A Study on the Effect Of Iron Fortificated Biscuits on Hemoglobin Level On Children at pre-school Sinnar Hospital, Sennar State

BY

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Co-supervisor: Dr. Hamza Eltigani Omer

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Examination committee

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Date Of Examination: 6/8/2012
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ABSTRACT
Nutritional anemia is the most common problem among children under five years. This study aims to observe the change in hemoglobin level in the children, through diet prepared from wheat, oil, dates, sesame. In form of dry biscuits, so as to easy intake and decreases the spoilage effect. After proximate analysis of prepared biscuit content of Moisture, ash, fat, protein, carbohydrate, 4.43, 1.904, 16.81, 10.22, 39.264, g/100g respectively. Iron content was found to be 3.5 mg/100 g. Check made for 10 befor and after consumed biscuit for 10 days, 7 children showed an increases in hemogloglin level and 3 do not. and that possibly due to autumn season at which child infection by (fever, malaria, malnutrition, jaundice) more than any other season. Since this diet indicated positive influence in increasing hemoglobin level so its recommended to manufacture this biscuit at factory level to easily intake for preschool and camps Children as well as pregnant women, Women education and training is needed to prepare this nutritious biscuit as the items is available locally.
دراسة حول أثر البسكويت المدعوم بالحديد على مستوى الهيموقلوبين لدى الأطفال ما قبل سن
الدراسة بمستشفى سنار, ولاية سنار
أمل محمد الخير أحمد
ماجستير في هندسة الأغذية (أغسطس, 2012)
قسم علوم وتكنولوجيا الأغذية
كلية الهندسة والتكنولوجيا
جامعة الجزيرة

الملخص
الأنيميا التغذوية من أكثر المشاكل التي تصيب الأطفال دون الخامسة ؛هذه الدراسة تهدف
لملاحظة التغير في مستوى الهيموقلوبين في الدم خلال غذاء تم إعداده من دقيق القمح والزيت
والبلح والسمسم بمقدار 120 جرام لكل منها ، وجميعها من السوق المحلي لسنار ، في شكل
بسكويت جاف حتى يسهل تناوله في أي وقت ونقل به نسبة التلوث ويكون جاذب للأطفال. بعد
التحليل التقاربي للبسكويت تحصلنا علي محتوى رطوبة, رماد, دهون, بروتين, كاربوهيدرته
(39,264),(10,22),(16,81),(1,904,43) جرام لكل 100 جرام على التوالي. ووجد
محتوى الحديد في البسكويت 3.5 ملليجرام لكل 100 جرام. تم فحص 10 أطفال قبل وبعد
تناول البسكويت ب 10 أيام. 7 أطفال زادت نسبة الهيموقلوبين لديهم 3 لم تزد وذلك بفعل ظروف
الخريف الشائع فيها إصابة الأطفال بالالتهاب , الحمى, سؤ التغذية , نقص التغذية , الأملا ريا , اليرقان أكثر
من بقية فصول السنة . وبما أن النتائج أظهرت تأثير إيجابي على مستوى الهيموقلوبين لعدد
7 أطفال يمكن تصنيعه على مستوى المصنع حتى يسهل تناوله لأطفال المدارس , المعسكرات
, النساء الحوامل , وتعليم الأمهات طريقة أعداد البسكويت لان مواده متاحة محلياً.
Dedication

To my dear father

To my kind mother

To my husband

To my brothers and sisters

To my family

To my village

To my friend and everyone help and shared in this project

Great thanks with love and respect.
ACKNOWLEDGEMENT

ALL Praise is due to GOD for help me and gave me acknowledge, health, patience to continuous my learning.

Sincere thanks are extending to my supervisor Prof. Dr. Sir El Khatim Al Hardallou
For encouragement, patience and valuable help to complete this work.
I am very thankfull to ministry of health, in a person Anisa El huwers, for help and encouragement,

I owe much gratitude and sincere thank to Dr. Hamza El Tegani my Co supervisor for assistance and guidance.

Deep sense to my family, grandmother, mother, father, sisters, brothers, aunts, bridegroom, for patience, advice and encouragements.

I am very thanks to my friends for their support.
To all volunteer children and mother and who have been eagerly waiting to see the fruitful end to this effort.
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CHAPTER ONE
INTRODUCTION

1.1 Source of Dietary iron:

Haem and non-haem are the two type of dietary iron. Haem iron is a constituent of hemoglobin, and myoglobin, therefore it is found in meat, fish and poultry. It accounts for a relatively small fraction of the total food in developing countries. Non haem part is found in food of plant origin and is the major source.

1.2 Iron requirements:

Iron requirements are expressed, as the amount of iron needed by the body for growth. Therefore growing children are of great risk of developing IDA. As they grow up, the growth rate becomes stabilized, so the need for it declined.

<table>
<thead>
<tr>
<th>Age</th>
<th>Mg / day</th>
</tr>
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<tr>
<td>4-12month</td>
<td>0.96</td>
</tr>
<tr>
<td>13-24month</td>
<td>0.61</td>
</tr>
<tr>
<td>2-5years</td>
<td>0.7</td>
</tr>
</tbody>
</table>

1.3 Degradation of hemoglobin; and iron stores:

Iron obtained from destroyed red cells is recycled either into bone marrow or if there is excess to iron stores. Iron is stored in cells into two forms:

1. Ferritine from which iron is readily available.
2. Hemosedrine which is a more stable form and constitute the bulk
3. of iron stores.
1.4 Functions of folic acid:

Folate functions as an coenzyme in the THF form, which is essential in Purine and pyrimidine synthesis, thus essential for DNA synthesis.

Also it plays a major role in converting amino acids to another through one carbon unit metabolism.

Folic acid and vita B12 are indispensable for conversion of homocysteine to methionin, therefore promote DNA synthesis. There are 16 folate dependent enzymes .(Oski,1990).

1.5 Determination of recommended daily Allowance(RDA):

The dietary folate requirement is defined as the amount needed to prevent a deficiency sever enough to cause symptoms like anemia. The most recent RDA was based primarily on the adequacy of R.B.C folate concentration at different levels of folate stores. Secondly to maintain normal blood homocystiene level. Thirdly , an indicator of one carbon unit metabolism, which was considered only as ancillary indicator of adequate folate intake. Because pregnancy is associated with a significant increase in cell division and other metabolic processes requiring folate coenzyme, the RDA of pregnant women is considerably higher than who are not pregnant. Finally the prevention of neural tubal defect (NTD) was taken into consideration, however, reducing the risk of NTD was considered in separate recommendation for women capable of becoming pregnant because the crucial event in the development of NTD occur before many women aware that they are pregnant. The daily by WHO\FAO is 16 mg \ daily between birth and three months of age; 24 mg\ daily between three and six months of age; 23 mg\ daily, and 3 mg\ kg daily for adults of both sexes. (Herbert,1987).
Iron is present in all can cells of the human body. It had several functions; as a carrier of oxygen from the lungs to the tissues in form of hemoglobin, it facilitates the oxygen use and storage in the muscles in form of myoglobin, finally it is integral part of enzymatic reactions in various tissues.

The adult healthy body contains 4.5 mg of iron (Keele, Neil and Joel's 1985).

Body iron is divided into two main components: functional and strong iron. The storage part found as ferritin from which iron is fairly readily available and haemosedrine which is the stable form and constitute the bulk of iron stores in the liver, spleen and bone marrow, it serves as a reserve pool for the functional group.

1.6 Health Benefits of sesame seeds:

Not only are sesame seeds a very good source of manganese and copper, but they are also a good source of calcium, magnesium, iron, phosphorus, vitamin B₁, zinc and dietary fiber. In addition to these important nutrients, sesame seeds contain two unique substances: sesamin and sesamolin. Both of these substances belong to a group of special beneficial fibers called lignans, and have been shown to have a cholesterol-lowering effect in humans, and to prevent high blood pressure and increase vitamin E supplies in animals. Sesamin has also been found to protect the liver from oxidative damage.

1.7 Sesame Rich In Beneficial Minerals:

Sesame seeds are a very good source of copper, magnesium, and calcium. Just a quarter-cup of sesame seeds (36.00 grams) supplies 74.0% of the daily value (DV) for copper, 31.6% of the DV for magnesium, and 35.1% of the DV for calcium. This rich assortment of minerals translates into the following health benefits:
Table (1.1): Minerals found in sesame seeds.

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>Amount</th>
<th>DV (%)</th>
<th>Nutrient Density</th>
<th>Nutrient Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Copper</td>
<td>1.47 mg</td>
<td>73.5</td>
<td>6.4</td>
<td>very good</td>
</tr>
<tr>
<td>Manganese</td>
<td>0.89 mg</td>
<td>44.5</td>
<td>3.9</td>
<td>very good</td>
</tr>
<tr>
<td>Tryptophan</td>
<td>0.12 g</td>
<td>37.5</td>
<td>3.3</td>
<td>good</td>
</tr>
<tr>
<td>Calcium</td>
<td>351.00 mg</td>
<td>35.1</td>
<td>3.1</td>
<td>good</td>
</tr>
<tr>
<td>Magnesium</td>
<td>126.36 mg</td>
<td>31.6</td>
<td>2.8</td>
<td>good</td>
</tr>
<tr>
<td>Iron</td>
<td>5.24 mg</td>
<td>29.1</td>
<td>2.5</td>
<td>good</td>
</tr>
<tr>
<td>Phosphorus</td>
<td>226.44 mg</td>
<td>22.6</td>
<td>2.0</td>
<td>good</td>
</tr>
<tr>
<td>vitamin B1</td>
<td>0.28 mg</td>
<td>18.7</td>
<td>1.6</td>
<td>good</td>
</tr>
<tr>
<td>Zinc</td>
<td>2.79 mg</td>
<td>18.6</td>
<td>1.6</td>
<td>good</td>
</tr>
<tr>
<td>Selenium</td>
<td>12.38 mcg</td>
<td>17.7</td>
<td>1.5</td>
<td>good</td>
</tr>
<tr>
<td>Fiber</td>
<td>4.25 g</td>
<td>17.0</td>
<td>1.5</td>
<td>good</td>
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</table>

Iron is believed to be an essential element for all life forms, widely distributed over the earth in rocks and soils, and known to be the fourth most abundant element in the earth, iron might seem readily available to satisfy any biological requirement (Nestle, 1995).

Nutritional anemia refer to a condition in which hemoglobin content of blood is lower than normal as a result of a deficiency of one or more essential nutrients (usually iron, less frequently folate or vita B12) regardless the cause of such deficiency.

There are no sharp cuts of points below which can be stated at present. (WHO_EM\NUT\177, E\G\11.96).
1.8 Objectives:

1. To analyze the edible components of the sesame and date so as to assess certain quality factors including, carbohydrates, protein, fat, ash, calorific value, and iron contents.

2. To study anthropometric parameters among children in the community at sinner city.

3. To prepare acceptable diet in the form of biscuits to children, supplemented with sesames and dates as an iron source.

4. To measure blood hemoglobin for selected children before and after treatment with prepared diet.

5. To estimate the effect of supplementary feeding on prevention of anemia.
CHAPTER TWO
LITERATURE REVIEW

2.1 Nutritional status:

2.1.1 Definition of anemia:

Anemia is defined as a low hemoglobin concentration in blood, or less often, as a low haematocrit, or as the percentage of blood volume that consist of red blood cell

Nutritional anemia:

Protein –energy malnutrition generally occurs during the crucial transitional phases when children are weaned from liquid to semisolid foods. During this period, because of their rapid growth, children need nutritionally balanced, calorie-dense supplementary foods in addition to breast milk (Cameron and Hofvander, 1983).

Iron deficiency anemia is a common problem worldwide, affecting 50% of individuals in high-risk groups such as preschool children and women of childbearing. Its' consequences include impaired school performance (Lozott al 1991); Soemantri et al 1985). Work performance (Li eta 1994); motor and mental development (Aukett et al 1986). It is generally accepted that iron deficiency is the most common cause of low hemoglobin concentration; therefore, iron deficiency is the main focus of programs that try to alleviate anemia. However, iron deficiency may be accompanied by other micronutrient deficiencies because both can result from high rates of infection, diarrhea, anorexia, and poor dietary quality and nutrient bioavailability.

Sudan is in similar situation to other African countries in that supplement.
2.2 Types of Anemia:

2.2.1 Iron Deficiency Anemia (IDA):

Iron deficiency due to iron loss. This is usually from a gastrointestinal site with gastrointestinal bleeding. In the United States, this is rarely from a nutritional deficiency and in such cases, it usually takes over 10-20 years to develop. This type of anemia is also affected by:

(a) Vitamin B12 deficiency
(b) Folic acid deficiency
(c) Rarely copper or mineral deficiencies.

2.2.2. Hemolytic anemia (a shortening of red cells survival) as in:

(a) Non-immune hemolytic anemia such as sickle cell, hemoglobinopathies, spherocytosis, elliptocytosis (oval) or .
(b) Autoimmune hemolytic anemia with a positive comb test.

2.3 Etiology of iron deficiency and anemia:

Nutritional anemia is common, world-wide deficiency syndrome. The prevalence of iron-responsive microcytic. Hypochromic anemia varies from 9% to 70% in different population groups examined (Allen, et al, 1995). Understandably, the incidence is higher in developing countries and in underprivileged segments of population in the industrialized world. Nutritional surveys using hemoglobin, red blood cells indices, transferring saturation, free erythrocyte protoporphyrin, and serum ferreting as criteria for the diagnosis of clinical and sub-clinical iron deficiency have revealed prevalence figures of 2.3% to 27% in Canada and the United States, respectively. It is known, however, that anemia is a late manifestation of iron deficiency and that changes in enzyme activity and cellular function can be detected well before any changes in
erythropoietin many parasitic diseases, as well as dietary and cultural practices, can result in iron under nutrition. Poverty dictates a lower intake of iron-rich meats and vegetables.

Moreover, the big-availability of iron in different foods varies considerably, parasitic infestations, particularly hookworm disease, and other infections increase iron losses. Low birth-weight infants have smaller stores of iron and more prone to develop iron deficiency.

In industrialized countries, the common causes of iron deficiency include consumption of highly refined foods, use of aspirin or chronic gastrointestinal disease. In the case of iron, the immediate cause is inadequate dietary iron intake and quality of food sources that provide iron are essential determinants of the amount of bioavailability iron.

Hemoglobin pathy of various types is also quite prevalent, with prevalence of 35%-40%. In addition, blood losses due to common pathological conditions, namely parasitic infections such as hook worm, bleeding related to peptic ulcer or diverticulosis, contribute to increased demand. Thus, the underlying causes of IDA include lack of Knowledge of increased demand, lack of proper dietary practices to provide bioavailability of iron sources, and poor sanitation and hygiene. Tackling the problem of IDA requires several front of intervention, and should be well integrated to simultaneously address the problems of bioavailability, physiological needs, and pathological losses (Allen et al., 1995).

2.4 Causes of anemia:

The etiologic factors responsible for anemia are multiple and their relative contribution can be expected to vary by geographic area and season (Van et al., 2000). Besides iron and other nutrient deficiencies, general infections chronic disease including HIV/ADIS, may impair
hematopoietic and consequently can cause anemia (Nestel and Davidson, 2000).

Some parasitic infection, e.g., hookworm, Schistosomiasis, and trichuriasis cause blood loss directly. Malaria and nutritional deficiencies are more frequently responsible for anemia in infants and young children (Staubli et al. 2001).

Whereas in school children, hookworm infestation, malnutrition and anemia of acute and chronic infections are more important contributors to anemia (Stoltzfus et al., 1997).

**Level of iron deficiency:**

The severity of iron deficiency may be classified into three stages:

(I) Stage 1: Iron depletion - iron stores drop, while transport and functional iron are unaffected.

(ii) Stage 2: Iron deficient erythropoiesis – iron stores are exhausted, transport iron also decreases and the synthesis of hemoglobin and other functional compound is compromised.

(iii) Stage 3: Iron deficiency _haem synthesis is reduced and red blood cells become hypo chromic and microcytic. (Schlumbom 2001)

**2.5 Vitamins related to anemia:**

In many countries, and often in specific areas within a country, severe manifestations of vitamin and or mineral deficiencies are found a) Vitamin A: Several micronutrient deficiencies in addition to iron can cause anemia. The evidence that vitamin A deficiency causes anemia through modulation of iron metabolism is strong and supported by observations from both experimental animal models and human studies. Studies indicate that the lake of vitamin A may lead to mild anemia characterized by serum iron and elevated levels of iron in storage depots,
particulary in the liver. Mechanisms which might underlie the effects of vitamin A deficiency on anemia are:

1. Impaired mobilization of iron stores.
2. Impaired erythropoietin, and
3. Increased susceptibility to infection (fish man et al.,2000).

b) Riboflavin: Riboflavin in deficiency also tends to co-exist and interact with iron deficiency (Allen and Caster line –Sabel,2001). Riboflavin deficiency impairs iron absorption and increases the gastrointestinal loss of endogenous iron (powers et al.,1991, Powers 1995).

It is also suggested that it reduces the efficiency of iron utilization for heme synthesis (powers,1995).

Results from riboflavin supplementation trials that have assessed the effects on anemia are inconsistent. However, it is suggested that supplementation with riboflavin enhances the response of Hb, hematocrit and erythrocyte count to iron supplementation in pregnant women and improves the hematological status of anemic children and men (Fishman et al.,2000).

C) Vitamin B₁₂:A second nutritional cause of megaloblastic anemia is vitamin B₁₂ deficiency .There are few data on global prevalence of vitamin B₁₂ deficiency and even less is known about its global contribution to anemia (Allen and casterline-sabel,2000).

d) vitamin B₁₂ deficiency In studies in Mexico and Guatemala, was found in 19%-47% of young children ,school children ,adults, and pregnant and lactating women (Allen et al.,1995). Study in anemic preschoolers in Mexico showed that children with higher initial vitamin B₁₂ concentration were more likely to respond to iron supplements with improved Hb concentrations than children with low vitamin B₁₂ status. However, (Fishman et al.,2000). reviewed the effects of vitamin B₁₂ supplementation on pregnant women and found no effects on Hb concentration .In
premature and low birth weight infants, vitamin B\textsubscript{12} supplementation may improve Hb status and reduce the severity on the anemia (Fishman et al., 2000).

2.6 Prevalence of anemia and iron deficiency:

2.6.1 Nutritional anemia:

Nutritional anemia remains a major public health problem throughout the World. (Baker and De Maeyer, 1979, WHO, 1972). The vast majority of nutritional anemia’s are due to iron deficiency (WHO, 1972). Several facts were recognized about the concept of anemia.

Firstly, no given level of deficit of hemoglobin concentrations or of haematocrit conveys an absolute diagnosis of anemia for a given individual, but rather indicates a given probability of being associated with a true deficiency of oxygen transport capacity for that person (WHO, 1972). Thus, there is a universal cut-off criterion for anemia.

Secondary, the expression of frank anemia in a population is only the tip off the iceberg of iron nutrition problems in a susceptible population.

Iron depletion and iron deficiency, not yet reflected in a failure of red cell production, are likely to be common in population in which overt anemia is manifested. Iron deficiency states even without anemia can produce immunodeficiency, cognitive impairment and muscle dysfunction.

2.6.2 Iron deficiency anemia:

Confirmation of the etiology of anemia from large scale surveys is very limited, Iron deficiency is presumably the underlying nutrient
deficiency causing anemia, though a substantial proportion of the population also exhibits hemoglobinopathy.

Anumber of surveys on anemia with nationally representative samples have been available. Most data are on pregnant women and children under five.

(More than 500 million people have iron deficiency anemia). and a much larger number have iron deficiency without anemia. Iron deficiency is a result of the amount of dietary iron absorbed being insufficient to meet iron requirements. This situation is more common when iron requirements increase during pregnancy and growth, when iron is lost in menses or through some parasitic infections, and when food constituents impair iron absorption.

Iron is an essential micronutrient. As an integral part of hemoglobin, it is require for the transport of oxygen and carbon dioxide in blood. Iron is also a component of several tissue enzymes, such as cytochromes that are critical for energy production, and enzymes involved in the immune system. The symptoms of iron deficiency include low concentration of serum ferreting which reflects iron stores, progressing to anemia (defined as low hemoglobin concentration). Iron deficiency, before the onset of anemia may have adverse effects on functions such as work performance (Baynes and Both well 1990).

Once anemia results, there are also impairments in cognitive performance and behavior (Idjradinata and pollitt, 1993), low birth weight due to prematurity (Scholl and Hedgier, 1994) and other pregnancy complications. For each 12 percent deficit in hemoglobin concentration, there is a 10%-to deficit in work performance(Edgerton et al 1979). The total iron intake of populations that are dependent on predominantly plant-based diets may meet dietary recommendations and
even exceed that of populations consuming more animal products (FAO-WHO, 1988 Baynes and Both well(1990)).

However, due to diets constitute is usually poor, so that a high prevalence of iron deficiency and anemia often co-exist with inadequate total iron intakes.

Iron deficiency anemia can be cause by insufficient dietary intake of iron, chronic gastro-intestinal tract bleeding, especially from hookworm, mal-absorption conditions and infection. Other significant causes of anemia that vary in their significance from country include malaria, congenital hemolytic diseases such as sickle cell anemia and thalassic anemia.(WHO, Geneva, 1992). In Africa, for example, the five commonest causes of anemia include iron deficiency, malaria, sickle cell disease, and AIDS.(WHO, Geneva, 1992). In Africa, for example, the five commonest causes of anemia include iron deficiency, malaria, sickle cell disease, and AIDS.(WHO, Geneva, 1992).

Studies conducted by the Hashemite Kingdom of Jordan’s Health Ministry and UNICEF in 1995 had shown anemia due to iron deficiency to be "major public health problem". (Osama, 1999).

Iron deficiency anemia is still one of the most common nutritional deficiency disease in the world, existing even in countries whose level of iron deficiency is mainly prevalent among infants, (pregnant women, and women of child – bearing age). Heam iron, derived mainly from hemoglobin and myoglobin, is absorbed intact as iron porphyrin, and is liberated within the partial cells of the intestinal mucosa. Iron absorption from this pool is higher than the absorption from the non- haem iron pool and is not affected by vegetables or ascorbic acid , (ESPGAN Committee on Nutrition, 1982).

Studies have shown that non- haem iron in a single food can be uniformly labeled by an inorganic radio- iron tracer added to the food,
probably by a very rapid isotopic exchange between the tracer and the native food iron within a common pool of non-haem iron.

International experts have recommended iron fortification of food as the best method to prevent iron deficiency anemia in the world. Different foods have been used as fortified vehicles in different countries and areas. Infant formulas, powdered milk, cereals, fish sauce, sugar, and salt, have been fortified with varying degrees of success. (Hurrell, and Cook, 1990; Hurrell, 1989).

2.7 Causes of malnutrition:

Malnutrition at its fundamental biological level is inadequate supply of nutrients to the cell. A lack of essential nutrients at the cellular level, however, is the result of a complex web of factors: psychological, personal, social, cultural, economic, political, and educational. On biological level, nutritional deficiency diseases may be classified as primary or secondary, according to the availability of the nutrient (Williams, 1973). A disease caused by malnutrition may exist in many varieties, degrees, and combinations. It is often complicated by the presence of other disease, or skin sepsis. A synergism is, in fact, known to exist between malnutrition and infection. Each compounds the other, and together they cause more serious illness than either would bring alone. For example, a common infectious disease of childhood such as meals, which would otherwise be mild in a severely malnourished child may cause death. Infectious diarrhea is a common complication of kwashiorkor, and may be the irreversible factor that causes death, (Williams, 1973).

Some of the many related causes of malnutrition can be classed under the three factors that are classically cited by the epidemiologist as
the trail of variables that influences disease (1) agent, (2) host, and (3) environment.

2.7.1 The agent:

This fundamental cause of malnutrition disease is a lack of food. Various factors may cause lack of food:
a\ Food quantity: The total quantity of food ingested may be below the level required to maintain the body tissues. The food deficiency may be partial or complete, seasonal or constant.
b\ Food supply: Imbalance between community food supply and need. The amount of food available per person may be reduced by natural disaster (drought, flood) or by man-made disaster (war, over population, poor distribution, poverty).
c\ Food quality: The food available may be too poor in its physical quality or biological value.
d\ Food timing: The food may not present (as infant and child feeding) when needed, in proper balance.

2.7.2 The host:

It is the person- infant, child, adult- who suffers from malnutrition. Various characteristics in the host may influence the disease.
a\ presence of other disease: Infections, allergies metabolic diseases, gastrointestinal disease; and so no compound the cause of malnutrition.
b/ increased dietary needs: Any physiological cause of stress such as growth, pregnancy, lactation, injury, illness or physical labor increases the demand for nutrients.

2.7.3 Environmental factors influence malnutrition:

Some are close at hand and may be controlled by the individual.
Many more far reaching once are too enormous, too powerful, and too remote in their source to be influenced by a single person. Mass action and extensive study are needed to deal with these problems (Williams, 1973).

a\ Sanitation: Food contamination causes food loss and produces disease, thus compounding malnutrition.

b\ Culture: Traditional food habits and customs may hinder nutrition.

c\ Social factors: Interrelated social problems, such as those created by poverty, racial discrimination inadequate housing, and family disintegration, may contribute to lack of food and malnutrition.

d\ Economic and political structure: The economic and political system of a region controls the power structure, governs administrative policy and controls challenges of food supply and form.

E\ Agriculture: Geography, climate, food technology and methods of agriculture influence food supply. The interaction of some of these factors leading to malnutrition. (William, 1962).

2.8 Exclusive Breast feeding:

Frequent, exclusive breast feeding is important in the early weeks of lactation in order to stimulate optimal milk production. "On demand feeding leads to earlier maximal milk production than feeding on a fixed schedule. The introduction of any other foods or fluids, is likely to reduce the infant's demand for breast milk, and to interfere with the maintenance of lactation, ending with early termination of breastfeeding. No fluids other than breast milk are required by the young infant.

When infants are given solid foods, or even non milk fluids, the prevalence of diarrhea is much higher due to contamination of the bottle or food (popkin et al., 1990; Brown et al., 1989).
During diarrhea and fever, breastfed infants will continue to consume breast milk but will reduce their intake of complementary food and fluids (Brown, 1990). From a nutrition perspective, it is important to recognize that any other foods will displace at least some breast milk, especially in the first six months of life. Because breast milk is generally higher in most nutrients than other foods are introduced too early.

Also there are many other biological, nutrition and psychological advantages to breastfeeding.

Exclusive Breastfeeding is recommended for the first 6 months of life (WHO, 2001). Reviewers of evidence as to whether 4 or 6 months is the best age to introduce complementary foods concluded that there was no advantage to starting before six months (Brown et al., 1998).

In a traditional setting, all infants are breast-fed in West African villages; nearly 300 mothers had mean period of breast-feeding slightly less than 24 months and 27 months (Martin et al., 1964). Only a few women stopped nursing before 15 months, and some continued for 3 years. The median interval between births of 34 months was reduced to 17 months with a still birth or earl infant death. In parts of West Africa there is cultural taboo forbidden sexual intercourse during during breast feeding which in traditional societies, prolongs the birth intervals. Birth intervals of 3 years will produce a moderately sized and well-spaced family (Morely, 1973).

Another retrospective study showed that breast-feeding prolongs after birth intervals by about 4 months in urban areas and by 8 months in rural areas (Rosa, 1975) Psychological, cultural, and nutritional factors. Play important roles in determining the duration of breast-feeding and the birth interval.
2.9 Diet and feeding practice in Sudan:

In many traditional societies breast feeding is the common practice. The average weaning period in the Sudan was found to be about 14 months (ICN report, 1993). The age at which breast milk alone become an inadequate sole source of nutrients appears to be influenced by maternal nutritional status.

Under favorable circumstances, breast feeding alone is capable of meeting an infant's nutritional requirements and of supporting normal growth for the first four to six months of life (Waterlow, 1980).

Scattered studies on weaning practices and diet in different parts of the Sudan were reported. Supplementation represents major nutritional problems of infants in poor rural areas (Omer et al., 1975).

The majority of the children suffered from delayed supplementation. Only 37% of the moderately malnourished and 28% of the severely malnourished children received supplementary feeding at the age of 4 months.

Inadequate feeding practices during the weaning period cause a high mortality among infants and young children. Sudanese diet is based on cereal grain, or root crops such as cassava predominate in the south. The diversity in food production and the various ethnic groups in the different regions of the country each having their own food habits and traditions, have ultimately resulted in the consumption of varied types of diets. Weaning pattern in Sudan as well was found to vary widely due to region differences in food supplies, availability and food habits (ICN, 1993). Weaned child in most part of Sudan depends largely on adult traditional foods, Aced a, Mullah, and sharmout.

Milk is provided in morning or evening where it is available (Dirrar, 1993). Never the less the major traditional food used in Sudan is Nasha (ICN, 1993).
It is a thin porridge made from sour sorghum flour usually containing not more than 10% dry mater with a poor energy density of about 20-30 Kcal/100g.

2.10 Weaning food in developing countries:

The problem of age malnutrition resulting from inadequate breast milk after 4 to 6 months of age and inadequate and late introduction of semi-solid food, so addition of semi-solids would seem to be a better term rather than weaning food.

Period of weaning in the context of the existing practices is not a period when breast milk is being replaced by other food, but when foods are introduced in addition to breast milk. Several studies had shown that large breast milk alone is not adequate for sustaining growth of the baby after 4 months of age. The growth rate begins to slow down after 4 months and the weight curve becomes more or less flat after 6 months. The mother in most cases continues feeding with breast milk in dirty unhygienic bottles, resulting in diarrhea and further malnutrition, therefore, advice introduction of semi-solids at about 4 months of age, so that breast milk plus semisolids would sustain adequate weight gain. The problem in most cases is not in availability of a suitable weaning food, but the lack of knowledge that more food is needed for the baby, breast milk alone is not adequate and that it need to be animal milk only. In most developing countries there is a Sudanese tradition from breast milk to the normal family food, whenever the baby cries or demand food, the mother hands him a bit of the family food, usually cereal-based bread. Nutrients required by a weaned child were specified by number of organizations. Prepared the guidelines "Recommendation for international standard of infants and children foods" recommends ingredients described in that section are wheat barley, rye, millet, corn, sorghum and
legumes of low water content processed under conditions that allow their reconstitution with milk or water.

If the product is to be mixed with water, it is required that protein content should not be less than 15% (dry basis) with an energy density of 400Kcal, and protein quality of at least 70% of casein value. The final level of fat should provide not less than 20% of energy FAO/WHO (1994). Recommended daily requirements of vitamins and minerals set by the FAO/WHO, (1994), (Table 2.2)
Table (2.2): vitamins and minerals deficiency in infants and young children:

<table>
<thead>
<tr>
<th>Nutrients</th>
<th>Recommended daily requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Vitamins:</strong></td>
<td></td>
</tr>
<tr>
<td>Vitamin A (Retinol equivalent)</td>
<td>400 mg</td>
</tr>
<tr>
<td>Vitamin D</td>
<td>10 mg</td>
</tr>
<tr>
<td>Vitamin E</td>
<td>5 mg</td>
</tr>
<tr>
<td>Vitamin C</td>
<td>20 mg</td>
</tr>
<tr>
<td>Thiamine</td>
<td>0.5 mg</td>
</tr>
<tr>
<td>Riboflavin</td>
<td>0.8 mg</td>
</tr>
<tr>
<td>Niacin</td>
<td>9.0 mg</td>
</tr>
<tr>
<td>Vitamin B6</td>
<td>0.9 mg</td>
</tr>
<tr>
<td>Folate</td>
<td>50 mg</td>
</tr>
<tr>
<td>Vitamin B12</td>
<td>1 mg</td>
</tr>
<tr>
<td><strong>Minerals:</strong></td>
<td></td>
</tr>
<tr>
<td>Calcium</td>
<td>600 mg</td>
</tr>
<tr>
<td>Iron</td>
<td>12 mg</td>
</tr>
<tr>
<td>Zinc</td>
<td>10 mg</td>
</tr>
<tr>
<td>Magnesium</td>
<td>130 mg</td>
</tr>
<tr>
<td>Iodine</td>
<td>90 ppm</td>
</tr>
<tr>
<td>Phosphour</td>
<td>500 mg</td>
</tr>
<tr>
<td>Selenium</td>
<td>20 ppm</td>
</tr>
</tbody>
</table>

Source: FAO/WHO(1994)
In human body, iron is present in all cells. It has several vital functions, including binding and transport of oxygen, electron transfer reactions, and regulation of gene, cell growth and differentiation. The iron containing compounds in body are grouped into two categories: those known to have metabolic or enzymatic functions and those associated with iron storage and transport (Both well et al., 1979). The main iron containing protein is the Hb in erythrocytes. It accounts for about two thirds of the body iron.

Hb binds oxygen as the blood passes through the lungs, and distributes this oxygen to the body tissues. Similarly, myoglobin is the during muscle contraction. Most other functional iron-containing proteins are enzymes, they called heme-enzymes, such as cytochromes, catalase and peroxidase, depend on heme as a coenzyme (Dallman, 1986).

They act as electron carries within the cell. Avery large number of other iron containing enzymes have also been described. They play key roles not only in the oxygen and electron transport, but also as signal-controlling substances in some neurotransmitter systems in the brain (Hallberg et al., 1993).Iron stores have no physiological function other than to serve as a buffer against increasing iron demands such as that occur during pregnancy or with acute blood loss (Cook et al., 1992).The major iron storage compounds are ferritin and hemosiderin.

There are large quantities of ferritin in iron storage tissue such as the liver, spleen and bone marrow, but only small quantities are present in human serum, normally between 12 and 300 μ (Cook et al., 1992).

Hemosiderin is the major iron storage protein present when excessive iron accumulates in the tissues. The contribution of the two types of storage iron to total body iron can vary widely from less than 5% to more than 30% (Dallman, 1986).
The extra cellular transport of iron within the body is accomplished by it being binding to transferring, a specific carrier protein. Transferring accounts for only about 0.1% of the body iron (Dallman, 1986). The movement of number of transferring receptors on surface of body cells when a cell senses a need for iron, the synthesis of transferring receptors is up regulated, allowing it to compete more effectively for circulating transferring iron (Cook et al., 1993).

2.11 Iron requirements:

Dietary iron intake is closely related to energy intake. A cereal-based diet in developing counties may contain about 7mg Fe/1,000 kcal (FAO, 1980). Relative differences in iron and energy requirements between adult men and children are reflected in the variation in the percent of dietary iron that must be absorbed to meet physiological needs. Adult men with high energy intakes and relatively low iron requirements are least likely to suffer from iron deficiency; a more 5 percent absorption of ingested iron would be enough to satisfy their needs whereas, between 1 and 8 percent of nonheme iron from a solely vegetable diet will be absorbed, when physiological needs for iron are high, indicated by low iron stores and a higher proportion of the available iron is absorbed, most dietary iron is wasted due to body's inability to extract the needed iron; thus, the bioavailability of dietary iron is as important, or even more important, in maintaining iron balance than the total amount of iron ingested.

The balance between the amount of iron required and absorbed is affected by three factors; changed physiological requirements, extensive iron losses, and inadequate in diet.

In addressing the problem of IDA in developing countries, the emphasis has generally been directed toward preventing excessive blood
loss through parasite infestation and less so toward improving the dietary factors. However, with an increasing awareness of the wide variation in the bioavailability of iron in cereal vegetable-based diets that is major cause of IDA in developing countries.

Net iron losses from the body through the skin, urine, and blood are about 2 mg/day for women, 1 mg/day for men and 0.8 mg/day for children, reflecting that net iron requirements are indeed very low. The Recommended Dietary Allowances (RDA) are 15 mg/day for women and 12 mg/day for men, which is 7.5 and 12 times higher than net iron requirements; therefore, the RDA take into account the low bioavailability of dietary iron (Herbert, 1987).

Iron absorption is greatly influenced by a number of dietary and host-related factors.

Measurements of iron intake are of limited value in assessing the nutritional value of the diet without some indications of iron bioavailability, which is defined as the proportion of the total dietary intake that is utilized for normal body function. 80% to 100% of absorbed iron is incorporated in red blood cells, the amount depending on the iron status and erythropoietic activity of the individual.

In many populations, the amount of iron absorbed from the diet is not sufficient to meet many individuals requirements (Stoltzfus and Dreyfuss, 1998).

2.12 effect of food processing on iron bioavailability:

A number of studies have shown change in iron bioavailability as a result of various forms of food processing. These can be attributed to changes in the chemistry of iron (Valency, solubility, and type of chelation) and/or the nature of food constitutes that modify iron absorption (e.g., proteins and phytates).
Food processing encompasses a wide range of treatments, including heating, cooling, freezing, curing, pickling, dehydration, homogenization, fermentation, and various forms cooking. The effect of heat processing on the bioavailability of native and added (fortification) iron is reviewed by Lee (1982).

In some cases, heating has an inhibitory effect and in others it increases the bioavailability of iron; the observed effect depends on the food matrix and the physicochemical form of any added iron. With added iron, wet-heat processing usually appears to increase iron bioavailability, whereas dry-heat processing has little effect. The addition of ascorbic acid to an aqueous food before heating enhances iron bioavailability.

Iron bioavailability is increased with processes that add organic acids to food, for example, in the preparation of sauerkraut, any increase in ascorbic acid, as occurs when beans are allowed to germinate, may well improve iron bioavailability.

In general, fermentation (e.g., leaving bread with yeast) or gentle heat treatment of food has a beneficial effect on the bioavailability of iron from high phytate foods, because it cause hydrolysis of myo-inositol hex phosphate (phytate) to lower inositol phosphates that do not reduce iron absorption.

However, more severe heating may have the opposite effects. Oats are often subjected to autoclaving or steam treatment to destroy their relatively high content of lipase enzyme, which causes rancidity of lipids on storage, but this also inactivates endogenous phytasa. Consequently, processed oat products have a relatively high phytate content that inhibits iron absorption (Rossander et al., 1990).
2.13 Effect of quantity of iron in food, and its bioavailability:

Typical diets can be separated into three broad categories of "low", "intermediate", and "high" bioavailability, with mean absorption from the mixture of heme and non-heme iron of approximately 5, 10, and 15 present respectively by individuals with very low iron stores; but normal hemoglobin concentrations (FAO, 1988).

A low bioavailability diet (5% of iron absorbed) is a simple, monotonous diet containing cereals and root vegetables with negligible quantities of meat, fish, or ascorbic acid–rich foods. This diet contains a preponderance of foods that inhibit iron absorption (maize, beans, and whole wheat flour) and is common in many developing countries, particularly among lower socioeconomic groups.

An intermediate bioavailability diet (10% of iron absorbed) consists mainly of cereals and root vegetables, but contains some ascorbic acid–rich foods and meat. High bioavailability diet can be reduced to this intermediate level by regular consumption of inhibitors of iron absorption, such as tea, coffee, cereal fiber, beans, and high calcium foods with main meals.

A high bioavailability diet (15% of iron absorbed) is diversified diet containing generous quantities of meat, poultry, fish, and/or foods containing high amounts of ascorbic acid. This is the type of diet generally consumed by people in develop countries.

2.14 Dietary iron content and intake:

Iron is present in many foodstuffs. Table 2.3 shows the iron content of different African foods (FAO, 1968). The iron contents of sorghum and millet are high and probably reflect a high content of contamination iron. Data on dietary iron intakes in Africa are scanty, but, as table (2.3) shows, variations in Intake are wide among countries.
Nevertheless, caution must be exercised in comparing published estimates, because much of the iron in some foods is probably of extrinsic origin, either from soil dust, or from surfaces or containers or cooking utensils; Table (2.3) suggests that per capita iron intake are on the order of 10 to 20 mg/day, which is consistent with an analysis of food balance sheet FAO,(1980), showed that the total per capita iron intake in developing countries varies from 14 to 21 mg/day. Staple cereals such as maize, millet, and sorghum supply, on average over 60 % of dietary iron while staple roots and tubers only supply about 24 %.

This most likely reflects the lower intrinsic iron content of these staples (Table2.3) and that these staples are less likely to become contaminated with iron during processing.

The latter is because cereals and pluses have a larger surface area compared with their volume than roots and tubers; thus they contain relatively more contamination iron. Furthermore, cereals and pulses are usually prepared as gruels, which mean that a lot of water (with its contaminated iron) is added. In contrast, roots and tubers are more often boiled in pieces ,thus ,relatively less water is taken up.

Average per capita iron supply, calculated from food production data (FAO,1990) confirms the data on iron intake.

Daily per capita iron intake in Asia and south America is lower than in African countries, but intake from animal source are higher in certain regions.
Table 2.3: Iron content of different vegetable foods from Africa

<table>
<thead>
<tr>
<th>Food</th>
<th>Fe content (mg/100g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maize</td>
<td>3.6 - 4.9</td>
</tr>
<tr>
<td>Sorghum</td>
<td>5 - 15.6</td>
</tr>
<tr>
<td>Millet</td>
<td>39</td>
</tr>
<tr>
<td>Tiff</td>
<td>20.9 - 75.5</td>
</tr>
<tr>
<td>Rice</td>
<td>1.7 - 2</td>
</tr>
<tr>
<td>Cassava</td>
<td>1.9</td>
</tr>
<tr>
<td>Yam</td>
<td>0.8</td>
</tr>
<tr>
<td>Geri</td>
<td>1.6</td>
</tr>
<tr>
<td>Lentils</td>
<td>7</td>
</tr>
<tr>
<td>Chickpea</td>
<td>11.1</td>
</tr>
<tr>
<td>Cowpea</td>
<td>7.6</td>
</tr>
<tr>
<td>Soybean</td>
<td>6.1</td>
</tr>
</tbody>
</table>

Source: FAO (1968).

2.15 Iron Deficiency prevention:

To combat iron deficiency and IDA several strategies are available. To ensure a sustainable prevention, a combination of different approaches (WHO, UNICEF and UNU, 2001b). Besides the improvement of food diversity to increase iron bioavailability, the promotion of better care and feeding practices and the improvement of health services and sanitation are necessary. Ideally, all countries where IDA exists would have a comprehensive anemia control program that includes an appropriate mix of interventions adapted to the local conditions, (Stoltzfus and Dreyfuss, 1998).

Many types of anemia can’t be prevented. However, you can help avoid iron deficiency anemia and vitamin deficiency anemia by eating healthy, varied diets that includes food rich in iron, folate and vitamin
The best sources of iron are beef and other meats. Other foods rich in iron include beans, lentils, iron-fortified cereals, dark green leafy vegetables, dried fruit, nuts and seeds. Folate, and its synthetic form, folic acid, can be found in citrus juices and fruits, dark green leafy vegetables, legumes and fortified breakfast cereals. Vitamin B₁₂ is plentiful in meat and dairy products. Foods containing vitamin C help increase iron absorption.

Eating plenty of iron-containing foods is particularly important for people who have high iron requirements, such as children—iron is needed during growth spurts—and pregnant and menstruating women. Adequate iron intake is also crucial for infants, strict vegetarians and long-distance runners.
CHAPTER THREE
MATERIALS AND METHODS

3.1 Materials:
Wheat flour (72% extraction), white sesame, pea nut oil, dates (Brakawi) and sugar, were bought from the local market of sinner.

3.2 Biscuit formulation and preparation:
The following Table shows biscuit formulation:
Table 3.1 Biscuit formulation including iron-rich materials.

<table>
<thead>
<tr>
<th>Ingredients</th>
<th>Quantity (home level)</th>
<th>Quantity in gram</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wheat</td>
<td>3 cups</td>
<td>360 gram</td>
</tr>
<tr>
<td>Sugar</td>
<td>1 cup</td>
<td>120 gram</td>
</tr>
<tr>
<td>Oil</td>
<td></td>
<td>120 ml</td>
</tr>
<tr>
<td>Mild sesame</td>
<td>&quot;</td>
<td>120 gram</td>
</tr>
<tr>
<td>Mild dates</td>
<td>&quot;</td>
<td>120 gram</td>
</tr>
</tbody>
</table>

3.3 Biscuit preparation:
To above mentioned formation, water added to ingredient to form a paste, Biscuits cuts in shaped, which processed in an oven for 15min, then pisces cooled and packed, ready for children use. All process done under full hygiene.

3.4 Proximate analysis:
The sample was analyzed for approximate composition as (moisture content, ash content, cured protein, fat content, crude fiber, and carbohydrate. also the contents of minerals like iron, Calcium, Potassium, and Sodium were determined.
3.4.1 Moisture content:

The standard method of the association official Analytical Chemists (AOAC, 1984) was used to determine the moisture content of the sample in the present work. The sample were weight into a predried, weighed and clean porcelain dish. The samples placed in an air oven and dried at 130°C for 2 hours.

Finally, the samples were remove from the oven, cooled in desiccators at room temperature and weighted. Moisture content was then calculated as follows:

\[
\text{Moisture content} = \frac{\text{Loss in moisture}}{\text{weight of sample}} \times 100
\]

\[\text{D M } \% = 100 \% - \text{ moisture}\]

3.4.2 Protein content:

Protein content of the samples were determined according to (A.A.C.C, 1983) in which one sample was digested by heating with concentrated sulphuric acid for 3 hours in the presence of copper sulphate and potassium sulphate as catalysts.

After cooling, the digest was diluted to a volume of 100 ml with distilled water. Then 5 ml of the diluted digest was transferred to a clean stem distillation unit and 10 ml of 40% Na oh solution was poured into the distillation flask. The ammonia was distillated and received into a receiver flask containing boric acid solution. The ammonia trapped in boric solution was titrated directly with a standard 0.1 N HCL solution. The change in color of the mixture from blue to faint pink was taken as the end point.

The crude protein value computed from the nitrogen content multiplied by a conversion factor (6.25), i.e., % crude protein = % N × 6.25.
The nitrogen content of the sample was calculated using the following expression:

\[
N\% = \frac{\text{mg of HCl} \times (\text{Normality} \times (\text{volume made up} \times 14 \text{ used in titration}) \text{ of HCl} \text{ of the digest})}{(\text{Aliquot of the digest taken}) \times (\text{weight of sample taken}) \times 1000} \times 100
\]

\[
\text{Protein\% (on DM basis)} = \frac{\text{Ml of 0.1N HCl} \times 0.0014 \times 6.25 \times 20 \times 100}{\text{Weight of the sample} \times \text{DM\%}}
\]

### 3.4.3 Crude fiber content:

Crude fiber content of the various samples was determined according to the AOAC method (1994). Two grams of the defatted sample were weighed into 600 ml beaker. Then 200 ml of 1.25% w/w boiling dilute sulphouric acid solution was added. The contents were digested for 30 minutes and the beaker was shaken about every 5 minutes while boiling to mix the contents thoroughly, and then filtered using a Buchner funnel. The residue was then transferred back into the beaker. 200 ml of 1.25% w/w boiling sodium hydroxide solution were added and digested for 30 min. After filtering the contents, the residue was transferred to pre-weighed porcelain dish and dried at 100°C for 5 hours. After cooling in desicators the dish containing the ignited sample was weighed again. The crude fiber content was calculated as follows:

\[
\text{C. f\%} = \frac{\text{Loss in weight of dish content}}{\text{weight of the sample}} \times 100
\]

\[
\text{C. f on (DM basis)} = \frac{\text{Loss in weight of dish and contents}}{\text{weight of the sample} \times \text{DM\%}} \times 100
\]

### 3.4.4 Ash content:

The method of A.O.A.C (1984) was used to determine the ash content of the sample analyzed in this study. 2 – 3 g of sample were weighed into a clean dish. The dish containing the sample was placed in a muffle furnace at 550°C and left burning for 5 hours at this temperature. Then, the dish with its content was weighed
again after cooling in desiccators to room temperature. Ash contents were calculated as follows:

\[
\text{Ash}\% = \frac{\text{Weight gain by the dish}}{\text{weight of the sample}} \times 100
\]

3.4.5 Crude fat content:

Crude fact was determined according to the method of the American Oil Chemist Society (A.O.C.S, 1981).

4.3 g of the sample were weighed into a filter paper and wrapped in such a fashion as to prevent escape of the meal. The wrapped sample was put into thimble tube; one piece of absorbent cotton was placed at the top of the thimble to distribute the solvent as it drops on the sample. The thimble containing the sample was then placed in a soxhlet extraction tube, and attached to a pre-weighed extraction flask containing 50 ml of n. hexane. The extraction flask was disconnected after 6 hours extraction period and then the hexane was recovered by distillation. Last trace of the solvent was removed by putting the flask in the air oven. The flask containing the crude oil was cooled in desiccators at room temperature and weighed. The crude fat content was calculated as follows:

\[
\text{Crude fat}\% = \frac{\text{Weight of oil extracted}}{\text{Weight of the sample}} \times 100
\]

\[
\text{Oil}\% \text{ (on DM basis)} = \frac{\text{Weight gain by the dish}}{\text{Weight of the sample} \times \text{DM}\%} \times 100
\]

3.4.6 Total carbohydrate content:

The total carbohydrate was obtained by calculation as the difference between the sum of the other major ingredients, namely protein and fat and fiber and ash subtracting from 100.
3.4.7 Minerals Measurements:

To determine the endogenous minerals for each sample; the ash of 3 g of sample prepared at 550-600°C for six hour was transferred to 250 ml beaker and 10ml HCL was added to dissolve the ash then transferred to 100 ml volumetric flask and volume completed by distilled water. This solution ready for minerals determination.

3.4.8 Determination of Fe by colorimetric method:

1) Apparatus
   Colorimetric, Burette, Pipette, Beaker, and Volumetric flask

ii) Reagents
   NH₄ SCN and HNO₃

iii) Preparation of iron stock solution
   Weight required was determined by using the following equation:

   \[ \text{Weight of mineral (g/l)} = \frac{\text{Required mineral concentration}}{\text{Atomic weight of the mineral}} \times \text{Mw of salt} \]

   Fe₂(SO₄)₃ dissolved and prepared to obtain a concentration of 10mg/ml

iv) Standard solution of Fe
   Standard solution of Fe was prepared in the range (0-2mg/ml Fe) in 100 ml flasks, from stock solution to each flask 5ml NH₄SCN were taken and then added; all flasks become red in color except B (blank), Complete to the mark with distilled water, 10 ml from sample were taken 5-10 drops of HNO₃ were added and completed as previously to the mark with distilled water.
   The absorbance of each standard was read using the colorimeter at follows:
<table>
<thead>
<tr>
<th>Standard Solution</th>
<th>Absorbance at 540 nm</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0.0</td>
</tr>
<tr>
<td>2</td>
<td>0.313</td>
</tr>
<tr>
<td>4</td>
<td>0.543</td>
</tr>
<tr>
<td>6</td>
<td>0.615</td>
</tr>
<tr>
<td>8</td>
<td>0.418</td>
</tr>
<tr>
<td>10</td>
<td>0.281</td>
</tr>
</tbody>
</table>

The calibration curve (Absorption v concentration) (A vs. C) was plotted; then from the curve the quantity of Fe in the sample was calculated.

**Calculation:**

\[
\frac{\text{Instrument reading} \times \text{Dilution Factor} \times 100}{\text{Wt of sample} \times 1000}
\]

**3.4.9 Determination of calcium:**

Calcium was determined by using the flame photometer apparatus

**I) Ca Stock Solution**

(CaCO₃) was dissolved and diluted in 1 lit distilled water to obtain (1000 ppm Ca)

**ii) Ca standard solution**

Standard solution of Ca was prepared in the range (0-100 ppm Ca).

In 100 ml vol. flasks, from stock solution to each flask 2,4,6,8,10 ml were taken and completed as previously to the mark with distilled water; then the emissions for standard and sample were read using the flame photometer.

<table>
<thead>
<tr>
<th>Standard Solution</th>
<th>Emission</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>50</td>
<td>20</td>
</tr>
<tr>
<td>100</td>
<td>40</td>
</tr>
<tr>
<td>150</td>
<td>60</td>
</tr>
<tr>
<td>200</td>
<td>80</td>
</tr>
<tr>
<td>250</td>
<td>100</td>
</tr>
</tbody>
</table>
calibration curve (A vs. C) was plotted; then from the curve the quantity of Ca in the sample was calculated.

3.4.10 Determination of sodium:

Sodium was determined by using the flame photometer apparatus

I) Na stock solution

(Na CL) dissolved and diluted in 1 liter distilled water to obtain (1000 ppm Na)

ii) Na standard solution

Standard solution of Na was prepared in the range (0-100 ppm m Na). In 100 ml vol. flasks, from stock solution to each flask 2,4,6,8,10 ml were taken and completed as a previously to the mark with distill water; then the emissions for standard and sample were read using the flame photometer apparatus.

<table>
<thead>
<tr>
<th>Standard Solution</th>
<th>Emission</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2</td>
<td>13</td>
</tr>
<tr>
<td>4</td>
<td>37</td>
</tr>
<tr>
<td>6</td>
<td>63</td>
</tr>
<tr>
<td>8</td>
<td>80</td>
</tr>
<tr>
<td>10</td>
<td>100</td>
</tr>
</tbody>
</table>

The calibration curve (A vs. C) was plotted; then from the curve the quantity of Na in the sample was calculated.

3.4.11 Determination of potassium:

Potassium was determined by using the flame photometer apparatus.
I) Potassium Stock Solution
(KCL) was dissolved and diluted in one liter distilled water to obtain (1000 ppm K)

ii) Potassium standard solution
Standard solution of potassium (K) was prepared in the range (0-100 ppm K). In 100 ml vol. flasks, from stock solution to each flask 2,4,6,8,10 ml were taken and completed as a previously to the mark with distill water; then the emissions for standard and sample were read using the flame photometer apparatus.

<table>
<thead>
<tr>
<th>Standard Solution</th>
<th>Emission</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0.0</td>
</tr>
<tr>
<td>4</td>
<td>38</td>
</tr>
<tr>
<td>6</td>
<td>62</td>
</tr>
<tr>
<td>8</td>
<td>72</td>
</tr>
<tr>
<td>10</td>
<td>92</td>
</tr>
</tbody>
</table>

The calibration curve (A vs. C) was plotted; then from the curve the quantity of K in the sample was calculated.
CHAPTER FOUR
RESULTS AND DISCUSSION

4.1 Proximate analysis:

Table (4.1) show the proximate composition of prepared biscuits

<p>| | | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Moisture</td>
<td>protein</td>
<td>Fat</td>
<td>Ash</td>
<td>Fiber</td>
<td>CHO</td>
</tr>
<tr>
<td>4.43g</td>
<td>10.22g</td>
<td>16.81g</td>
<td>1.904g</td>
<td>2.4g</td>
<td>39.264g</td>
</tr>
</tbody>
</table>

Results are average of two replicates.

Carbohydrates (CHO) were determined by difference (100 - (moisture + protein + fat + ash + crude fiber)).

Table (4.2) shows the minerals content of the prepared biscuit

4.2 Children treated with prepared biscuits:

10 children selected randomize from Sinner hospital at 13/7/2012 up to age 5 years, to determine the effects of the diet which fortificated by sesame and dates to increase hemoglobin level in 10 days, treatment using the colorimeter for reading iron level. Every child take his fully quantity from the biscuits, 3 pieces per day.

Hemoglobin level recorded before children take a diet and after 10 days.

The result showed that 5 of them whom treated by diet increase sharply in hemoglobin level. And 5 their hemoglobin level were decreased for many reasons, such as; other infections, Many child depend on the new diet totally and leave the family diet. This indicate a good iron quantity in diet, and effects in reducing anemia.
Discussion:

t-test was used to test the significance of Hemoglobin levels, the result of Hemoglobin levels of studied children showed a significant increase after Biscuit treatment.

Therefore this prepared biscuit can be processed at home or factory level for treatment of nutritional anemia.

Table (4.3) Hemoglobin status of children before and after intake biscuit fortified for 10 days

<table>
<thead>
<tr>
<th>NO</th>
<th>Age</th>
<th>Weight before</th>
<th>Weight after</th>
<th>Hb % before</th>
<th>Hb % after</th>
<th>deference</th>
<th>Observations</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Years mon</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>-   10</td>
<td>8.5</td>
<td>8.9</td>
<td>67</td>
<td>72</td>
<td>+5</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>3   10</td>
<td>14</td>
<td>14.7</td>
<td>78</td>
<td>75</td>
<td>-3</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>1   5</td>
<td>10</td>
<td>10</td>
<td>57</td>
<td>67</td>
<td>+10</td>
<td>Depend on diet just</td>
</tr>
<tr>
<td>4</td>
<td>1   4</td>
<td>11</td>
<td>11.7</td>
<td>60</td>
<td>64</td>
<td>+4</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>4   8</td>
<td>14</td>
<td>14.4</td>
<td>75</td>
<td>64</td>
<td>-11</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>2   5</td>
<td>11</td>
<td>11.7</td>
<td>57</td>
<td>60</td>
<td>+3</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>5   -</td>
<td>15</td>
<td>16.4</td>
<td>57</td>
<td>64</td>
<td>+7</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>1   -</td>
<td>9.5</td>
<td>8.7</td>
<td>67</td>
<td>61</td>
<td>-6</td>
<td>Acute infection</td>
</tr>
<tr>
<td>9</td>
<td>2   10</td>
<td>13</td>
<td>12.8</td>
<td>71</td>
<td>82</td>
<td>+11</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>4   -</td>
<td>17</td>
<td>17.8</td>
<td>71</td>
<td>74</td>
<td>+3</td>
<td>jaundice</td>
</tr>
</tbody>
</table>
CHAPTER FIVE
CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion:
The biscuit was found rich in protein 10.22g fat 16.81, iron 3.5mg/100g which is close to recommended daily allowance.

5.2 Recommendation:
1. Mothers need education to treat their children against nutritional anemia. This can be through preparation the iron-rich biscuit at home level.
2. Tannin in tea effect on iron absorption so mother discourage tea and instead of that give the child vitamin C after the diet to increase hemoglobin level or iron absorption.
3. The diet can be suggested for production at factory level and be made commercially available to intervention in vulnerable group such as pregnant women and school children.
4. Mother should take enough amount of iron during pregnant to bring healthy children, and there should be space of two to three years before another baby.
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