 = Like slightly; 5 = Neither like nor dislike; 4 = Dislike slightly; 3 = Dislike moderately; 2 = Dislike very much; 1 = Dislike extremely.

**Table 4.4.8 Analysis of variance (ANOVA) for texture**

| Source | Degree of freedom | Sum of squares | Mean squares | F- value | |
|---|---|---|---|---|---|
| | | | | Calculated | Tabulated |
| Judges | 9 | 6.100 | 0.678 | 1.2282 | 2.250 |
| Products | 3 | 24.100 | 8.033 | 14.5570 | 2.960 |
| Error | 27 | 14.900 | 0.552 | | |
| Total | 39 | 45.100 | | | |

**Table 4.4.9 Duncan's Multiple Range Test (DMRT) for texture**

**LSD value =0.6818, P<0.05**

| Sample Code | Original order of means | Sample Code | Ranked order of means |
|---|---|---|---|
| $T_1$ | $7.200^a$ | $T_3$ | $7.500^a$ |
| $T_2$ | $6.500^b$ | $T_1$ | $7.200^a$ |
| $T_3$ | $7.500^a$ | $T_2$ | $6.500^b$ |
| $T_4$ | $5.500^c$ | $T_4$ | $5.500^c$ |

**Table 4.4.10 Rating score for Taste of Potato flour incorporated biscuit**

| Panelist No. | Sample No. | | | | Total |
|---|---|---|---|---|---|
| | $T_1$ | $T_2$ | $T_3$ | $T_4$ | |
| 1 | 7 | 6 | 7 | 4 | 24 |
| 2 | 8 | 6 | 6 | 5 | 25 |
| 3 | 7 | 9 | 8 | 5 | 29 |
| 4 | 8 | 6 | 7 | 6 | 27 |
| 5 | 6 | 5 | 7 | 5 | 23 |
| 6 | 8 | 7 | 6 | 6 | 27 |
| 7 | 8 | 6 | 7 | 4 | 25 |
| 8 | 7 | 7 | 8 | 6 | 28 |
| 9 | 8 | 8 | 7 | 5 | 28 |
| 10 | 7 | 5 | 6 | 6 | 24 |
| Total | 74 | 65 | 69 | 52 | 260 |
| Mean | 7.4 | 6.5 | 6.9 | 5.2 | |

Hedonic scale used: 9 = Like extremely; 8 = Like very much; 7 = Like moderately; 6 = Like slightly; 5 = Neither like nor dislike; 4 = Dislike slightly; 3 = Dislike moderately; 2 = Dislike very much; 1 = Dislike extremely.

**Table 4.4.11 Analysis of variance (ANOVA) for taste**

| Source | Degree of freedom | Sum of squares | Mean squares | F- value | |
|---|---|---|---|---|---|
| | | | | Calculated | Tabulated |
| Judges | 9 | 9.500 | 1.056 | 1.4322 | 2.250 |
| Products | 3 | 26.600 | 8.867 | 12.0302 | 2.960 |
| Error | 27 | 19.900 | 0.737 | | |
| Total | 39 | 56.000 | | | |

**Table 4.4.12 Duncan's Multiple Range Test (DMRT) for taste**

**LSD value =0.7878, $P<0.05$**

| Sample Code | Original order of means | Sample Code | Ranked order of means |
|---|---|---|---|
| $T_1$ | $7.400^{a}$ | $T_1$ | $7.400^{a}$ |
| $T_2$ | $6.500^{b}$ | $T_3$ | $6.900^{ab}$ |
| $T_3$ | $6.900^{ab}$ | $T_2$ | $6.500^{b}$ |
| $T_4$ | $5.200^{c}$ | $T_4$ | $5.200^{c}$ |

**Table 4.4.15 Duncan's Multiple Range Test (DMRT) for Overall Acceptability LSD value =0.6623, P<0.05**

| Sample Code | Original order of means | Sample Code | Ranked order of means |
|---|---|---|---|
| $T_1$ | $6.900^a$ | $T_3$ | $7.200^a$ |
| $T_2$ | $6.200^b$ | $T_1$ | $6.900^a$ |
| $T_3$ | $7.200^a$ | $T_2$ | $6.200^b$ |
| $T_4$ | $5.200^c$ | $T_4$ | $5.200^c$ |