

## **Introduction**

In most developing countries, protein-energy malnutrition (PEM) is evidenced by the prevalence of stunting, wasting and low weight for age among children is the major public health problem. Other vulnerable groups include pregnant and lactating mothers leading to low birth weights and can affect milk production.

Lysine is the limiting amino acid in cereals while methionine is limiting in legumes, thus the deficiency of lysine can be over-come by the addition of legumes in the right amount to give a food with good quality protein.

In Sudan, prevalence of (PEM) was documented in many studies especially among children, for more than forty years.

However, (PEM) is one the increase in the south due to cyclical periods of drought.

The increase in poverty in urban areas and the rural migration to the urban centers particularly, Khartoum adds to problem.

Since the seventies, many attempts were made to decrease the prevalence of (PEM) in Sudan. Many home-based food recipes were reported, in which cereals were fortified with legumes or oil seeds and the improvement of the food in question was supported by chemical and biological studies.

Sudan's production of legumes is mostly for domestic consumption and in some years, when production is lower than consumption some legumes are imported e.g. broad-beans. However, groundnuts, sesame seed have always been of the major agricultural export commodities. Thus fortification of

cereals with these oilseeds is only logical to produce high protein foods on an industrial scale.

Biscuits produced commercially in Sudan are all of the traditional type i.e. not fortified to improve any nutrient element. Recently, the production of high energy adequate protein biscuits was revived. It was produced on a pilot scale and acceptability tests were carried out. These biscuits were based on wheat flour fortified with unhulled sesame seed and groundnut, their production is on a semi commercial scale, at present.

To produce high protein adequate energy biscuits on industrial scale, the need arose to reduce the cost and improve the quality of the product.

### **1-1 Objectives of the Study:**

1. To produce low cost biscuits of high protein quality that provide adequate energy for use in emergencies and by children especially from low socio-economic strata of the population.
2. To study the nutritive value of the product.
3. To compare fortified biscuits with commercial.
4. To study the quality of the product.

## Literature review

### 2-1 Biscuit industry:

Biscuit is a popular item in the diet of weaned infants and young children. The word (biscuit) is derived from the Latin, *biscoctus*, or the old French, *bescoit*, (Concise Oxford Dictionary, 1995), meaning twice cooked, a reference to the practice of first baking the product in a hot oven and then transferring it to a cooler oven to complete the drying out process. The product known as (biscuit) in the U.S.K Wade (1988)

### 2-2 Production and consumption of biscuits in Sudan:

The biscuits industry started in Sudan in the early sixties with three pioneer factories namely (Sinnar) Karam and Kambal in Sudan. The estimated biscuit production was 12500 tones in the year 1996

### 2-3 Biscuit raw materials:

#### 2-3-1 Wheat flour:

Finny 1994 mentioned that the international commercial wheat crop is limited for all practical purposes to two species *triticum* and *aestivum* which include the common hard and soft wheat used to produce bread and many products and *triticum* and *turgidum* which include the durum or macaroni wheat. Lorenz 1994 reported that edible fats and oil are complex mixtures of triglycerides and small amounts of other substances occurring naturally or derived through processing and storage of the fat. A triglyceride is composed of glycerol and three fatty acids. The majority of sweeteners are obtained from sugar in one form or another, and sugar (sucrose) is derived from two sources. The main source is sugar cane and the secondary source is sugar beet (Whiteley, 1971).

### **2-3-2 Dairy products:**

Whietely (1971) reported that ,although milk is approximately 87% water,

### **2-3-3 Dairy products –cookies:**

Whietely (1971) reported that, although milk is approximately

- water, it is a remarkably well balanced and nutritious food, consequently, it will enrich any product in which it is used in place of water. It will enhance flavor and because of the sugar present, it will increase the color.

Wade (1988) noticed that fresh whole milk is replaced successively by evaporated or condensed milk, whole milk powder, skimmed milk powder and currently by demineralized whey powder.

The presence of amino acids derived from milk is desirable in many product formulations to promote the browning reaction during baking which is responsible for the development of the color and flavor of biscuits.

### **2-3-4 Aerating agent:**

Whitely (1971) reported that to improve texture, bite, and appearance, it is necessary to achieve some form of aeration e.g. mechanical, biological and chemical. Stauffer (1994) noticed that leavening of cookies produces two results: An increase in the total volume of the cookie and an alteration of the spread ratio, cookies are leavened by steam, CO<sub>2</sub> from the

decomposition of added soda and ammonium bicarbonate. Soda is added to cookie dough's both to raise the pH and to give some leavening effect through release of CO<sub>2</sub> in the oven.

Also ammonium bicarbonate is frequently used in cookie doughs, particularly the low moisture types such as rotary cookies, to increase the volume.

## **2-4 Fortification:**

Food fortification or enrichment is the process of adding micronutrients (essential trace elements and vitamins) to food. It may be a purely commercial choice to provide extra nutrients in a food, while other times it is a public health policy which aims to reduce the number of people with dietary deficiencies within a population. Staple foods of a region can lack particular nutrients due to the soil of the region or from inherent inadequacy of a normal diet. Addition of micronutrients to staples and condiments can prevent large-scale deficiency diseases in these cases.

Manufactured from wheat kernels, flour is the key ingredient found in about 75 percent of all grain products. The per capita annual consumption of flour is about 138 pounds in the United States in such foods as bread, cakes and cookies. Flour varieties are produced by milling and combining different parts and types of wheat grain. As nutrient loss occurs during milling, nutrients are added to flour in amounts equal to those present before processing to make enriched flour. Fortified flour is made by adding nutrients in excess to quantities lost during milling, or additional nutrients are added to improve its nutritive value."Micronutrient Fortification and Biofortification Challenge | Copenhagen Consensus Center".

The four main methods of food fortification (named as to indicate the procedure that is used in order to fortify the food):

Biofortification (i.e. breeding crops to increase their nutritional value, which can include both conventional selective breeding, and modern genetic modification) Synthetic biology (i.e. addition of robotic bacteria to foods) .

Commercial and industrial fortification (i.e. flour, rice, oils (common cooking foods) Home fortification (e.g. vitamin D drops)[4] Fortification is adding vitamins and minerals to foods to prevent nutritional deficiencies. The nutrients regularly used in grain fortification prevent diseases, strengthen immune systems, and improve productivity and cognitive development.

#### **2-4-1 Wheat flour, maize flour, and rice are primarily fortified to:**

Prevent nutritional anemia .

Prevent birth defects of the brain and spine .

Increase productivity .

Improve economic progress .

Fortification is successful because it makes frequently eaten foods more nutritious without relying on consumers to change their habits.

The following 12 vitamins and minerals are used in flour and rice fortification globally. Each country sets standards to include the specific nutrients its population needs.

Iron, riboflavin, folic acid, zinc, and vitamin B12 help prevent nutritional anemia which improves productivity, maternal health, and cognitive development.

Folic acid (vitamin B9) reduces the risk of severe birth defects of the brain and spine.

Zinc helps children develop, strengthens immune systems, and lessens complications from diarrhea.

Niacin (vitamin B3) prevents the skin disease known as pellagra.

Riboflavin (vitamin B2) helps with metabolism of fats, carbohydrates, and proteins.

Thiamin (vitamin B1) prevents the nervous system disease called beriberi.

Vitamin B12 maintains functions of the brain and nervous system.

Vitamin D helps bodies absorb calcium which improves bone health.

Vitamin A deficiency is the leading cause of childhood blindness. It also diminishes an individual's ability to fight infections. Vitamin A can be added to wheat or maize flour, but it is often added to rice, cooking oils, margarine, or sugar instead.

Calcium builds strong bones, helps transmit nerve messages and assists with muscle function and blood clotting. A few countries add calcium to flour, but it is more commonly added to other foods.

Selenium helps with reproduction and thyroid gland function.

Vitamin B6 is needed for enzyme reactions involved in metabolism.

Fortification as part of a country's nutrition strategy is supported by global organizations such as UNICEF, the World Health Organization (WHO), the U.S. Centers for Disease Control and Prevention (CDC), the Global Alliance for Improved Nutrition (GAIN), and Nutrition International. For the latest evidence and guidance on nutrition interventions, see the WHO e-Library of Evidence for Nutrition Actions (Elena).

Through its global partnership, FFI provides advocacy support and technical assistance to help you plan, implement, and monitor high-quality fortification practices. For assistance, please contact us at [info@ffinetwork.org](mailto:info@ffinetwork.org).

## **2-4-2 Iron**

### **2-4-2-1 Iron in the body :**

Iron is an important dietary mineral which carries oxygen around the body.

Iron is stored in hemoglobin (Hb) which is found in red blood cells.

Your hemoglobin levels in your blood may be low ( anemia ) if you do not have enough iron. This will make you feel tired, have poor concentration and an increased risk of infection.

### **2-4-2-2 Iron in food:**

**There are two types of iron in food:**

- haem iron (from animal foods)
- non-haem iron (from plant foods)

Haem iron is absorbed by the body about 10 times more easily than non-haem iron.

Meats are the best source of iron.



The redder the meat, the higher it is in iron.

This means beef, lamb & kangaroo are higher in iron than pork, chicken or fish.

Colored flesh fish (e.g. tuna and mullet) are higher in iron than reef fish, such as barramundi.

Non-haem iron is found in some plant foods and is not absorbed by the body as well as iron from animal foods. You will need to eat more of these foods if they are your only iron source.

### **Plant foods high in non-haem iron are:**

- legumes (eg. kidney beans, baked beans, chick peas) .
- whole grain and iron fortified breads and breakfast cereals .
- green leafy vegetables (e.g. spinach, broccoli, bok choy, kale) .
- nuts and dried fruit .

To increase how much iron the body absorbs from plant foods, eat foods high in vitamin C (e.g. fruits and vegetables), or foods containing haem iron (red meat, colored flesh fish) at the same meal.

### **2-4-2-3 Iron blockers :**

Tea, coffee, unprocessed bran, some soy proteins and various mineral, herbal and other medications can block plant iron being absorbed by the body.

### **What to do if your iron levels are low ?**

- Regularly eat animal sources of iron –remember the redder the better

- Eat wholegrain and iron fortified foods(eg. breakfast cereals with added iron) .
- Eat vitamin C foods at meals (orangejuice, capsicum, citrus fruit, tomatoes) .
- Try to limit “iron blockers“ .
- If your iron is still low after trying thesehints, talk to your doctor about takingiron tablets .

This is a consensus document from Dietitian/ Nutritionists from the Nutrition Education Materials Online, "NEMO", team.

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### **2-4-2-4 Iron tablets :**

Iron tablets should only be taken when a blood test confirms that your levels are low. You may experience constipation from taking iron tablets. You can manage this by having a diet high in unprocessed plant foods (fruits, vegetables, wholegrain, legumes), drinking more water and being physically active.

### **How much iron do you need?**

Men 8mg/day

Women (19-50) 18mg/day

Women (51+) 8mg/day

Requirements vary during pregnancy and lactation – refer to the NEMO resource

‘Iron for Pregnant Women’.

### **How much iron is in food?**

Food (serving size) Iron (mg)

**Meat and meat alternatives :**

Kangaroo (100 g) 4.4

Lean beef (100 g) 3.1

Lean Lamb (100 g) 2.5

Chicken (100 g) 0.9

Lean Pork (100 g) 1.4

Tuna (100 g or one small can) 1.0

Sardines (120 g or one reg tin) 3.24

Egg (1 egg= 55 g) 1.1

Snapper (100 g) 0.3

Kidney beans (1/2 cup) 2.1

Baked beans (1 sml can=140g) 2.24

3 bean mix (1/2 cup) 2.0

Tofu (2 large squares = 100 g) 5.2

Chickpeas (100 g) 6.2

**Bread and Cereal Foods :**

Iron fortified breakfast cereal(1 bowl or 2 biscuits = 30 g)3

Non-fortified breakfast cereal (30g) 1

Wheat biscuits (2 pieces) 3

Oats (1 cup) 1.3

Wholegrain bread (1 slice) 0.63

Wholemeal bread (1 slice) 0.69

White bread (1 slice) 0.36

Brown rice (100 g) 0.5

Pasta (1 cup cooked) 0.6

Wholegrain cracker (4 crackers) 0.6

**Vegetables :**

0.5 cup cooked spinach 2.2

5 asparagus spears 1.0

0.5 cup green beans 1.0

3 slices beetroot 1.2

0.5 cup cooked silver beet 1.3

Potato (1 small) 0.5

0.5 cup green peas 0.9

Bok Choy (100 g) 0.8

**Fruit :**

Dried Apricots (8-10 apricot halves) 1.5

Prunes (5-6 prunes) 0.55

Sultanas (1 little box =37 g) 0.74

Fresh fruit (100 g) 0.2–0.7

## **Dairy foods :**

Cheese (1 slice) 0.1

Milk (1 cup) 0.3

Snack foods and drinks

Cashews (2–3 tablespoons = 50 g) 2.5

Pine nuts (50 g) 2

Pistachios (2–3 tablespoons =50 g) 1.95

Almonds (50 g) 1.8

Milo (4 heaped teaspoons) 6

Peanut Butter (1 tablespoon) 0.5

Vegemite (1 tsp) 0.13

Liquor ice (1 long strap =50 g) 4.4

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### **- What is Fortified Flour?**

Manufactured from wheat kernels, flour is the key ingredient found in about 75 percent of all grain products. The per capita annual consumption of flour is about 138 pounds in the United States in such foods as bread, cakes and cookies.

Flour varieties are produced by milling and combining different parts and types of wheat grain. As nutrient loss occurs during milling, nutrients are added to flour in amounts equal to those present before processing to make enriched flour.

Fortified flour is made by adding nutrients in excess to quantities lost during milling, or additional nutrients are added to improve its nutritive value.

## **2-5 Chemical composition of sesame seeds:**

### **2-5-1 Moisture content :**

Johnson and Raymond (1964) reported a value of 5.47% moisture content for sesame seed while a value of 6.2% moisture content was reported by Khalid (1994) who showed that the moisture content ranges between 3.4% and EL-Nadeef (1990) reported that the moisture content of sesame seeds samples range from 1.5% to 2.5% .

Ali (2000) reported that sesame seed cake ( white and brown ) gave an average value of 5.8% and 5.3% respectively .

### **2-5-2 Lipids :**

Air-dried sesame seeds usually has an oil content between 44-54% but oil content as low as 35% and as high as 57% were know , the most outstanding characteristic of the oil is its stability , which is due to natural antioxidants (EL-Tinay et al., 1976) .

The oil content varies with genetic and environmental factors, a wide range of the oil content of sesame seed from 37% to 63% was reported by Bernadine (1986) .

Sabah EL-Khrir (1994) reported oil content of sesame cultivars as ranging from 47% to 54% . Weiss ( 1983) reported that lipids of sesame seeds are mostly composed of neutral triglyceride with small quantities of phosphatides (0.03 to 0.13%) and unsaponifiable matter (1.2%) .

Sesame oil deep to pale yellow in color , it has a pleasant odor and taste , it contains about 80% unsaturated fatty acids , oleic and linoleic acids are the major fatty acids present in approximately equally amounts , The saturated fatty acids for

less than 20% of total fatty acids , palmitic and stearic acids are the major saturated fatty acids in sesame oil (Lyon 1972).

### **2-5-3 Sesame protein :**

Joshi (1961) and Lyon (1972) reported that the average protein content in sesame seeds ranges from 19% to 31% The protein content of oil free residue varied from 45% to 60% in the local varieties , as reported by EL-Tinay et al .(1976) .

Meksongsee and Swatditat (1974) indicated that the protein content of the defatted flour of between and white sesame seed was 33.3% to 44% .

Ali (2000) reported that sesame seed cakes (white and brown) give an average value of 44% and 45.3% protein , respectively .

Rivas et al. (1981) classified the sesame protein to globulins 67.3% , prolamin 1.3% , albumin 8.6% and glutelin 6.9% . Sesame protein are rich in sulfur-containing amino acids , particularly , methionine (Rao and rao ,1981) . Evans and Bandemer(1967) reported protein nutritive value of sesame as 15 to 42 relative to casein as 100 .

Fisher (1973) noticed that the net protein utilization (NPU) of sesame meal was 0.56 as whole egg powder .

The protein efficiency ratio (PER) of sesame seeds, meal , and isolated protein are 1.86 , 1.35 and 1.2 , respectively . Commercial prepared flour and press cake showed values of 0.9 and 1.03 .

Supplementation of sesame seeds protein with lysine can increase its PER value to 2.9 biological value of sesame seeds protein is 62, which is lower than of soybean (Hui, 1996) .

#### **2-5-4 Carbohydrates :**

Joshi (1961) reported that the carbohydrates contents of sesame seeds is comparable to that of ground nut seeds and is higher than that of soybean seeds Sesame seeds contain 21-25% carbohydrates , most of the sugars are reducing type . Defatted sesame flour contains more sugar than sesame seeds .

#### **2-5-5 Crude fiber :**

Johnson and Raymond (1964) showed a value of 2.86% crude fiber in white sesame seeds while Sawaya et al. (1983) reported a value of 2.3% crude fiber in sesame seed and Revero (1983) reported a value of 6.5% crude fiber . Khalid (1994) found that the crude fiber content in sesame seeds ranged from 9.1 to 11.5% However , El-Nadeef (1990) reported that the fiber content of sesame seeds ranged between 5.2% and 7.6% .

Ali (2000) reported that sesame seed cakes (white and brown) give an average value of 5.6 and 6.0% fiber , respectively .

#### **2-5-6 Ash :**

Sawaya et al. (1985) reported that sesame seed contains about 3% ash while Rivero (1983) reported a value of 6.93% ash content .

Sabah El-Khair (1994) showed that the total ash content of sesame cultivars ranged from 8.1 to 13.5% However , Ali (2000) reported that sesame seed cakes ( white and brown) gave average value of 16.7% and 9.6% respectively .

#### **2-5-7 Minerals:**

Sesame seed is a good source of certain minerals particularly calcium , phosphorus and iron . Deosthale (1981)



reported 1% calcium and 07% phosphorus in the seeds , calcium is mostly present in the seed coat , which is the lost during dehulling .

Furthermore the bioavailabilityof calcium from sesame is less than the from milk or bread probably because of the high concentration of oxalate and phytate in the seed .

Ponerose-Schneier and Eerdam (1989) reported the bioavailability of calcium from food products, as follows: non fat dry milk 100% , whole wheat bread 95% almond powder 60% , sesame seeds 65% and Spanish 47% .

### **2-5-8 Vitamins :**

Sesame seeds are important source of certain vitamins , particularly niacin , folic acid and tocopherols, (vitamin E include several tocopherols) , sesame oil is rich in tocopherols , while vitamin A is very low (Gopalan et al., and weiss , 1983) .

## **Materials and methods**

Fortified energy biscuit who collected from company Food security and another two type of biscuit glucose biscuits (GB) and Baraka biscuit (BB) were bought from local market in Khartoum North.

### **3-1 materials**

#### **3-1-1 Food Materials**

Food materials include red sesame seed, white sesame seed, wheat flour, shortening, vegetable ghee, sugar, skimmed milk powder, aerating agent preservative agent. All the food materials were purchased from local markets at Khartoum North.

##### **3-1-1-1 wheat flour:**

Australian wheat flour, Blue color (all purpose) and yellow color (for biscuits and sweeter) for local flour mills used in the recipes.

#### **3.1.2 Preparation of biscuit samples:**

Biscuits were prepared according to modified method based on Whiteley (1971) method:

Ingredients	Quantily (g)	
	Modified method	Whitley method (1971)
Flour	100	100
Suger	44	35
Shortening	24	25
Skimmed milk powder	12	2.0
Sodium chloride	0.60	1.17
Sodium bicarbonate	0.60	0.36
Ammonium bicarbonate	1.20	0.27
Glucose	5	4.0
Water	As required	.....
BHA + BHT	0.004	.....

### **3-1-3 Component of Baraka biscuit:**

1. Wheat flower.
2. Sugar.
3. Vegetable Ghee.
4. Liquid glucose.
5. Skimmed milk powder.
6. Arisen Agents (ammonium bi carbonate).
7. Sodium bi carbonate.
8. Lecithin.
9. Citric acid.
10. Vanilla flavor.

### **3-1-4 Component of glucose biscuit:**

1. Wheat flour.
2. Sugar.
3. Vegetable ghee.
4. Ammonium bi carbonate.
5. Sodium bi carbonate.
6. Salt.
7. Milk powder.
8. Soya lecithin.
9. Vanillin flavor.
10. Glucose.
11. Butter flavor.

Potassium sorbet.

## Results & Discussion

### 4-1 Proximate analysis:

#### 4-1-1 Moisture content:

The moisture content was determined according to the method described by AOAC (2000). Three grams of well-mixed samples were weighed accurately in clean preheated moisture dish of known weight by using sensitive balance. The uncovered dishes with the sample were kept in an air oven provided with a fan at 130<sup>0</sup>C for 1 hour. The dish was then covered and transferred to desiccators and weighed after cooled to room temperature.

The loss of weight was calculated as percent of sample weight and expresses as moisture content:

$$\text{Moisture content \%} = \frac{(W_{t_1} - W_{t_2})}{\text{Sample wt.}} \times 100$$

Sample wt.

**Where:**

$W_{t_1}$  = Weight of sample + dish before oven dry.

$W_{t_2}$  = Weight of sample + dish after oven dry.

#### 4-1-2 Ash content:

The ash content of the sample was measured according to the AOAC (2000). 2g sample was weight into a clean dry porcelain crucible and placed muffle furnace (model Tipoforno Z A No. 18203 Get Ran 1002) at 6000<sup>0</sup>C for 6 hours.

The crucible was transferred to a desiccator, cooled to room temperature and weighed. The ash content was calculated as follows:

$$\text{Ash content \%} = \frac{(W_{t_1} - W_{t_2}) \times 100 \times 100}{\text{Weight of sample} \times (100 - m)}$$

**Where:**

$W_{t_1}$  = Weight of crucible with ash.

$W_{t_2}$  = Weight of empty crucible.

m = Initial sample moisture

**4-1-3 Protein content:**

The protein content of the samples was determined by the micro-kjeldahl method (AOAC, 2000). Sample of 0.2g was weighed accurately into a micro-kjeldahl flask, 0.4g of catalyst mixture and 3.5 ml of concentrated sulphuric acid were added, the flask was placed into the kjeldahl digestion unit for about 2 hours until a colorless digest solution was obtained. The flask was left to cool at room temperature, and then transferred to distillation unit. Twenty ml of 40% sodium hydroxide solution were added to the digested solution and the mixture was heated.

The ammonia evolved was trapped into 10 ml of 2% boric acid solution, then titrated against 0.1 N hydrochloric acid using universal indicator (methyl red +bromo cresol green). The total nitrogen and protein were calculated using the following formula:

$$\text{Nitrogen [\%]} = \frac{\text{Volume of HCl} \times N \times 14 \times 100}{\text{Weight of sample} \times 1000}$$

$$\text{Protein [\%]} = \frac{\text{Nitrogen [\%]} \times 6.25 \times 100}{100-m}$$

**Where:**

Nitrogen [%] = Crude nitrogen.

Protein [%] = Crude Protein

N = Normality of HCl.

14 = Equivalent weight of nitrogen.

m = Initial sample moisture.

**4-1-4 Crude fat:**

Crude fat was determined according to the AOAC (2000) method. A 5g weight of sample was extracted with hexane for 8 hours using Soxhlet apparatus. The solvent was evaporated and the remaining crude fat was evaporated and the remaining crude fat was determined.

$$\text{Fat \%} = \frac{(W_2 - W_1) \times 100 \times 100}{\text{Weight of sample} \times (100 - m)}$$

**Where:**

W<sub>t1</sub> = Weight of empty flask.

W<sub>t2</sub> = Weight of flask with oil.

m = Initial sample moisture

#### **4-1-5 Crude fiber:**

Crude fiber was determined according to the AOAC (2000) method. Two grams of an air dried fat-free sample were transferred to a dry 600 ml beaker. The sample was digested with 200 ml of 1.25% (0.26N) H<sub>2</sub>SO<sub>4</sub> for 30 minutes, and the beaker was periodically swirled.

The contents were removed and filtered Buchner funnel, and washed with boiling water. The digestion was repeated using 200 ml of 1.25% (0.26N) NaOH for 30 minutes, and treated similarly as above. After the last washing the residue was transferred to ashing dish, and dried in an oven at 105<sup>0</sup>C overnight then cooled and weighed. The dried residue was ignited in a muffle furnace at 550<sup>0</sup>C to constant weight, and allowed to cool, then weighed.

**The fiber percentage was calculated as follows:**

$$\text{Crude fiber \%} = \frac{(W_1 - W_2) \times 100 \times 100}{\text{Wt. sample} \times (100 - \text{moisture})}$$

$$\text{Wt. sample} \times (100 - \text{moisture})$$

**Where:**

Wt1= Weight of sample and dish.

Wt2= Weight of dish with ashed sample.

#### **4-1-6 Available carbohydrate content:**

Total carbohydrate were calculated by difference according to Pearson (1970) using the following formula:

$$\text{Available carbohydrates\%} = 100 - (\text{moisture\%} + \text{crude fat\%} + \text{crude protein\%} + \text{ash\%} + \text{fiber\%}).$$



**Table (1): Proximate composition (%) of biscuits**

Sample	Moisture content	Ash content	Fat content	Crude protein	Crude fiber
A	3.077 <sup>a</sup> ±0.00	0.875 <sup>c</sup> ±0.23	2.915 <sup>c</sup> ±0.05	16.188 <sup>c</sup> ±0.62	-
B	3.049 <sup>b</sup> ±0.03	1.925 <sup>a</sup> ±0.52	3.595 <sup>a</sup> ±0.11	20.125 <sup>a</sup> ±3.71	2.97 ±0.50
C	3.050 <sup>b</sup> ±0.02	1.070 <sup>b</sup> ±0.13	3.015 <sup>b</sup> ±0.02	16.626 <sup>b</sup> ±1.24	-
<b>Lsd<sub>0.05</sub></b>	0.026 <sup>*</sup>	0.931 <sup>*</sup>	0.085 <sup>*</sup>	0.437 <sup>*</sup>	-
<b>SE±</b>	0.017	0.310	0.027	0.146	-

Values are mean±SD.

Mean values having different superscripts in a column are significantly different ( $P \leq 0.05$ ).

**Key:**

A ≡ Glucose biscuit

B ≡ Energy biscuit

C ≡ Baraka biscuit

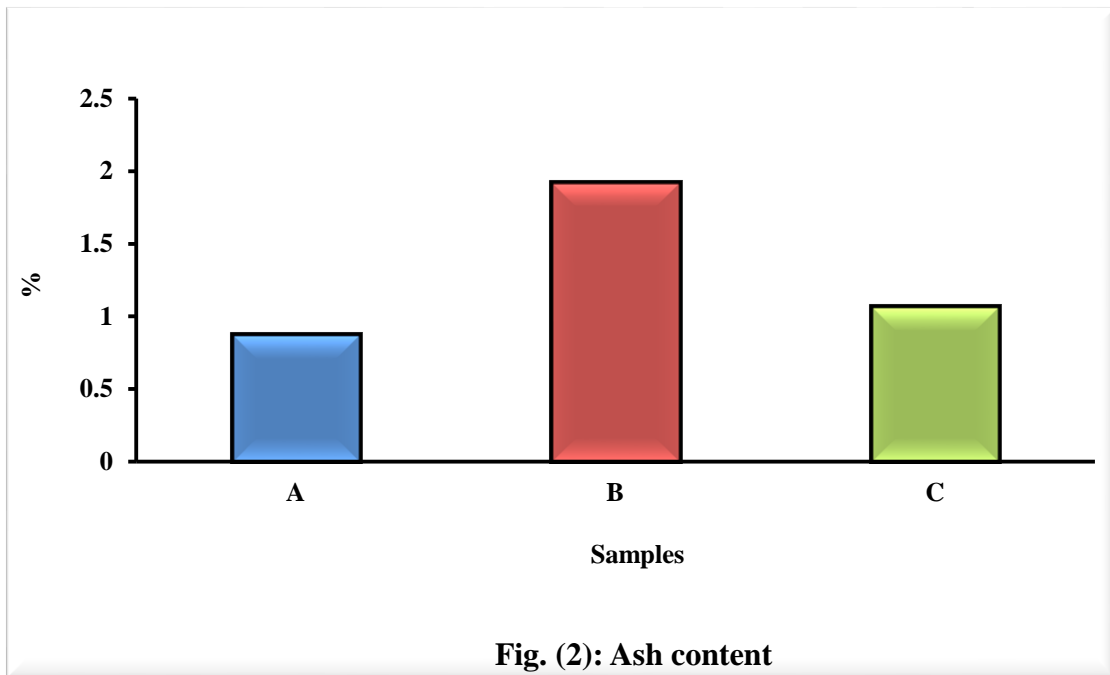
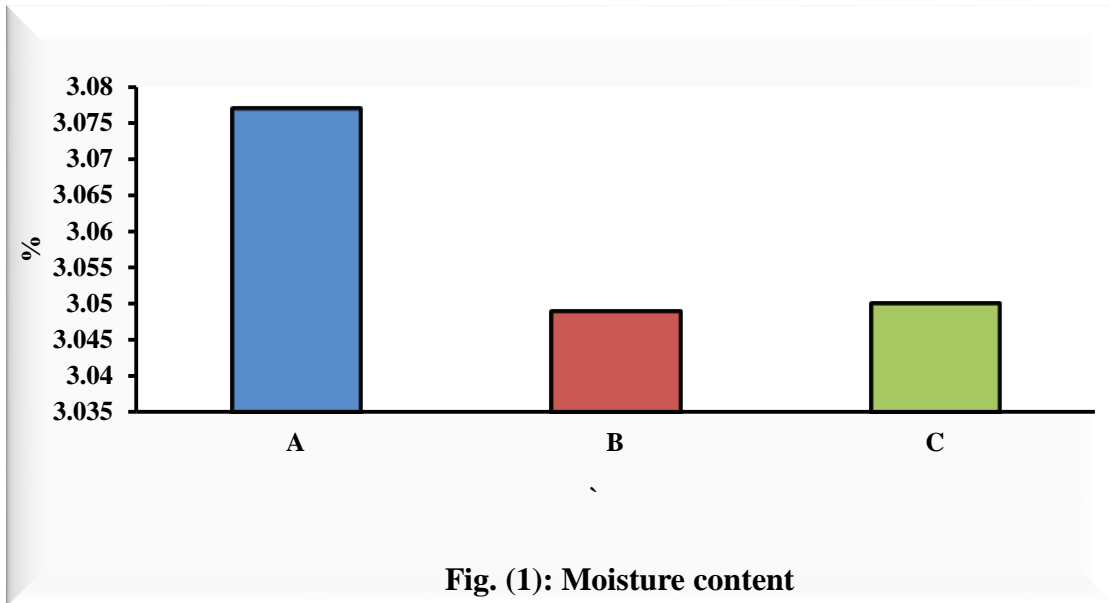
**Table (1):** shows the proximate composition of three types of commercial biscuit. The moisture content of glucose biscuit (GB) (3.077) is significantly lower than both types of energy biscuit (EB) and Baraka biscuit (BB), 3.044, 3.050% respectively. All the reads of moisture content of different commercial types of biscuit were higher than reported by Elshiekh, 2004 which are ranged between 1.8 to 2.9 % for wheat and sesame for formulation of biscuit.

**Table (2):** shows the proximate composition of three types of commercial biscuit. The protein content of glucose biscuit (GB) (16.1188) was significantly lower than both types of energy biscuit (EB) and Baraka biscuit (BB) 20.125, 16.626 respectively.

**Table (3):** shows the proximate composition of three types of commercial biscuit. The fat content of glucose biscuit (GB) (2.915) fat content for energy biscuit were higher than Baraka biscuit and glucose biscuit respectively. (3.015) (2.915).

**Table (4):** show the proximate composition of three types of commercial biscuit. The ash content of biscuit Baraka were lower significantly (1.070) than energy biscuit, glucose biscuit respectively (1.925) (0.875) energy biscuit is significantly higher than glucose and Baraka.

**Table (5):** Only fortified biscuit had content of crude fiber (2.97).

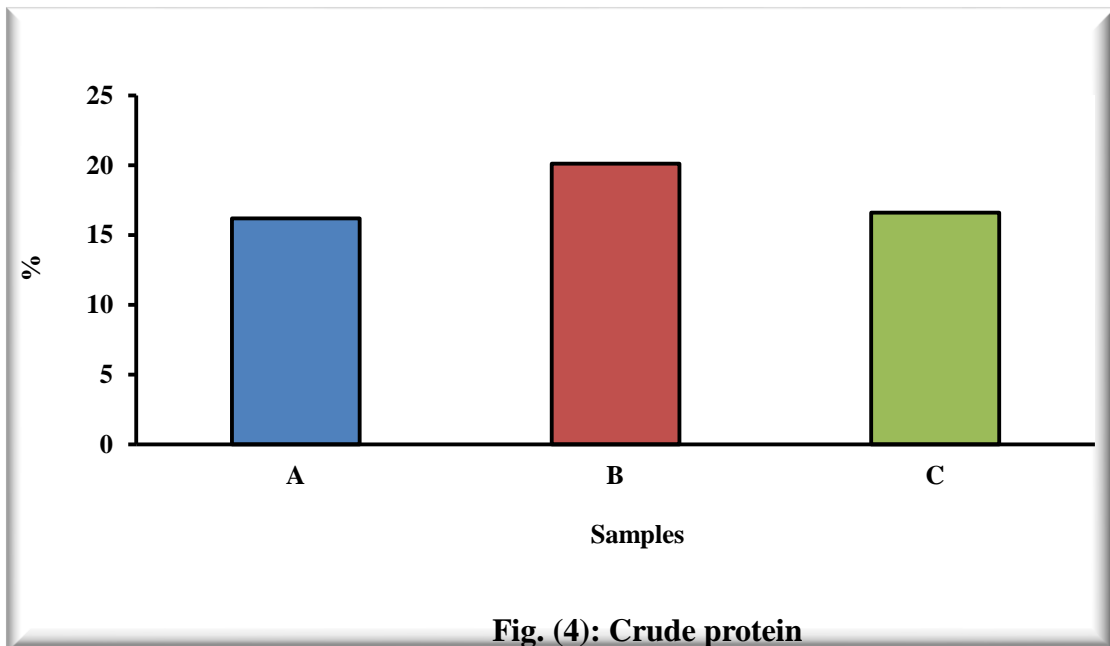
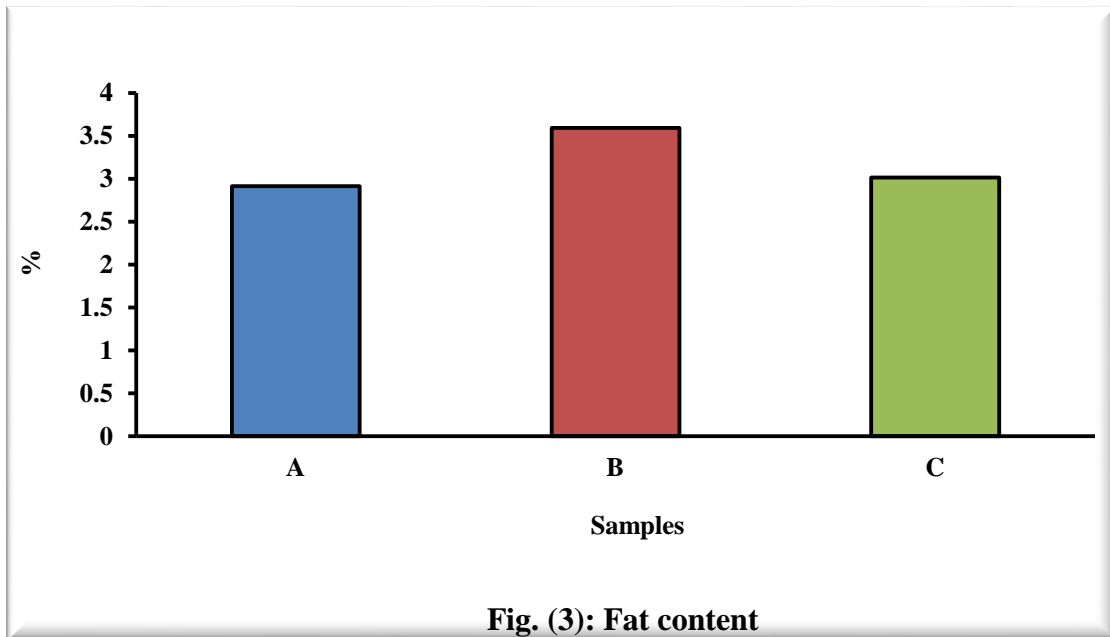


**Key:**

A ≡ Glucose biscuit

B ≡ Energy biscuit

C ≡ Baraka biscuit



**Key:**

A ≡ Glucose biscuit

B ≡ Energy biscuit

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## Moisture

### ANALYSIS OF VARIANCE TABLE

S. of Var.	df	SS	MS	F-value	Prob.
Between	2	0.001	0.000	6.112	0.0453
Within	3	0.001	0.000		

Total 5 0.002

Coefficient of Variation = 0.69%

1	Number	Sum	Average	SD	SE
0.01	0.00	3.077	6.154	2.00	1
0.01	0.03	3.049	6.097	2.00	2
0.01	0.02	3.050	6.101	2.00	3

## Ash

### ANALYSIS OF VARIANCE TABLE

S. of Var.	df	SS	MS	F-value	Prob.
Between	2	1.248	0.624	5.552	0.0492
Within	3	0.337	0.112		

Total 5 1.585

Coefficient of Variation = 25.99%

1	Number	Sum	Average	SD	SE
0.24	0.23	0.875	1.750	2.00	1
0.24	0.52	1.925	3.850	2.00	2
0.24	0.13	1.070	2.140	2.00	3

## Fat

### ANALYSIS OF VARIANCE TABLE

S. of Var.	df	SS	MS	F-value	Prob.
Between	2	0.539	0.270	57.159	0.0041
Within	3	0.014	0.005		

Total 5 0.553

Coefficient of Variation = 2.16%

1	Number	Sum	Average	SD	SE
0.05	0.05	2.915	5.830	2.00	1
0.05	0.11	3.595	7.190	2.00	2
0.05	0.02	3.015	6.030	2.00	3

## Protein

### ANALYSIS OF VARIANCE TABLE

S. of Var.	df	SS	MS	F-value	Prob.
Between	2	18.621	9.311	12.780	0.0392
Within	3	15.691	5.230		

Total 5 34.312

Coefficient of Variation = 12.96%

1	Number	Sum	Average	SD	SE
1.62	0.62	16.188	32.377	2.00	1
1.62	3.71	20.125	40.250	2.00	2
1.62	1.24	16.626	33.252	2.00	3

## **Conclusions & Recommendation**

### **5-1 Conclusions:**

1. The increase in protein content of biscuits with sesame meal, increase the cost of biscuits, noticeably.

## **5-2 Recommendations:**

1. You should add the vitamin (c) folic Acid and iron to produce a high nutritive value.

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