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Effect of Some Traditional Foods on Malnutrition Treatment of Children (1-5 years) in Alfashir West Sudan

أثر بعض الأغذية التقليدية في معالجة سوء التغذية لدى الأطفال (1- 5 سنوات) في منطقة الفاشر-غرب السودان

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DEDICATION

To my great mother who gave me love,,,

To my Husband and small family,,,

To my dear brothers and sisters who were there when I’m in need,,,

To my teachers, friends and colleagues,,,

With love

Amra

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Thanks and gratefulness firstly and lastly to “ALLAH” who gave me mind, determination and patience to carry out this study successfully.

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Abstract

This is a case study at Zamzam refugee campus, Elfashir district, Sudan, targeting malnourished children(1-5 years). Meals in porridge form were prepared from traditional foods,70g/L sesame + 250ml cow milk, and 70g/L millet + 250ml cow milk, supplemented with 5g of sugar and 5g of salt. Proximate chemical composition % of the sesame meal was found to be for protein, fat, ash, moisture, crude fiber, carbohydrate (14.30,19.00,7.40, 26.60,18.10,14.70), respectively. On the other hand.

proximate chemical composition % of the millet meal was found to be (7.70,15.00,4.10,35.10,15.70,22.70), respectively. Both meals were found rich in essential amino acids . The amino acid, methioneine important to children in sesame and millet meals was found to be 158 and 151 mg/g, respectively. The 24 protein energy malnourished admitted children were treated with prepared meals for two months and checked before and after the processed meal is given. The activity was found to increase after the meal was given to the children (MUAC) which was found to be under 11cm in the malnourished children and it was 12.5 cm after 3 weeks.

The studied malnourished children responded positively to the local meals developed from sesame and millet which gave a good results in treating the diseased children. So traditional foods from the local materials are recommended is solving problems of malnutrition of 1-5 children.

ملخص الدراسة

هذه دراسة حالة لمعسكر زمزم بمنطقة الفاشر، السودان. مستهدفة الأطفال (1-5 سنوات) المصابين بمرض سوء التغذية. صنعت وجبات في شكل عصائر من الأغذية التقليدية (70 جرام/ ليتر سمسم + 250 ملي لبن أبقار و 70 جرام / ليتر دخن + 250 مل لبن أبقار ودعمت بإضافة 5 جرام سكر و 5 جرام ملح طعام).

أثبتت التحاليل الكيميائية التقريبية أن وجبة السمسم أعطت من البروتين، الدهون، الرماد، الرطوبة، الألياف، والكربوهيدرات 14.3، 19.00، 7.40، 26.60، 18.10 و14.70%، على التوالي. أما وجبة الدخن فقد أعطت من البروتين، الدهون، الرماد، الرطوبة، الألياف، والكربوهيدرات 7.70، 15.00، 4.10، 35.10، 15.70 و22.70%، على التوالي. كلا الوجبتين وجد أنهما غنيتان بالأحماض الأمينية الأساسية. ولقد وجد الحامض الأميني الميثونين الهام للأطفال حوالي 158 ملجم/ جرام في وجبة السمسم و 151 ملجم/ جرام في وجبة الدخن.

الأطفال (24) المصابين بمرض سوء التغذية تم تغذيتهم بالوجبات المصنعة المذكورة أعلاه لمدة شهران وتم اختبارهم قبل وبعد إعطائهم الوجبات. وجد أن النشاط في الأطفال ارتفع من 11 سم في الأطفال المرضى إلى 12.5 سم بعد ثلاثة أسابيع من تناول الوجبات.

لقد استجاب الأطفال المصابون بسوء التغذية إيجابا بعد تناولهم للأغذية المعدة من السمسم والدخن التي أعطت نتائج جيدة في معالجة الأطفال المرضى. عليه فإن الأغذية التقليدية من المواد المحلية يمكن أن يوصى بها لحل مشاكل سوء التغذية في الأطفال (1-5 سنوات).

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CHAPTER ONE

INTRODUCTION

Local food is far better value for money and much more nutritious and can provide suitable guide to promote for overcoming malnutrition and hunger in developing countries such as Sudan. Millet and Sesame are famous and common in the menu of local foods of Sudan.

Sudan is one of the Sub-Saharan African (SSA) countries suffering from a severe problem of food and nutrition insecurity among its population during the last two decades (Jenny and Egal, 2002; Samar and Ingrid-Ute, 2013). Cereal traditional foods and milk are the major contributors for both energy and protein and comprise about 49.8% and 5.6 % of the total dietary energy respectively ; hence their availability are important to ensure food security in the country (FAO, 2010). Traditional food or local food refers to food that is produced based on the resources, consumed by the local community and that constitute an essential aspect of people's cultural heritage, background and their environmental conditions. In addition, traditional foods represent an important component of people's diet and are very much related to their food habit and nutrition. The traditional foods have a high nutritive value and therefore can play an important role in providing essential nutrient in Sudan, and they can also supplement the main dishes and improve the nutrition composition of a meal such as porridge (Nasr, 2015).

Pearl millet (*Pennisetum glaucum*), also known as Dokhun in Sudan, is one of the four most important cereals (rice, maize, sorghum and millet) grown in tropical and semi-arid regions of the world primarily in Africa and Asia.

Millets are major food sources for millions of people, especially those who live in hot, dry areas of the world. They are grown mostly in marginal areas under agricultural conditions in which major cereals fail to give substantial yields (Adekunle, 2012). Millets are important foods in many underdeveloped countries because of their ability to grow under adverse weather conditions like limited rainfall. In contrast, millet is the major source of energy and protein for millions of people in Africa. It has been reported that millet has many nutritious and medical functions (Obilana and Manyasa, 2002; Yang *et al*., 2012). It is a drought resistant crop and can be stored for a long time without insect damage (Adekunle, 2012); hence, it can be important during famine. Millets are unique among the cereals because of their richness in calcium, dietary fibre, polyphenols and protein (Devi *et al*., 2011), also provide, fatty acids, minerals, vitamins and typical millet protein contains high quantity of essential amino acids (FAO, 2009).

Millets generally contain significant amounts of essential amino acids particularly the sulphur containing amino acids (methionine and cysteine); they are also higher in fat content than maize, rice, and sorghum (Obilana and Manyasa, 2002). Sesame (*Sesamum indicum* L.) is grown primarily in less developed tropical and subtropical areas of Asia and Mediterranean countries and South and Central America (Carter *et al*., 1961). In the Sudan, it is grown under rainfed conditions by subsistence, semi-commercial and commercial farmers.

Protein energy malnutrition is the most important nutritional problem especially at times of emergency so that measures should be taken to solve it.
Severe malnutrition will be in both medical and social disorder that is the medical problems of the child result in part from the social problems of home in which the child lives.

Malnutrition is the end result of chronic nutritional and frequently emotional deprivation by careers because of poor understanding poverty of family. Problems are unable to provide the child with the nutrition and care he/ she requires. Successful management of the severely malnourished child requires both medical and social problems to be recognized and corrected. If the illness is viewed as being only a medical disorder, the child is likely to relapse when he/ or she returns home and other children in the family will remain at risk of developing the same problem (WHO, 2002).

Protein energy malnutrition (PEM) is the most common form of malnutrition occurring among infants and young children. Mild PEM is manifested mainly as poor physical growth, whereas individuals with severe PE have high case fatality rates. Maras us and Kwashiorkor are the two forms of severe PEM. Both conditions may be distinguished by their own particular clinical characteristics.

Albumin is very important as a negatively charged, water-soluble protein (molecular weight 65KD) that is synthesized in liver. Its functions include maintaining osmotic presure and transporting a variety of circulating molecules (Sugio *et al*.,1999).

Malnutrition is the result of inadequate dietary intake or infections or a combination of both (WFP, 2002).

Children with severe PEM need careful treatment with special food and drugs. Some of them may die, and children who recover may relapse and become malnourished again and die later (King and Burgess, 2000).

The number of malnourished children presenting at many hospitals had increased dramatically. WHO (2000) estimated that malnourished children numbered 181.9 million children, younger than 5 years.

Malnutrition is the main problem among the children in El Fasher district, western Sudan. Data are needed to help in intervention programs to fight malnutrition.

General objective**:**

To define the causes and to assess the management of protein energy malnutrition (PEM) in El Fasher district.

Specific objectives:

1. To find any relation between displacement of population and malnutrition.
2. To assess the impact of socio- economic factors on the prevalence of PEM.
3. To find the correlation between PEM and infectious diseases and other nutritional problems.
4. To formulate meals for the improvement of the nutrition status of children in El Fasher district.

CHAPTER TWO

LITERATURE REVIEW

2.1 Definition of malnutrition:

Malnutrition is a condition of impaired development or function caused by long term deficiency excess or imbalance in energy and/or nutrient intake (Philip *et al*., 1975).

Many children do not get enough of the right foods to eat, they do not grow well, they become ill, many die and they do not grow up as clever as healthy or as tall as they should be, we say that they are malnourished or that they are suffering from malnutrition (WHO, 2000).

Malnutrition not only makes a child more prone to illness and death it may also have debilitating mental and physical consequences that the child carries into adult hood (WFP, 2000).

Malnutrition also is defined as disturbance of form or function arising from a deficiency or excess of one or more nutrient (Bender, 1982).

In many developing countries large sectors of their population suffer from protein- caloric malnutrition. In Sudan, the native home of the author, the incidence of malnutrition is severe, even though the country is rich in agricultural resources (Yousif *et al*., 1973; Taha, 1974).

Severe malnutrition in children, particularly during the first year of life, may lead to irreversible impairment of mental development muscle motor function, language; inter sensory perception, normal competence and social adjustment. This problem was critically analyzed at the first National Food and Nutrition Seminar by the National Council for Research, Khartoum, 1973 (Yousif *et al*., 1973), which concluded that the Sudanese people need supplementary foods for feeding infants and children, and recommended that protein from locally abundant oil seeds be more extensively utilized for human food. Also, there currently is extensive famine in Somalia and Eastern African countries.

2.2 Definition of protein energy malnutrition (PEM):

The term (PEM) is used to identify a complex group if related nutritional problems.

Because energy intake is regarded by many authorities as the more important problem in children malnutrition today, the term energy protein malnutrition (EPM) is also used to describe these conditions (Anderson *et al.*, 1982).

PEM is also defined as marked dietary deficiency of both energy and protein, which include a spectrum of disorders ranging from under nutrition to kwashiorkor and marasmus (Bender, 1982).

Protein energy malnutrition present either as kwashiorkor, marasmus or marasmic kwashiorkor (Bender, 1982).

Traditionally nutritionists have distinguished between marasmus as severe partial starvation and kwashiorkor as a protein deficiency, it is doubtful that this is an entirely useful or correct classification (C. V. Mosby Company, 1981).

PEM occurs in children with various conditions associated with increased caloric requirement e. g. infection, trauma and cancer (Tershakovec *et al.*, 2002).

2.3 Forms of protein energy malnutrition (PEM):

2.3.1 Maramus:

It is a disease that results from consuming a grossly insufficient amount of protein energy. The child with marasmus had little or no fat stores and shows muscle wasting. Death from infection in common (Tershakovec *et al*., 2002)

This result from insufficient food (not enough calories) usually occurs in the first 2 years of life.

Marasmus (or severe wasting) is a form of severe PEM that may occur at any age, particularly in early infancy and is characterized by severe wasting (body weight is less than 60% of the expected), loss of subcutaneous fat, gross muscle was thin and absence of edema (Tershakovec *et al*., 2002).

2.3.2 Kwashiorkor:

It is more complicated, it is commonest in children aged 1-3 years, but can occur in older or younger children.

Kwashiorkor is mainly due to lack of protein and other nutrients but there are other factors also that cause some children to develop Kwashiorkor (Tershakovec *et al*., 2002).

2.3.3 Marasmic Kwashiorkor:

Some children have signs of both marasmus and Kwashiorkor at the same time (Tershakovec *et al*., 2002).

2.3.4 Signs of marasmus:

- The child's weight is usually less than 60% of the reference weight.
- The child has lost much of his/ her fat and muscle, so his/ her body looks very thin and his/ her legs look like sticks.

- The child face is wasted and the skin may be in folds, he looks like a very old person.
- The child’s abdomen sticks out because the muscles of the abdominal wall are wasted and weak.
- The child looks very miserable and cries and complains a lot (Tershakovec *et al*., 2002).

2.3.5 Signs of Kwashiorkor:

- Edema of the legs and arms and face is swelling due to fluid in the tissues.
- The child’s face becomes rounder than usual and may even look fat (moon face).
- Moderately low weight out usually so severely underweight due to edema fluids wasted muscle most clearly over shoulder where there is less fat and no edema.
- Weak muscle.
- The child looks unhappy (misery and apathy).
- The child may not want to eat (poor appetite).
- Pale, sparse hair with weak roots, pale, thin, peeling skin.
- Enlarged liver, the child’s liver become full of fat which makes it larger (you can feel the enlarged liver in the upper right side of the children abdomen (Tershakovec *et al*., 2002).

2.3.6 Signs of marasmic Kwashiorkor:

- The child looks extremely thin and wasted; the weight is usually less than 60% of the reference weight.
- The child has mild edema of her legs and sometime of her arms and face.

- The child may have any of other signs of Kwashiorkor or marasmus, a thin or moon face, weak hair, skin changer and misery (Tershakovec *et al.*, 2002).

2.3.7 Dangers of marasmus and Kwashiorkor:

- Children with severe malnutrition are ill, they feel miserable and they may be in pain. Their frequent illnesses cost the family a lot of worry and expenses.
- A malnourished child is more prone to illness and more likely to die than a well nourished child.

Recent studies have linked childhood malnutrition with heart disease and cancer in an individual's middle aged years (King and Burgess, 2000).

2.4 Calories/ protein interaction:

Calorie intake affects protein utilization in two ways:

First, nitrogen cannot be retained and used by the body unless accompanied by a sufficient intake of calories.

Secondly, once calorie intake and nitrogen concentration are at equilibrium in the body even if that equilibrium is suboptimal by conventional standards. Increase in protein intake will not stimulate growth or development. When calorie intake is insufficient for maintaining the bodily activities, part of the dietary protein is diverted to provide the energy (Schimitt, 1979).

2.5 Magnitude of malnutrition:

2.5.1 Magnitude of malnutrition in the world:

Malnutrition contributes to 60% of 10.9 million deaths of children under five years in the world. This translates into one child death every 5 seconds (WHO, 2002).

According to the report on the state of the world's children, hunger and early infections caused the death of 40,000 children every day in the world.

According to estimates of the Pan American Health Organization one million children die every year of PEM, 38% of children under one year old (Sasson,1990).

2.5.2 Magnitude of malnutrition in developing countries:

Geographically more than 70% of children with protein energy malnutrition live in Asia, 26% in Africa (WHO, 2002).

Millions of people in developing countries still need emergency food assistance as a result of natural disasters. In Eastern Africa food supply difficulties persist in some parts as a consequence of poor rainy seasons and civil conflicts. In Somalia where the 2001 main reasons crops were poor, more than 500,000 people faced severe food difficulties. Approximately 5.2 million people in Ethiopia, 1.5 million in Kenya, 2 million in the Sudan and 300,000 in Uganda will depend on food aid.

In Eritrea and estimated 1.3 million people will require emergency food assistance. In the United Republic of Tanzania nearly 120.000 people are in need of food assistance (FAO, 2002).

2.5.3 Magnitude of malnutrition in Sudan:

People in many parts of Sudan often experience difficult or lean periods during the year when food is in short supply. This may be just before the harvest when last year's grain stores are nearly finished and market prices are high because the next harvest is yet to come. This kind of seasonal food scarcity is a recurring problem but may be made worse by:

- War, insecurity or armed conflicts which prevent people from carrying on their normal lives (in Dar fur region, South Sudan and Eastern Sudan).
- Drought, floods, pests or crop disease which adversely affect the food supply or people's access to it (in some parts of Sudan Kassala, Kordofan region…etc) (WHO, 2002).

The nutritional survey in 14 States in Sudan from (1995- 2001) showed that the malnutrition among children less than 5 years was 14% in Elgadarif State, 15% in Sinnar, 16.6% in Khartoum, 32.4% in Upper Nile, 30.7% in North Darfur, 17.4% in White Nile, 28.4% in River Nile, 19.3% in Kassala, 16.4% in North Kordofan, 25.2% in Red Seas, 20.4% in Elgazira, 23.2% in West Kordofan and 33% in Blue Nile and 15.4%, respectively (FAO, 2002).

2.6 Indicators of malnutrition:

Body measurements provide a good indication of these different forms of malnutrition among the individuals; other community indicators include clinical observation and morbidity data (WHO, 2002).

2.7 Nutritional assessment:

There are various clinical signs useful for diagnosis but most obviously a marasmic child is extremely emaciated and a child with kwashiorkor bilateral edema.

Most standardized indicators of malnutrition in children are based on measurement of the body to see if growth has been adequate (WHO, 2002).

2.7.1 Height for age (H/A):

Height for age a comparison of child's height or length with the reference median height for the children of the same age and sex.

H/A is an indicator of chronic malnutrition (WHO, 2002).

2.7.2 Weight for age (W/A):

W/A is not particularly useful index for screening or for assessment surveys in nutritional emergencies because it ignores height, it fails to distinguish between short children with adequate body weight and tall, thin children. It also requires exact knowledge of children's ages (WHO, 2002).

2.7.3 Weight for Height (W/H):

According to WHO(2002) It is and indicator of acute malnutrition that tells us if a child is too thin for a given height (wasting). W/H is the best indicator as:

- It reflects the present situation.
- It is sensitive to rapid changes in problems and recovery.
- It is a good predictor of immediate mortality risk.
- It can be used to monitor the evaluation of the nutritional status of the population.

Bilateral oedema is an indicator of kwashiorkor. All children with oedema are regarded as being severely acutely malnourished irrespective of their W/H therefore, it is essential to assess W/H and the presence of bilateral oedema to define acute malnutrition (WHO, 2002).

2.7.4 Middle Upper Arm Circumference (MUAC):

It is anthropometric indicator, MUAC is simple fast and is a good predictor of immediate risk of death and can be used to measure acute malnutrition from 6 month to 59 months, they are useful when resources are limited and where weight and height measurements cannot be done, however arm circumference measurements are inaccurate (WHO, 2002).

2.8 History and physical examination:

2.8.1 Medical history: According to WHO(2002)

- Useful diet before current episode of illness.

- Breast feeding and history.

- Food and fluids taken in past few days.

- Recent sinking of eyes.

- Duration and frequency of vomiting or diarrhea, appearance of vomit or diarrhea stool.

- Time when urine was last passed.

- Contact with people with measles or tuberculosis.

- Any deaths of siblings.

- Birth weight.

- Milestones reached (sitting up, standing).

- Immunizations.

2.8.2 Physical examination: According to WHO(2002)

- Weight and length or height.

- Enlargement or tenderness of liver, junicle.

- Abdominal distension, bowel sounds.

- Severe pallor.

-Signs of circulatory collapse: Cold hands and feet, weak radial pulse, diminished consciousness.

- Temperature: Hypothermia or fever.

- Thirst.

- Eyes corneal lesions indicative of vitamin A deficiency.

- Ear, mouth, throat, evidence of infection.

- Skin evidence of infection or purpura.

- Respiratory rate and type of respiration.

Causes of protein energy malnutrition (PEM):

2.9 factors influenced by PEM:

2.9.1 Poverty:

Malnutrition is closely linked to conditions of poverty. It is hard to bring up a family on a low income, not only hard to feed and provide them with care and conditions required for them to develop and thrive but poverty also often diminishes the capacity of parents to be supportive, consistent and involved with their children (Rudof and Leven, 2006).

Poverty has strong effect on the physical health of children and children for poor families have than average rates of death and illness from almost all causes (Radof and Leven, 2006).

Food rich in animal protein and fat are more expensive than predominantly carbohydrate foods. People who are not themselves producers of food may not be able to buy nutritious foods simply because they do not have sufficient money (Latham, 1979) where people are extremely poor and can not afford to feed themselves adequately, there will be very high rates of infant mortality (Sasson, 1990).

2.9.2 Lack of knowledge or education:

Some children are today dying because their mothers do not know what foods are necessary to prevent their illness. There is very wide spread lack of understanding of the function of food (Latham, 1979).

2.9.3 Mal- distribution of food:

Food can be unevenly distributed both within the family itself and within the region as a whole. Within the family the nutritionally vulnerable members often have lowest priority and therefore little choice of what food is available at any meal. It is a custom that the meals of the household eat first and little of the food itself for the children and women who come last. Poor distribution of food in a country as a whole may be the result of a lack of certain foods in some areas. Uneven distribution in a community may be due to poverty (Latham, 1979). Gender can determine food distribution within the family with women and girls receiving less of food than men and boys (Young, 2000).

2.9.4 Conflicts:

Most people become refugees as a result of conflicts. In the early stages of refugee emergencies malnutrition runs rampant exotically increasing the risk of disease and death (WHO, 2002).

2.10 Factors affecting nutritional status:

2.10.1 Feeding practices.

2.10.1.1 Breast feeding (BF):

Breast feeding is the most important nutritional act in ensuring the adequate growth and development of the new born child. It simultaneously addresses her/his food, health and care requirements.

Breast feeding should be exclusive for about the first six months of a child's life after which time semi solids should be progressively introduced to the diet to complement the continued breast feeding. If a child less than six months old is not being breast fed it is important to understand the reasons and possible constraints (WFP, 2002).

2.10.1.2 Bottle feeding:

Infant milk formulas are manufactured from cow's milk or soya beans. Despite continuing advances in technology such formulas cannot wholly mimic the composition of human breast milk (Thomas, 1989).This method of feeding causes inadequate weight gain because the feeds may be either too few or too small or the feed being over diluted, under current illness and intolerance to a component of the feed (Jolly's, 1994).

2.10.1.3 Complementary feeding (supplementary):

Complementary feeding needs to be intimated at around six months of age in addition to sustained breast feeding. By this age in the nutritional needs of the infant cannot be met by breast milk alone. Complementary foods should no longer be referred to as (weaning foods) as this incorrectly implies the cessation of breast feeding. The quantity, quality and form of complementary foods should be safe, palatable, energy dense and micronutrient -rich (WFP, 2002).

Weaning practices are one of the major factors contributing to child malnutrition due to in appropriate feeding during the weaning period. The healthy infants do not require complementary feeding until six months of age (Rudof and Leven, 2006).

Weaning process which begins when breast or bottle milk start to be complementary by mixed diet (Mosby Company, 1981).

2.10.2 The weaning process:

0- 6 months → Exclusive breasted.

6 months → Introduce pureed or liquidized foods.

7-8 months → Give more soft foods before milk feed, encourage

Finger feeding, give fruit juices in a cup.

9-12 months → Mash food with a spoon three meals a day, at least one with the family.

1 year and beyond → Undiluted cow milk in a cup, eating with the family.

2.10.3 Family planning:

Large family size, short intervals between children and abrupt termination of breast feeding are all associated with ill health including malnutrition and even increased mortality rates in the mother and child. Family planning is intimately related to health and nutritional status (Latham, 1979).

2.10.4 Food habits and beliefs:

Some taboos in some tribes affect the child nutrition for example customary habits of ceasing breast feeding once a new pregnancy has started.

Food taboos also play their role in some communities including not allowing the children to eat eggs in order to discourage them from stealing the eggs of sitting hens. Other customs, again often affecting women and children concern fish, other food beliefs concern goat’s milk and goat’s meat. In some tribes it is said that a child who drinks goat’s milk will grow to look like a goat (Latham, 1979).

2.11 Malnutrition and low birth weight (LBW):

The birth weight of a baby is an important anthropometric indicator, reflecting both of the duration of gestation and the rate of fetal growth. It is an indicator of the child’s future health and nutritional status as well as an indicator of the mother’s nutritional health status.

Children born with weight below 2.5Kg are defined as LBW.

LBW baby is effectively born malnourished and is at higher risk of dying in early life.

LBW with intrauterine growth retardation affect 11% of infants born in developing countries (WHO, 2000).

2.12 Malnutrition and brain development:

The brain is very sensitive to the conditions of nutrition while it is growing that is during the fetal stage and in childhood.

Malnutrition impairs its future development and causes anomalies in its structure and functioning. If those disorders occur during the period of rapid growth there is a risk of serious and permanent mental deficiency (Sasson, 1990).

2.13 Malnutrition and immunity:

Cell- mediated immunity is depressed in patients with PEM severely malnourished children fail to respond to tuberculin testing (Tershakovec *et al*., 2002).

Children suffering from kwashiorkor are not able to produce antibodies in response to anti- typhoid or anti- diphtheria vaccine, but the synthesis of the antibodies is resumed when protein is given.

The immune systems are inhibited and the malnourished child dose not has the normal defense mechanism (Thomas, 1989).

2.14 Malnutrition and immunization:

It is not a direct nutrition intervention but the childhood infectious diseases contribute importantly to malnutrition immunization needs to go hand in hand with more direct nutrition intervention (Latham, 1979).

Childhood immunization is the process of inducing immunity by vaccination with vaccine or toxic (Kliegman *et al.*, 2006).

2.15 Malnutrition and infections:

There is an interaction between infection and malnutrition. Infection reduces appetite; anorexia may be a central phenomenon or a local cause such as oral thrush, sore tongues and a pothouse ulcer. Many infectious diseases especially those lead to a rise in temperature (fever) cause an increase loss of nitrogen in urine. This nitrogen comes from the chemical break down of the muscles and has to be replaced by adequate amounts of protein in the child's food during the period of recovery (Anderson *et al*, 1982).

2.15.1 Diarrhea:

Malnourished children may have acute diarrhea with the same types of infection that all children may get such as viruses, bacteria and guardians (King and Burgess, 2000). A body fed child is also three times more at risk of contracting some form of diarrheas. In malnourished children, diarrhea is often persistent (Bender, 1982).

Chronic diarrhea also is common and starts slowly but continues for along times, and keeps recurring.

Persistent and chronic diarrheas are partly the result of under nutrition; the gut wall becomes thin and damaged. It takes longer to recover from infection and does not digest and absorb food properly.

Nutrients lost in the diarrhea makes under makes under nutrition worse. Diarrhea in malnourished children is also party due to bacterial over growth. The normally harmless bacteria that live in a child's lower gut spread to her upper gut and stomach where they can cause damage and make her ill (King and Burgress, 2000).

2.15.2 Measles:

Measles remain the biggest killer among the diseases that can be prevented by immunization and it is also the most closely related to malnutrition. Measles is particularly lethal for children who have vitamin deficiency and serious PEM (Latham, 1997).

The severe complication with measles for malnourished children leads to very high case fatality rate (30%). The mortality rates are in the case of measles, two hundred times higher in the developing countries than industrialized countries, it is largely due to the different states of nutrition and under- fed child is then ten times more likely to die from measles than one properly fed (Sasson, 1990).

2.15.3 Intestinal parasites:

Which may be extremely common are also closely liked malnutrition. It is well established that hook worms, which suck blood cause a loss of iron and other nutrients. Other intestinal parasites play varying roles in malnutrition (Latham, 1979). Most severely malnourished children suffer from worms.

2.15.4 Malaria:

A great public health problem in Africa tends to be aggravated by malnutrition.

Like other infections malaria readily cause nutritional deterioration in both children and adults (Thomas, 1989).

2.15.5 Acute Respirator Infections (ARI):

ARI are the largest single immediate cause of mortality in childhood in developing countries. Malnutrition is an important risk factor for development of ARI. Malnourished children and adults with a cough are more likely to develop pneumonia, and case fatality rate in pneumonia is higher among malnourished individuals (WHO, 2000).

2.15.5.1 Tuberculosis (TB):

The global burden of tuberculosis is growing with increasing poverty, overcrowding multiple drugs resistance and the spread of HIV infection and poor nutritional status.

Inadequate treated tuberculosis itself can cause moderate or severe malnutrition in both adults and children (WHO, 2000).

2.15.6 Malnutrition and environmental health:

Clean water, adequate sanitation and rubbish disposal are essential for the health of the population. But purely technical interventions such as the construction of latrines or the drilling of boreholes do not of themselves ensure a healthy environment. Hygiene promotions together with these technical inputs are an important component of environmental health work (Mears and Chowhdhury, 1994).

2.15.7 Malnutrition and vitamins:

2.15.7.1 Vitamin A deficiency:

Severely malnourished children are at high risk of developing blindness due to vitamin A deficiency. For this reason a large dose of vitamin A should be given routinely to all malnourished children on day 1 unless there is definitive evidence that a dose has been given during the past month. (Mears and Chowhdhury, 1994).

The dose is as follows:

50,000 International Units (IU) orally for infant $<$ 6 months of age, 100,000 (IU) orally infants 6- 12 months of age and 200,000 (IU) orally for children >12 months of age. If there are any clinical signs of vitamin A deficiency e. g. night blindness, conjunctiva xerosis with Bilot's Spots, Corneal xerosis or Ulceration or Keratomalacia, a large dose should be given on the first 2 days followed by a third dose at least 2 weeks later (WHO, 2002). It not unusual for PEM and vitamin A deficiency to occur together with severe consequences, when exerohpthalmia accompanies PEM, the mortality may be as high as 80%, whereas it is about 15% in a group equally malnourished but not deficient in vitamin A (Anderson *et al*., 1982).

2.15.7.2 Other vitamins deficiency:

All malnourished children should receive 5 mg of folic acid orally on day 1 and then 1 mg orally per day thereafter. Many malnourished children are also deficient in riboflavin, ascorbic acid, pyridoxine, thiamine and the fat soluble vitamins D, E and K (WHO, 2002).

2. 16 Complication of protein energy malnutrition:

2.16.1 Dehydration:

Malnourished children with diarrhea may become dehydrated. This increases the risk of death. A child wit is dehydrated may lose her/his oedema, which reappears when hydrated (WHO, 2002).

2.16.2 Anorexial (less appetite):

Severely malnourished children may not want to eat which makes it difficult to feed them; this is commonest with children who have kwashiorkor (King and Burgess, 2000).

2.16.3 Hypoglycemia:

Hypoglycemia is common in malnourished children with serious infections. Death from hypoglycemia occurs frequently and most often at night for this reason it is essential that there is regular feeding during day and night prolonged. Hypoglycemia can cause severe brain damage and death (WHO, 2000).

2.16.4 Hypothermia:

It is due to marked reduction in skin fold thickness and inadequate supply of substrates for energy production.

Hypothermia is a frequent cause of death, especially early in the morning. Severely malnourished children cannot regulate their body temperature adequately and they cool very quickly when there is a drop in external temperature (WHO, 2002).

2.16.5 Anaemia:

It is due deficiency of proteins, iron, folic acid and vitamins B_1 B_{12} and C. Hook worms and other parasites may aggravate the anaemia. Blood transfusion should not be given because of the danger of over loading the heart and transmission of infections (Bender, 1982).

2.16.6 Cardiac failure:

Cardiac failure can result from electrolyte disturbances, overload of fluids or severe anaemia. he first two causes should not occur when proper oral rehydration and nutritional rehabilitation scheme is followed (WHO, 2002).

2.16.7 Electrolyte imbalance:

All severely malnourished children have deficiencies of potassium and magnesium which may take two weeks or more to correct. Extra potassium (3-4 m mol/kg daily) and magnesium (0.4- 0.6 m mol/kg daily) with low sodium generally $<$ 125 m E. g/L is recommended along with food preparations having no salt (WHO, 2002).

2.17 Management of PEM:

The main actions are to treat complications which might include diarrhea, acute respiratory infections and otitis and give nutritional supplements and vitamin A (Mears and Chowdhury, 1994).

2.17.1 Dietary management:

2.17.1.1 Kwashiorkor:

Protein in the form of skimmed milk is commonly prescribed. An initial allowance of 2.5g protein per kilogram body weight is necessary. Sufficient carbohydrates and calories are needed to spare proteins and weight loss. After a week a mixed diet may be given in addition to milk. Minerals and vitamins supplementation should correct the other nutritional deficiencies (Thiels, 1980). (Mears and Chowhdhury, 1994).

2.17.1.1 Marsmus:

Dietary management depend on the presence of complications such as dehydration, electrolyte imbalance, vitamin deficiencies and infections. Fluid and electrolyte imbalance should correct promptly. Oral or parental administration of glucose golutin provides immediate energy.

2.18 World Food Program (WFP) management (Therapeutic Feeding Programs- TFP):

Two phases of (TFP) for children:

2.18.1 Phase 1:

All newly admitted severely malnourished children receive medical treatment to reduce mortality risk and carefully introduced sustenance level diet that prevents nutritional deterioration and allows normalization of the metabolic function. It takes time for the clinical abnormalities of the severely malnourished to be corrected. Until their condition is established, it is important not to overload their system, particularly with too much salt (sodium) and protein, as this can cause heart failure and sudden death. For this reason, low sodium and low protein milk feeds are given if the child is dehydrated, a modified oral rehydration solution (Resomal) is used in place of usual WHO formula for ORS. Children normally stay in phase 1 for up tone week.

The total amount of food should be given through many small feeds- every 2-3 hours. If frequent feeds are not possible, an absolute minimum is 6 feeds per day with at least one at night. Therapeutic milk, in the form of WHO F75 starter formula, is considered to be the most effective diet for phase 1 of treatment. This formula may be available in pre- prepared sachets or prepared locally from dried skimmed milk (DSM), oil, sugar and special salt/ mineral solution. Once medical complications like infection are under control, the child can be transferred to phase2.

Recovery of appetite and change of attitude/ expression are good guides to when this transition has been made (WHO, 2002).

2.18.2 Phase 2:

Children in this phase can tolerate much higher intakes of energy and nutrients necessary to promote rapid growth and nutritional rehabilitation. The high energy milk formula for phase 2 is known as F100 catch up formula (100 cal and 2.9g protein/100ml). Children should be fed on demand. Milk feeds can be alternated with porridge feeds, which are based on blended foods. Porridge should provide 150 k cal per 100ml (WHO, 2002).

Oil and sugar should be added. High energy biscuits are also sometimes used as easy meal or for night feeds.

Good weight gains have also been achieved using local diets. Breast feeding should be promoted and continued during the whole treatment for infants. It should be stimulated by sufficient feeding and liquid intake of the mother.

Artificial formula feeds should only be used in rare cases when breast feeding is not possible (WHO, 2002).

2.19 World Health Organization (WHO) management:

Management of the child with severe malnutrition is divided into three phases:

2.19.1 Initial treatment:

Life threatening problems are identified and treated in a hospital or residential care facility, specific deficiencies are corrected, metabolic abnormalities are reversed and feeding is begun (WHO, 2002).

2.19.2 Rehabilitation:

Intensive feeding is given to recover most of the lost weight, emotional and physical stimulations are increased, the mother or career is trained to continue care, at home and preparations are made for discharge of the child (WHO, 2002).

2.19.3 Follow- up:

After discharge the child and child’s family are followed to prevent relapse and assure the continued physical, mental and emotional development of the child (WHO, 2002). Time- frame for the management of a child with severe malnutrition (WHO, 2002).

2.19.4 Nasogastric (NG) feeding:

Many children will not take sufficient diet by mouth during the first few days of treatment. Common reasons include a very poor appetites, weakness and painful stomatitis. Such children should be fed using a NG tube.

However, NG feeding should end as soon as possible. At each feed, the child should first be offered the diet orally. After the child taken as much as he or she wants, the remainder should be given by NG tube (WHO, 2002).

The Ng tube should be removed when the child is taking three quarters of the day's diet orally or takes two consecutive feeds fully by mouth. If over the next 24 hours the child fails to take 80 k cal, the tube should be reinserted.

If the child develops abdominal distension during NG feedings, give 2 ml of a 50% solution of magnesium sulfate.

The NG tube should always be aspirated before fluids are administered. It should also be properly fixed so that it cannot move to the lungs during feeding. NG feeding should be done by experienced staff (WHO, 2002).

2.19.5 Prevention of malnutrition:

The Prevention of malnutrition begins at home and requires education and an increasing sense of responsibility.

Because PEM has been found to occur in early infancy where breast feeding is no longer common, mothers should be encouraged to breast feed their infants as long as they can, and exclusive breast feeding for about six months.

They should also be encouraged to add other appropriated foods to the infant diet; these foods should be of consistency suitable for the infant and should be free of contamination with harmful pathogens.

Mixtures of cereals and legumes such as rice and peas made into porridge and rubbed through a strainer may be used in combination with fruit and vegetable. The feeding of sick child is also an important factor in the prevention of PEM (Jolly's, 1994).

Mothers should be educated and informed of the location and activities of the health services in the area where they live.

Encouraging the use of simple growth charts which the mother should keep and bring with her to the clinic on each visit. Immunization of children should be regarded as a priority to hygiene promotion at a community, household and individual level may help to prevent PEM.

Hypoglycemia can be prevented by giving the child regular frequent diets. Hypoglycemia can be prevented by administration of frequent diet and keeping the patient in warm environment (WHO, 2002). Good feeding may be needed to prevent and treat the anemia.

2.19.6 Treatment of infectious disease:

Treat all severely malnourished children with antibiotics. Give the appropriate antibiotic in the standard therapeutic dose. Dehydrated children should be treated by rehydrating the child with oral rehydration solution.

2.20 Sesame:

Sesame (*Sesamum indicum* L.), a member of the pedaliceae family may be the earliest condiment used, and the oldest crop grown for edible oil. The seeds have been called the queen of the oil seed crop because of the high yield and quality of oil (Lyon, 1972).

Sesame (*Sesamum indicum* L.) is grown, in the Sudan, under rainfed conditions by subsistence, semi-commercial and commercial farmers. Selection by subsistence farmers resulted in many landraces adapted to different ecological areas, varying mainly in rainfall (300 - 1000 mm) and soil (sandy to heavy clay), and to the needs of the farmer (e.g. seed colour).

Three wild species of sesame are found in the Sudan, namely S. alatum (2n = 26), S. radiatum (2n = 64) and S. anguistifolium (2n = 64). S. alatum has long pods and winged seeds, and S. radiatum is characterized by dark black seeds with rough seed coat. Both have larger number of seeds per pod than the cultivated varieties (FAO, 1977).

Sesame with its high content of protein and unique balance of amino acids has potential for meeting much of these needs. Sesame has been extensively cultivated in Sudan for many years and 265,000 metric tons are produced annually (FAO, 1977). About 80,000 metric tons are exported annually, and the remainder of the seed is crushed for oil recovery. The meal (Low- oil residue) is utilized only for animal feeding. The potential for improving protein quality and nutritional value of other foods by Incorporation of Sesame Protein is considerable, if certain limitation of sesame can be resolved. As with nearly all oil seeds, sesame has fundamental characteristics that may limit its direct use as human food. These limitations of sesame protein are the presence of oxalate and phytate, which reduce nutritional quality, and the poor protein solubility, which reduces yields during isolation of protein from meal and may impart poor functionality in food systems.

Although the native country of sesame is not exactly known, Heupke and Reinhand (1973) reported that sesame probably originated in South East Asia. However, accordingly to Kassam (1976) sesame may have originated in Africa, perhaps Ethiopia. Accounts of ancient history and mythology document early recognition of sesame seed as a source of high quality food.

Archeological evidence indicates that sesame was cultivated in Palestine and Syria around 3000 BC, and in the civilization of Babylonia in 1970 BC and in the Indus Valley in 2500 BC.

Sesame is grown primarily in less developed tropical and subtropical areas of Asia and Mediterranean countries and South and Central America (Carter *et al*., 1961).

The current world production is estimated at about 2,000,000 metric tons annually (FAO, 1977). Sudan produces about 13.5% of world's sesame crop and it is the world's largest exporter (El Tinay *et al*., 1976).

Harvesting characteristics of sesame have precluded the development of a successful crop in the United States (Johnson *et al*., 1979). The seed capsules of normal dehiscent (scattering) sesame varieties open at maturity. Considerable care and hand harvesting is required to prevent excessive loss of seed. The recent development of indehiscent varieties may facilitate harvesting. However, most indehiscent varieties do not yet yield as much seed per acre as dehiscent varieties.

Sesame has been used as food in the orient (Arthur and Volkert, 1950). Fried sesame seed may be mixed with sugar to form sweet meats or sour ingredient. A peanut butter counterpart, called Tahini (Tahena in Arabic) is made from thick paste of roasted sesame seed. Halva (Halwa) is a candy made from Tahini, sugar and panama root juice. Halva is tradional food of Greek, Turkish and other Near Eastern people. In Sudan Halwa is a popular breakfast food for preschool children. In the Middle East, ground sesame is mixed with cooked chickpeas is such dishes as "Homos- 6- tab ina" (Sabry, 1961). Sesame is also used in high protein snack foods (Meksongsec and Swatditat, 1974). In Western cultures, sesame seed is used extensively as a garnish on specialty breads, buns and rolls. Nearly all the seed imported into the United States is consumed by the bakery, confecting and sesame butter industries (Johnson *et al*., 1979, Brasbett *et al*.,, 1975).

2.20.1 Characteristics of the seed:

The seed composition is well established (Weiss, 1971; El Tinay *et al*., 1976). Oil content ranges from 45 to 64% with an average of 50%, protein content ranges fro 19 to 31%, with an average of 25% (Betschart *et al*., 1975). The protein factor of 6.25 times total nitrogen content is generally applied to sesame protein, since it has been shown that ∝- globulin, which comprises 65 to 80% of sesame, is about 15.9% nitrogen (Prakash and Nandi, 1978).

The importance of utilizing oilseeds as complementary nutrient sources for human consumption has received considerable attention in recent years. There is a wide variety of oil crops ranging from largely known and highly utilized ones like soya bean, palm kernel, groundnut, extra, to underutilized ones like walnut, locust bean, African oil bean, sesame seed, etc. Sesame (*Sesamum indicum* L., synonymous with *S.orientale* L., also known as sesamum, gingelly, sim sim, benniseed, and til) is probably the most ancient oilseed known and used by humans as a food source. It has been cultivated for centuries, particularly in the developing countries of Asia and Africa. Nigeria produces about 90 thousand metric tons annually. It is, however, given little attention in Nigeria as its utilization is restricted to producing regions; for the most part, the surplus crop is commercialized, bulked and exported with minimal processing limited to cleaning and drying. Lack of knowledge of the nutritional qualities of lesser known oil seed grown in developing countries like Nigeria is responsible for the poor utilization of these crops in different food formulations. The chemical composition of sesame shows that the seed is an important source of oil (44-58%), protein (18–25%), carbohydrate (13.5%) and ash (5%) (htt://en wekipedia.org 2006).

Fermentation technologies play an important role in ensuring the food security of millions of people around the world, particularly the marginalised and vulnerable groups. This is achieved through improved food preservation, increasing the range of raw materials that can be used to produce edible food products and removing anti-nutritional factors to make food safe to eat. Previous research work on oilseeds points to fermentation more responsible for providing nutritionally better product than the raw seeds and the enzymes, especially α- amylase aid hydrolysis of the seed macromolecules. The anti-nutritional factor phytic acid, from raw sesame seed meal, could be reduced below detection limit by fermentation with lactic acid bacteria (*Lactobacillus acidophilus*) according to Mukhopadhyay. Traditional container such as banana (*Musa sapeinta*) leaf has been use since the earliest times for the fermentation of foods. However, they have poor barrier properties and are also unsuited to the needs of commercial production process. Modern technology has offered a wide range of materials that overcome the limitation from the use of leaves.

Food grade polyethylene (plastic) is typically polymers of high molecular mass. Due to their relatively low cost, ease of manufacture, versatility, and imperviousness to chemicals, polyethylene are used in an enormous and expanding range of products (htt://wekipedia.org). They have already displaced many traditional materials, such as paper; metal; glass; and ceramic, in most of their traditional uses.

Sesame (*Sesamum indicum* L.) belonging to the order tubiflorae, family Pedaliaceae, it is a herbaceous annual plant cultivated for its edible seed, oil and flavorsome value. It is also known as gingelly, til, benne seed and popularly as "Queen of Oilseeds" due to its high degree of resistance to oxidation and rancidity. Sesame seed contains 50-60% of high quality oil which is rich in polyunsaturated fatty acids (PUFA) and natural antioxidants, sesamin, sesamolin and tocopherol homologues. These bioactive components enhance the stability and keeping quality of sesame oil along with numerous health benefits. Sesame seeds are considered as valuable foods as they enhance the diet with the pleasing aroma and flavor and offer nutritional and physiological benefits. Recent studies on the antioxidant and anticarcinogenic activities of sesame seed have greatly increased its applications in health food products that assert for liver and heart protection and tumor prevention. Sesame seed is high in protein, vitamin B1, dietary fiber as well as an excellent source of phosphorous, iron, magnesium calcium, manganese, copper and zinc. 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 a cholesterol lowering effect in humans and prevent high blood pressure and increase vitamin E supplies in animals (htt://wekipedia.org. 2006).

2.20.2 Genetic wealth of sesame:

2.20.2.1 Varieties and gene diversity:

Sesame is believed to have been originated in India where maximum variability in genetic resources is available. Wide diversity is present in the sesame germplasm for the different desirable traits such as plant height, branching pattern, leaf shape, number of capsules per axil, number of seeds per capsule, 1000 seed weight, oil content, seed color, resistance to pest and diseases etc., Sesame samples from different agro-ecological zones of India were studied by (Bhat *et al*). using random amplified polymorphic deoxyribonucleic acid technique. Results showed a high level of genetic diversity, which indicated the nativity of the crop. Rajasthan and the north eastern states showed maximum genetic diversity. The exploitation of the available sesame diversity from these regions would enable improvement in productivity of existing sesame cultivars.

Large sesame collections are present at National Gene Bank at NBPGR, New Delhi with 9630 accessions stored for long term conservation at −20°C in the cold modules and 255 *Sesamum* species maintained at cryobank (NBPGR data, 2013, www.nbpgr.ernet.in). The sesame germplasm includes wild species, landraces and improved varieties and advanced breeding lines However, presence of a large number of uncharacterized accessions is a limitation in effective utilization of genetic diversity. The characterization, documentation and conservation of sesame germplasm for nutritional factors along with other traits of interest is essential for effective conservation and utilization of the sesame genetic resources (www.nbpgr.ernet.in, 2013).

2.20.2.2 Diversity in improved and wild species:

Sesame has a wide range of adaptation and a remarkably large number of varieties have been developed suiting to diverse agro climatic conditions. These varieties include some which are widely adapted and others are location and season specific. Spectrum of varietal diversity is represented by different agro ecological regions distributed as - East: Bihar-B-67, Krishna; West Bengal - B-67, Rama; West: Gujarat-Gujarat til l, Purva; North: Haryana - RT-46; Punjab-Punjab til l, TC-289, TC-25, RT-46; Northeast: Assam - Madhavi, Gauri; Andhra Pradesh - Gauri, Madhavi, Rajeshwari; Karnataka- E-8, CO-1; Kerala - Thilothama; Central - Madhya Pradesh - JT-7, TKG-22, T-12. Rich diversity is present in wild species in the African continent. In India, about five species occur and the Indian material largely includes *Sesamum malabaricum*, *Sesamum radiatum*, *Sesamum alatum*, *Sesamum laciniatum* and *Sesamum prostratum*. *Sesamum indicum* is the only cultivated species representing the sesame germplasm (Nath and Giri, 1957).

2.20.3 Protein distribution in sesame protein:

2.5% albumins, 76.4% globulins, 13.2% gluten protein, 2.7% prolamine protein and 2.6% non- nitrogenous protein (Nath and Giri, 1957).

Analysis of minerals in whole seed shows the following composition (per 100g dry matter): K, 0.5- P, 0.66- Ca, 1.2- Mg, 0.4 and S, 0.02 (Weiss, 1971).

Hull material accounts for 15- 16% of the whole seed weight and contains large quantities oxalic acid (2.3%), calcium (1.2%) and fiber (6.9%) (Krishnamurthy *et al.*, 1960; Shamanthaka Sastry *et al.*, 1989 ; Ramchandra *et al.*, 1970).

2.20.4 Processing sesame protein:

Whole sesame seed may be crushed to recover the oil as the primary valued product. However, dueling is critical if the meal is to be used as a food ingredient, since; 1) most oxalic acid in sesame is associated with the outer epidermal layer, and dehulling reduces oxalic acid content, 2) much of the fiber content is associated with hull and dehulling increases the protein content of the meal and 3) dehulling improve enzymatic digestibility of the protein.

The small size of sesame seed makes dehulling a difficult process, but numerous methods have been reported with varying degrees of success (Johnson *et al.*, 1979). Commercial process frequently involve caustic peeling, such as NaOH (pH- 8.0), removing the insoluble material by centrifugation and precipitation of the protein at pH 4.5 with HCl. The isoelectric curd is usually neutralized with NaOH and spray dried to produce an isolate (Smith and Circle, 1978). The process of extraction and isolation of protein under the above conditions is referred to as conventional isolation of protein. The material recovered in this manner usually contains more than 90% protein.

Sesame protein is substantially insoluble at low pH (approximately 10% soluble at pH 4.5), and some what soluble at high pH (Gurra and Park, 1975).

The extent to which salt improved protein solubility in alkali seems unique among oil seed proteins, and may be useful in commercial processing of sesame protein. Solubility profiles of various oil seed proteins indicate that sesame protein as less soluble at high pH than other common oil seed proteins under conditions normally used in commercial protein isolation (Lawhon *et al.*, 1972). Since the first step in protein isolation is extraction in alkali, the yield of protein isolate using conventional techniques is low (about 38% of the original protein content) when using NaCl for extractions of soy protein, precipitation of protein from the extract is lower than in conventional protein isolation (absence of salt), because NaCl also enhances protein solubility at the isoelectric pH (Anderson *et al.*, 1973). According to Rham and Jost (1979) this necessitates use of ultra fitration to recover protein in high yield and remove salt from the protein extract.

Ultra filtration is a separation technique which is based on the ability of polymeric membranes to separate various species on the basis of molecular size and shape. Ultra filtration is now available commercial process for producing purified protein concentrates from milk or cheese whey with excellent functional properties (Hill and Amundson, 1973).

It is application to oil seed protein processing is also well- documented (Lawhon *et al.*, 1977; Hensley *et al.*, 1977). Salts and other low molecular weight compounds pass through the membrane and high molecular weight compounds, predominantly proteins, are concentrated in the retentate.

Aqueous processing for simultaneous recovery of sesame protein and oil fro dehulled seed using hot calcium hydroxide has been patented (Liggett, 1969). Sesame protein was reported to be substantially soluble in an alkaline solution of $Ca\ (OH)_2$, and a high grade protein was obtained by acid precipitation. The protein was recovered by centrifugation and the oil was separated from the aqueous phase by decanting.

A similar aqueous process has been developed at the Food Protein Research and Development Center, Texas ARM University (Rhee *et al.*, 1972) and applied to sesame (Chen, 1976).

A sesame protein fraction, containing 78.2% protein, was isolated from dehulled sesame seed. Extraction was achieved by dispersing one part of the ground dehulled sesame seed in three parts of water at pH 10.5 for 30 min at 80℃. Oil soluble protein and insoluble fiberous residue were simultaneously separated.

The protein was precipitated from the alkaline extract by adjusting to pH 4.5. Approximately 56% of the seed protein was recovered as isolated protein.

2.20.5 Nutritional quality of sesame protein:

The defatted sesame meal from dehulled seed contains greater than 60% protein which is bland and white in color (Johnson *et al.*, 1979).

Table (1): Proximate composition of sesame

Content	**Percentage (%)**
Moisture	12.83
Fat	102.2
Protein	47.5
Ash	14.47
Fiber	13.77
Carbohydrate	18.1

Source: FAO(2003)

2.21 Pearl millet:

Pearl millet (*Pennisetum glaucum*), also known as Bajra, is one of the four most important cereals (rice, maize, sorghum and millets) grown in tropical semi-arid regions of the world primarily in Africa and Asia (www.wekipedia.org/wiki/millet, 2006).

Pearl Millet (*Pennisetum glaucum*), also known as Bajra, is a cereal crop grown in tropical semi-arid regions of the world primarily in Africa and Asia. Bajra is well adapted to production systems characterized by low rainfall (200-600 mm), low soil fertility, and high temperature, and thus can be grown in areas where other cereal crops, such as wheat or maize, would not survive. In its traditional growing areas, pearl millet is the basic staple for households in the poorest countries and among the poorest people (Figure 2). It is also one of the most drought resistant crops among cereals and millets. Pearl millet is generally used as a temporary summer pasture crop or in some areas as a food crop (www.wekipedia.org/wiki/millet, 2006).

Pearl millet is one of the four most important cereals (rice, maize, sorghum and millets) grown in the tropics and is rich in iron and zinc, contains high amount of antioxidants and these nutrients along with the antioxidants may be beneficial for the overall health and wellbeing.

Pearl millet serves as a major staple food for many populations around the globe, however, it is still considered poor man's food and does not find place in the food purchase lists of the elite. Millets, which are currently consumed in the rural and tribal areas of the world, need to be popularized. Unique health foods as well as traditional foods made from pearl millet need to be promoted.

Our aim of the study is to review the potential health benefits of pearl millet. This work is a part of a larger ongoing project on "Background Nutritional Studies on Pearl Millet - Gujarat, funded by CIAT/IFPRI/Harvest Plus, USA".

Pearl millet is a rich source of energy (361 Kcal/100g) which is comparable with commonly consumed cereals such as wheat (346 Kcal/100g), rice (345Kcal/100g) maize (125Kcal/100g) and sorghum (349Kcal/100g). The carbohydrate content of pearl millet is 67.5g/100g, which is lower than wheat, rice and sorghum, but higher than maize (NIN, 2003).

The germ of pearl millet has much larger percentage of the total kernel than the germ of sorghum (17.4% in millet and 9.8% in sorghum). This difference explains that pearl millet has lower starch and higher protein and oil content as compared to sorghum. Starch represents about 56 to 65% of the kernel and is about 20 to 22% amylose; free sugars range from 2.6 to 2.8% of the grain. The main sugar in pearl, foxtail, finger, and proso millets is sucrose. Pearl millet has high fiber content (1.2g/100g, NIN, 2003). Most of the dietary fiber is insoluble interestingly; α-amylase activity is 8 to 15 times greater in pearl millet than in wheat (Sheorain and Wagle, 1973). Pearl millet has a lowest glycemic index (55) as compared to sorghum, finger millet and mungbean (Mani *et al.*, 1993).

FAO (1977) have reported that the fat digestibility was much higher in pearl millet than corn. FAO (1977) have reported that pearl millet has large germs which give rise to rapid development of fatty acid in whole pearl millet meal, mainly due to action of lipase which causes bitterness and makes meal unacceptable within 5-8 days after milling.

2.21.1 Nutritive value of pearl millet:

The nutritional proprieties of pearl millet have received more attention than those of the .other common millets, because it is the largest-seeded, most widely grown type FAO, (1977).

Pearl millet is the staple food of millions of people in drier parts of tropical Africa. Air-dried grains contain approximately 12.4% water, 11.6% protein, 5% fat, 67.1% carbohydrate, 1.2% fiber and 2.7% ash .

Pearl millet is low in lysine, tryptophan, threonine and sulfer-containing amino acids. In an evaluation of several cereals, methionine content was found to be highest in proso, followed by sorghum, pearl millet, and maize. The level of lysine content of pearl millet grain on a dry matter basis was 0.35%, 21% greater than corn and 36% greater than low-tannin sorghum FAO (2002).

Generally, the amino acid profile of pearl millet compares favorably with that of wheat, barley and rice (Hulse *et al.*, 1980). Seed protein of pearl millet showed the essential amino acid leucine is the highest, but threonine, lysine and the sulfur were lower. The results indicate that this grain has a good nutritive value. (Basahy, 1996). Biological value of millet protein alone was 63.8 and was 84.2 when supplemented with lysine and threonine FAO (2002).Sorghum and millet cultivars were evaluated for nutritive values as affected by maturity. Results indicated that the dry matter content increased with advancing maturity, and this increase correlated positively with lignin and other cell-wall constituents, but negatively with crude protein, degradability of dry matter and inorganic nutrients. There was no significant difference in the nutritive values of sorghum and millet cultivars FAO (2002).

In comparison between sorghum and pearl millet, the phosphorus content was high in both grains, while calcium was low; also they were low in sulphur amino acids and lysine. Sorghum and millet were similar in their proximate constituents FAO (2002).

Milling of· pearl millet grains affects its gross composition, while milling and heat treatment during chapatti (an unleavened bread) making significantly affect the nutrient content of raw pearl millet flour FAO (2002).

Pearl millet is a· good source of mineral such as calcium, iron, zinc, copper and manganese (Hulse *et al.*, 1980). They are high in starch component (61.5 - 89.14) and thus serve as ari energy food.

2.21.1.1 Proximate Composition:

Proximate analysis of plant material consists of determining the major classes of chemical components, which include moisture, crude protein, crude fiber, ash and ether extract. Proximate analysis provides a good initial impression of the relative nutritive value and utility of an agricultural commodity. Differences in chemical composition have been attributed to soil, climate, strains and fertilizer treatment FAO (2002).

In general, dietary fiber is divided into soluble and insoluble water categories. Insoluble components present primarily in the pericarp, where they have protective functions. Most of dietary fiber of sorghum and millet is insoluble, therefore, their fiber transit and prevent gastrointestinal problems FAO (2002).. The fiber content of Sudanese local varieties ranged from 3.18% to 3.67% (Khatir, 1990). Eltinay *et al.* (2005) reported 2.4 and 8.6 fibers for two pearl millet cultivars. Aldogasabi (2009) gave values 2.7% 3.04% and 3.01 % for three Sudanese pearl millet cultivars. Idris (2001) found 1.10% for whole pearl millet, while for decorticated at (29.90% and 36.26% decortication rate) were0.75 and 0.55% respectively. Viswanath *et al,* (2009) gave 22.5, 9.9, 6.0 and 4.20/0 for (whole, 3%, 5% and 7% flour fraction), respectively.

Oil Contents:

In contrast to other cereals, pearl millet has the highest oil content due to the large proportion of the germ to the endosperm. Most lipids were concentrated in the germ, pericarp and the aleurone layers (Osagie and Kates, 1984). Abdelrahman (2004) reported that the range of ten genotypes as from 4% to 7.7%, while, Elyas (1999) reported 6.2% and 8.5% oil content for two pearl millet cultivars, Lestienne (2007) found the lipid content of two raw millet cultivars Gampela and IKM-5 (5.58% and 5.77 g/100g DM respectively) while for (12% decortications rate) were (5.08 and 5.19 g/100g). Idris (2001) showed 4.50% for whole pearl millet, while for decorticated (70.'ltd 63.7% extraction rate) were 4 and 3:25% respectively.

Crude Protein:

Among millets, pearl millet contains a higher protein content and better amino acid balance than sorghum. Protein content of 15.4%, 14.8% and 16.3% was reported for gray, yellow and brown pearl millet, respectively.

Local Sudanese cultivars investigated by Elyas *et al.* (1999) gave values of 10.8% and 14.9% for crude protein. Khatir (1990), found the protein content of local Sudanese varieties ranging between "14.2% to

15.5%" which is higher than sorghum, maize and rice. Lestienne *et al.* (2007) found protein content for whole two pearl millets were 8.73 and 10.11 % while for decorticated (12% decortications rate) were 7.60 and 8.80%. Idris (2001) found that the protein content of decorticated pearl millet (70.1 and 63.7% extraction rate) 'were 13.5 and 13% respectively. Protein content of decorticated finger millet 6.3% as investigated by (Hulse *et al.,* 1980).

Carbohydrate content:

In general carbohydrates component is about 75% of the content of cereals. The cereal major groups of carbohydrates are sugar, starches, cellulose and related materials (Hulse *et al.,* 1980). stated that the carbohydrate content of pearl millet was ranged from 58.5 to 70.67% for ten pearl millet cultivars. A range of carbohydrate from 70.67 to 71.40 % was reported by Eltinay *et al.* (2005) for tow pearl millet cultivars Hulse *et al.,* 1980)investigated tow pearl millet cultivars and reported 73.67% and 68.55% carbohydrate content. A range of carbohydrate from 67.24% to 71.14% was reported by Hulse *et al.,* (1980) for three pearl millet cultivars.

Enzymes Content:

Pearl millet like other cereal grains contains lipase, plus many other enzymes as indicated by Hoseney (1994) Pearl millet contains phenol oxidase and peroxidases which are involved in browning reaction.

2.21.1.2 Micronutrients:

Vitamins and minerals: Pearl millet contains various essential micro nutrients needed by the body. Overall mineral content of pearl millet is 2.3 mg/100g which is high as compared to commonly consumed cereals. It is rich in B-vitamins, potassium, phosphorous, magnesium, iron, zinc, copper and manganese (Sullivan *et al.*, 1990). Dried, matured kernels do not contain vitamin C and the B vitamins are concentrated in the aleurone layer and germ. Removing the hull by decortication reduces the levels of thiamine, riboflavin and niacin by about 50% in the flour. Niacin in cereals is found in free and bound forms and can be synthesized from tryptophan. The niacin content of the hulled millet seed is still significant. This is why the PP vitamin insufficiency disease, pellagra, is not found in areas where millet is consumed in great quantities. Pearl millet, along with other grains, contains oxalic acid, which forms an insoluble complex with calcium, thereby reducing biological availability of this mineral. Calcium concentration in pearl millet is quite low, and the presence of oxalate can exacerbate the deficiency (Sullivan *et al.*, 1990).

2.21.1.3 Millets have the following anti-nutrient components:

Polyphenols and tannin, phytic acid and phytate, goitrogens, and oxalic acid. Polyphenols and tannin compounds are concentrated in the bran. There is a strong relationship between the tannin levels and in-vitro protein digestibility. Decortication significantly decreases the amount of tannins with a corresponding increase in protein digestibility (Irén Léder, 2004). Millet changes color reversibly from grey to yellow-green at alkaline pH, and partially reversibly from grey to creamy white under acidic conditions due to the presence of phenolic compounds (glucosylvitexin, glucosylorientin, vitexin) (Abdelrahmen, 2004).

The presence of omega-3 fatty acids in pearl millet as compared to any other cereal grain highlights its potential in prevention and treatment of cardiovascular diseases, diabetes, arthritis and certain types of cancer.

Table (2): Proximate composition of pearl millet

Content	**Percentage (%)**
Moisture	14.7
Fat	11.8
Protein	27.77
Ash	5.37
CHO	67.5

Source: FAO(2003)

2.22 Milk:

Milk is a white liquid produced by the mammary glands of mammals. It is the primary source of nutrition for young mammals before they are able to digest other types of food. Early-lactation milk contains colostrum, which carries the mother's antibodies to its young and can reduce the risk of many diseases. Milk contains many other nutrients and the carbohydrate lactose. The majority of the world's population is lactose intolerant. As an agricultural product, milk is extracted from mammals during or soon after pregnancy and is used as food for humans. Worldwide, dairy farms produced about 730 million tons of milk in 2011, from 260 million dairy cows. India was the world's largest producer and consumer of milk, yet neither export nor imports it. New Zealand, the European Union's 28 member states, Australia, and the United States are the world's largest exporters of milk and milk products. China and Russia are the world's largest importers of milk and milk products (www. Wikipedia.org/milk/)

Throughout the world, there are more than six billion consumers of milk and milk products. Over 750 million people live within dairy farming households.

2.22.1 Types of consumption:

There are two distinct types of milk consumption: a natural source of nutrition for all infant mammals and a food product for humans of all ages that is derived from other animal ((www. Wikipedia.org/milk/)

2.22.2 Nutrition for infant mammals:

Main article: Breastfeeding

In almost all mammals, milk is fed to infants through breastfeeding, either directly or by expressing the milk to be stored and consumed later. The early milk from mammals is called colostrum. Colostrum contains antibodies that provide protection to the newborn baby as well as nutrients and growth factors. The makeup of the colostrum and the period of secretion vary from species to species. For humans, the World Health Organization recommends exclusive breastfeeding for six months and breastfeeding in addition to other food for at least two years. In some cultures it is common to breastfeed children for three to five years, and the period may be longer. Fresh goats' milk is sometimes substituted for breast milk. This introduces the risk of the child developing electrolyte imbalances, metabolic acidosis, metaloblistic anemia, and a host of allergic reactions (www. Wikipedia.org/milk/).

Table (3): Physcio- chemical properties of milk

Content	**Percentage**
Moisture	87.9% 87.3% 87.6%
Fat	3.7% 3.9% 3.8%
Protein	4.2% 4.0% 4.1%
Ash	0.8% 0.7% 0.8%
Carbohydrate (as lactose)	4.2%
E. C	5.1 Ms/g
pH	6.5
TSS	11.7%
TS	12.4%
SNF	8.6%
Titratable Acidity	0.18

Source: FAO(2003)

CHAPTER THREE

MATERIALS AND METHODS

3.1 Materials:

Food materials:

Grain sample of Pearl millet (*Pennisetum glaucum* L.) and Sesame (*Sesamum Indicum* L.) seeds were brought from El- Fashir district local market. The seeds were cleaned, freed from foreign seeds, broken and shrunken ones, and then milled into flour.

Fresh cow milk was collected from especial farm in El- Fashir district. Sugar and salt were brought from local market in El Fashir district then heated and pasteurized.

Preparation of meals:

The first meal was prepared by mixing of millet flour with cow milk at ratio of 70 g of millet flour and 250 ml of cow milk, 5g of sugar and salt were added and then cooked.

The second meal was prepared by mixing sesame seed flour with cow milk at the ratio of 70 g of sesame seed flour and 250 ml of cow milk, 5g of sugar and salt were added and then cooked.

The prepared meals were given to nourished children of Zamzam Campus at El Fashir district three times a day for two months.

3.1.1 Study area:

El Fashir (Zamzam campus) has many health problems within adequate health facilities. It is not surprised that malnutrition, especially protein energy malnutrition (PEM) is very prevalent.

3.1.2 Study population:

The subjects of the study were 24 children with PEM less than 5 years, who were admitted at Zamzam campus .

3.1.3 Data collection:

1. Questionnaires to be answered by mothers of admitted children.
2. Campus records.
3. Interviews with health workers and nutritionist in the Campus.

3.2 Methods:

3.2.1 Chemical methods:

3.2.1.1 Moisture content:

The moisture content was determined according to the standard method of Association of Official Analytical Chemists (AOAC, 1990).

Principle: The moisture content in a weighed sample is removed by heating the sample in an oven (under atmospheric pressure) at 105℃. Then, the difference in weight before and after drying is calculated as a percentage from the initial weight.

Procedure: A sample of 5g ±1mg was weighed into a pre- dried dish. Then, the sample was placed into an oven (No. 03822, FN 400,Turkey) at 105℃ ± 1℃ until a constant weight was obtained. After drying, the covered sample was transferred to a dessicator and cooled to room temperature before reweighing. Triplicate results were obtained for each sample and the mean value was reported to three decimal points according to the following formula:

Calculation:

$$\text{Moisture content (\%)} = \frac{M2-M3}{m2-m1} \times 100$$

Where:

m_1 = Mass of dish + cover

m_2 = Mass of dish + cover + sample before drying

m_3 = Mass of dish + cover + sample after drying

The drying matter (DM) or total solids (T. S) as percent were calculated by subtracting the percentage of moisture content from100%.

3.2.1.2 Crude protein content:

The protein content was determined in all samples by macro- Kjeldahl method using a copper sulphate- sodium catalyst according to the official method of the AOAC (1990).

Principle: The method consists of sample oxidation and conversion of nitrogen to ammonia, which reacts with the excess amount of sulphuric acid forming ammonium sulphate. After that, the solution is made alkaline and the ammonia is distilled into a standard solution of boric acid (2%) to form the ammonia- boric acid complex, which is titrated against a standard solution of HCl (0.1N). Accordingly, the protein content is calculated by multiplying the total N% by 6.25 as a conversion factor for protein.

Procedure: 2g ±0.5mg sample was accurately weighed and transferred together with 2g of Kjeldahl catalysts (No. 33064, BDH, England) and 25mlof concentrated sulphuric acid (No. 66700, BH 15, England) into a Kjeldahl digestion flask (Black color). After that, the flask was placed into a

Kjeldahl digestion unit (No. 01186069, Tape KII6, Gerhart Bonn) for about two hurs until a colorless digest was obtained (Blue greenish). The flask was left to cool to room temperature.

The distillation of ammonia was carried out in 25mlboric acid (2%) by using 100ml distilled water and 70ml sodium hydroxide solution (45%). Finally, the distillate was titrated with standard solution of 0.1N HCl in the presence of 2-3 drops of mixed indicators (Bromocreasol green and methyl red) until a pink color was observed.

Calculation:

Protein content (% DM) =

$$\frac{(ml\ HCl\ sample - ml\ HCl\ blank) \times 0.1 \times 1.4 \times 6.25 \times 100}{(Sample\ weight\ (g) \times (1000))}$$

Protein conversion factor = 6.25

3.2.1.3 Fat content:

Fat content was determined according to the official method of the AOAC (1990).

Principle: The method determines the substances, which are soluble in petroleum ether (B. P, 60- 70℃) and extractable under the specific conditions of Soxhlet extraction method. Then, the dried ether extract (fact content) is weighed and reported as a percentage of the initial dry matter.

Procedure: A sample of 5g ±1mg was weighed into an extraction thimble and covered with cotton that previously extracted with petroleum ether (No. 28111Doo, England). Then the sample and a pre- dried and weighed extraction flask containing about 100ml petroleum ether (No. 28111Doo, England) were attached to the extraction unit (Electro thermal, England). Then, the extraction was conducted for 6 hr. At the end of the distillation period, the flask was discounted from the unit and the solvent was redistilled. Later, the flask with the remaining crude ether extract was put in an oven at 105℃ for 3 hrs, cooled to room temperature in a dessicator, reweighed and the dried extract was registered as fat content (% DM) according to the following formula;

Calculation:

Fat content (%DM) =

$$\frac{Dry\ extract\ weight\ (g) \times 100}{Sample\ weight\ (g) \times (100\% - sample\ moisture\ (\%))}$$

3.2.1.4 Crude fiber content:

Crude fiber content was determined according to the official method of the AOAC (1990). Two g of fat free samples were treated successively with boiling solution of H_2SO_4 and KOH (0.26 N and 6.23 N, respectively). The residue is separated by filtration, washed, dried, weighed and ashed at 500℃. The lost in weight resulted from ashing corresponds to crude fibre in the sample.

Principle: The crude fiber is determined gravimetrically after the sample is chemically digested in chemical solution. The weight of the residue after ignition is then corrected for ash content and is considered as a crude fiber.

Procedure: About 2g $\pm$1mg of a defatted sample was placed in a conical flask containing 200 ml of H_2So_4 (0.255N). The flask was then fitted to a condenser and allowed to boil for 30 minutes. At the end of the digestion period, the flask was removed and the digest was filtered (under vacuum) through a proclaim filter crucible (No. 3). Further, the precipitate was repeatedly rinsed with distilled boiled water followed by boiling in 200ml NaOH (0.313N) solution for30 min under reflux condenser. After that, the precipitate was filtered and rinsed with hot distilled water, 20ml ethyle alcohol (96%) and 20 diethyl ether.

Finally, the crucible was dried at 105℃ to a constant weight, cooled (in a dessiccator), weighed and ashed in a muffle furnace (No. 20. 301870, Carbolite, England) at 550- 600℃ until a constant weight was obtained. After cooling to room temperature, the difference in weight was considered as crude fiber.

Calculation:

Crude fiber (%DM) =

$$\frac{\left(Dry\ residue + crucible\ (g)\right) - \left(ignited\ residue + crucible\ (g)\right) \times 100}{Sample\ weight\ (g)}$$

3.2.1.5 Ash content:

Total ash was determined according to the AOAC (1990) method. 2 g of sample was weighed accurately in to previously ignited and weighed crucible and then transferred to the muffle furnace at about 550℃ for overnight, cooled in a desiccators and re weighed.

Calculation:

Total ash was calculated as percent of original example given, that

Ash content (%) = $\frac{Residue\ weight\ (g) \times 100}{Sample\ weight\ (g)}$

$$= \frac{W3 - W2}{W2 - W1} \times 100$$

Where:

W1 = Weight of the empty crucible

W2 = Weight of crucible + weight of sample before drying and/or ashing.

W3 = Weight of crucible + ash

3.2.1.6 Carbohydrate content:

The carbohydrates was determined by difference between the sum of moisture content, protein content, fat content and ash content subtracted from 100 for each treatment to obtain the value (Pearson, 1976).

3.2.1.7 Amino acids profile:

The amino acids composition of all samples was determined according to the official methods by using Sykam HPLC system (Model S7130). The system is equipped with a programmable auto injector.

The samples were prepared by placing 200 mg of each sample in hydrolysis tubes. Five milliliters of 6N- hydrochloric acid were added to each and tightly closed. The tubes were incubated at 100℃ for 24 hours. The hydrolysis of each sample was then, filtered using 125 mm filter paper. A 200 µ of the filtrates were evaporated at 140℃ for about an hour. A diluted buffer was added to the dried samples and then the samples were ready for analysis.

The HPLC system was calibrated with a standard amino acid kit solution and then the sample hydrolysate was injected into HPLC analyzer system with an auto injector (AOAC, 1990).

3.3 Statistical analysis:

The samples were analyzed using Statistical Package for Social Science (SPSS) Programme. The analysis of variance (ANOVA) and least significant difference (LSD at $P \leq 0.0\ 5\ \%$) were used to separate the means according to Mead and Gurnow (1983).

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 Socioeconomic characteristics of malnourished children at Al-Fasher refugees' camp:

Table (4) shows socioeconomic characteristics of malnourished children at Al-Fasher refugees' camp. According to age 4.2% of children were less than one year, 29.2% were less than two years, 33.3 were less than three years, 20.8% were less than 4 years and 12.5% were more than five years old.

According to family size 70.8% represent 3-6 persons, 29.2% represents more than seven persons.

About 70.8% of mothers were illiterate, 4.2% were khalwa, 12.5% were basic education, 8.3% were secondary education and 4.2 were post graduated.

Almost 95.8% of children's parents were alive, non of them have died father and 4.2% of them with dead mother.

Children cared by father only were 4.2, 12.5% were cared by mother only, 79.2% were cared by both father and mother and 4.2% were cared by others

About 4.2% of children have had one meal per day they suffer from poverty, 70.8% had two meal per day they suffer from severe financial conditions and 25.0% had three meals per day they were in good condition or optimal care.

Drinking water was available for 33.3% of them and 66.7% their drinking water was not available.

Almost 25.0% have a satisfying income to cover the family requirements and 75.0% have not a satisfying income to cover the family requirements.

Other sources of food supports were 75.0% relives, 12.5% relatives, 8.3% charity organ and others 4.2%.

Table (4): Socioeconomic characteristics of malnourished children at Al-Fasher refugees' campus

Parameter	Frequency	%	P-value
Age of children (years):			
<1	1	4.2	0.0125*
2	7	29.2	
3	8	33.3	
4	5	20.8	
≥5	3	12.5	
Total	**24**	**100%**	
Family size (persons):			
<2	-	-	0.0036**
3-6	17	70.8	
≥7	7	29.2	
Total	**24**	**100%**	
Educational level of mothers:			
Illiterate	17	70.8	0.0194*
Khalwa	1	4.2	
Basic education	3	12.5	
Secondary	2	8.3	
University	1	4.2	
Total	**24**	**100%**	
Parent status:			
Alive	23	95.8	0.0015**
Died father	-	-	
Died mother	1	4.2	
Total	**24**	**100%**	
Children cared by:			
Father only	1	4.2	0.0137*
Mother only	3	12.5	
Father and mother	19	79.2	
Others	1	4.2	
Total	**24**	**100%**	
Number of meals per day:			
One meal (poverty)	1	4.2	0.0048**
Two meals (severe financial conditions)	17	70.8	
Three meals (good condition or optimal care)	6	25.0	
Total	**24**	**100%**	
Availability of drinking juice per day:			
Available	8	33.3	0.0039**
Not available	16	66.7	
Total	**24**	**100%**	
Satisfaction of monthly income in covering family requirements:			
Yes	6	25.0	0.0057**
No	18	75.0	
Total	**24**	**100%**	
Other sources of food supporting:			
Relives	18	75.0	0.0367*
Relatives	3	12.5	
Charity organ	2	8.3	
Other	1	4.2	
Total	**24**	**100%**	

* significant P>0.01 - P<0.05 ** highly significant P<0.01

As shown in figure (1), the majority of children (35%) in the age grow up (3) years, (30%) in the age grow up (2) years, (20%) represented (4) years, (10%) represented ≥ 5 years and 5% reflected ≤ (1) years.

Latham (1979) reported that all the children fell on the age (0-5) years were exposed to different types of illness and infections as well as the risk of malnutrition.

As shown in figure (2), the majority (80%) of the number of persons was (3-6), this represented the high level of family size, ≥ 7 pearsons, (40%) and > 2 pearsons (20%). The No of family indicates the amount of the food distributed inside the family.

Latham (1979) showed that large family size, short intervals between children and abrupt termination of breast feeding are all associated with ill health and increased mortality rates in the mother and child.

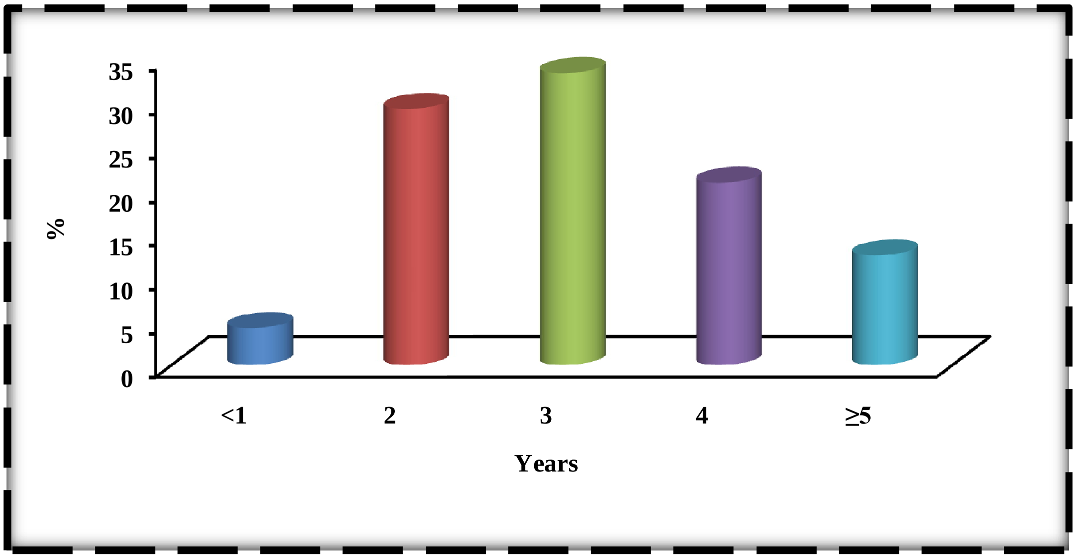

Figure (1): Age of children

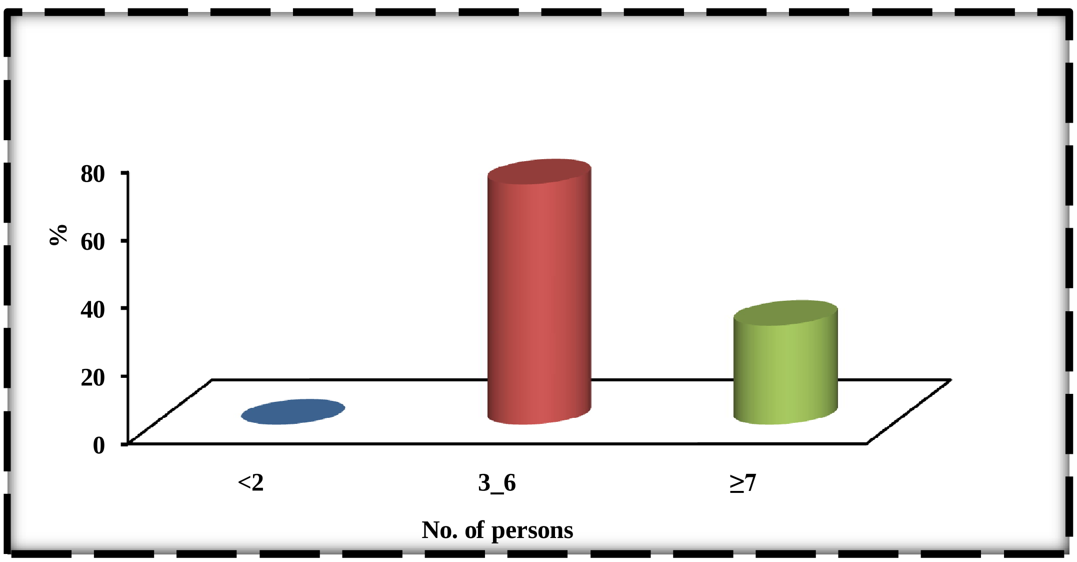

Figure (2): Family size

As shown in the figure (3) the majority of the mother (80%) were illiterate followed by (10%) of mothers with Khalwa level, (20%) of basic education, (15%) of secondary level and only, (5%) of mothers have university level of education. These results indicate prevalence of low levels of education.

Gillespic (1997) reported that low education is closely associated with poor nutrition and nutritional disorders under five years of age children. Thus one may expect high prevalence of malnutrition. Mothers should be educated and informed of the location and activities of health services in the area where they live.

Result in figure (4) show that mothers alive, (71%), died mothers 5% died father (24%) this.

WHO (2003) reports showed that most people became refugees as a result of conflicts, diseases and death.

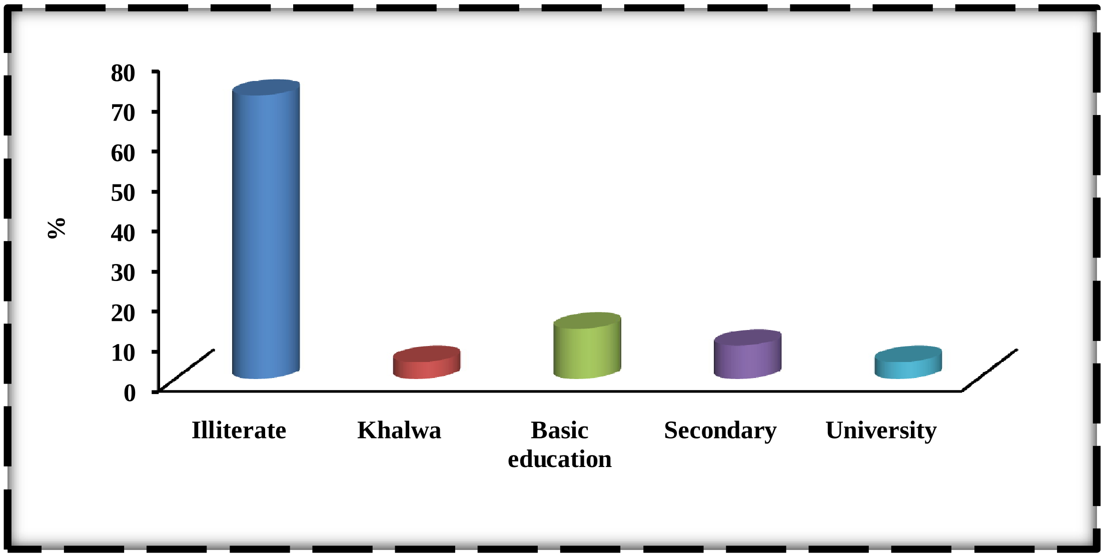

Figure (3): Educational level of the children mothers

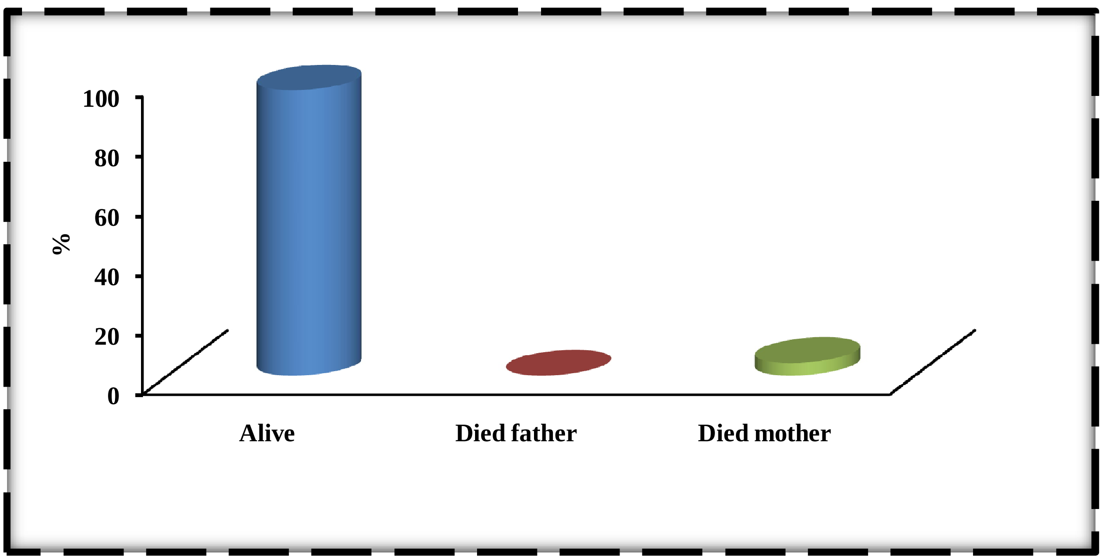

Figure (4): Family status

As shown in figure (5), the majority of children care was by father and mother (80%), by mother (20%) and only (5%) of both father and others.

Altshul (1974) reported that (93%) of mothers were responsible of children care, compared to (77%) of fathers who were working outside the house.

Result in figure (6) shows the number of meals /day, (10%) represented one meal, (80%) two meals and (40%) for three meals. When the number of the meals more than two meals that mean there is no sign of malnutrition.

Latham (1979) revealed that within the family the nutritionally vulnerable members have lowest priority a little choice of what food is available.

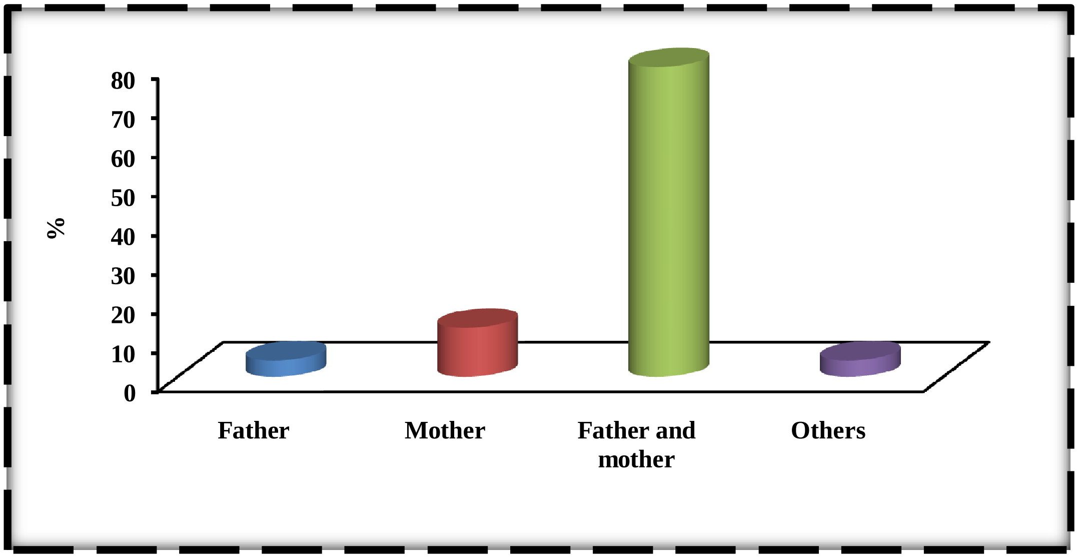

Figure (5):Care of children

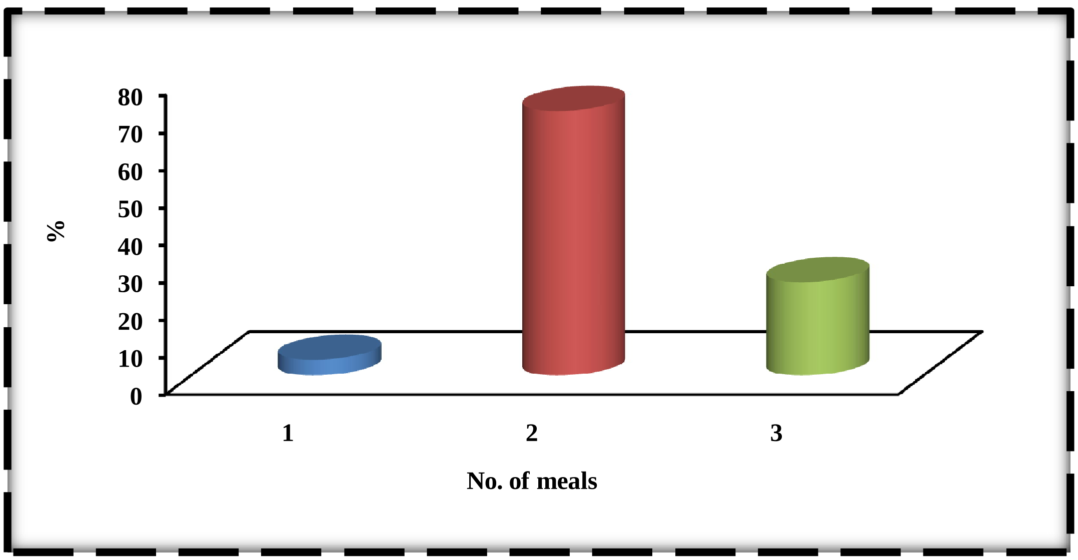

Figure (6): Number of meals/ day

As shown in figure (7) the majority of the availability of drinking juice, (66.7%) in the age group of children between 1-5 years and remainder (33.30%) were available of drinking juice.

Latham, (1979) showed that there was a very wide spread of understanding of function of food and drink.

The below figure (8) shows that the majority of the respondents (75%) have low income level per month, and remainder (25%) have quarter income cover the daily needs for the family members, particularly children. Good feeding is the one way to prevent P E M.

Radof and Leven (2006) reported that malnutrition was closely linked to condition of a family low income.

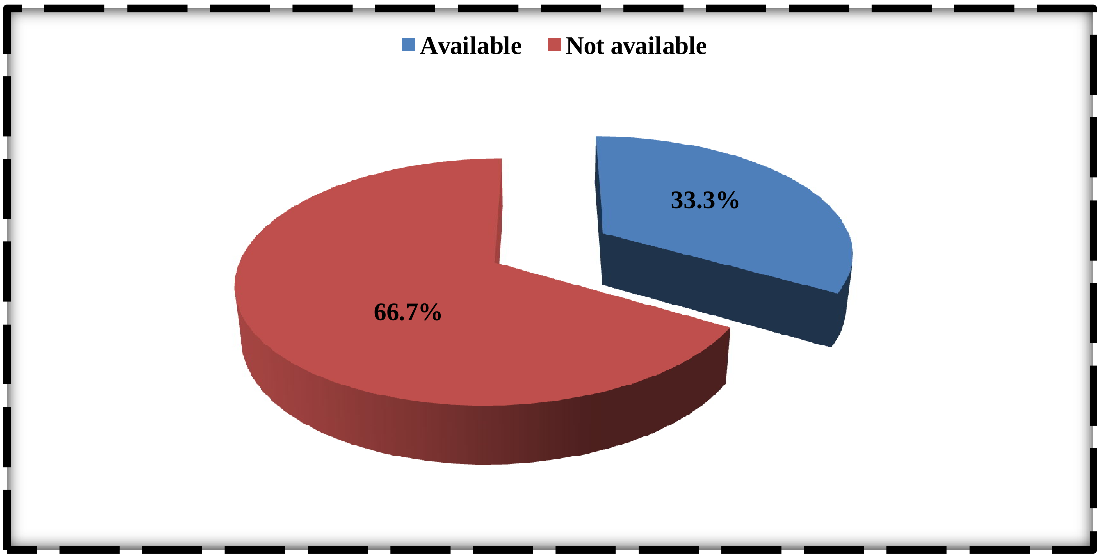

Figure (7): Availability of drinking juice

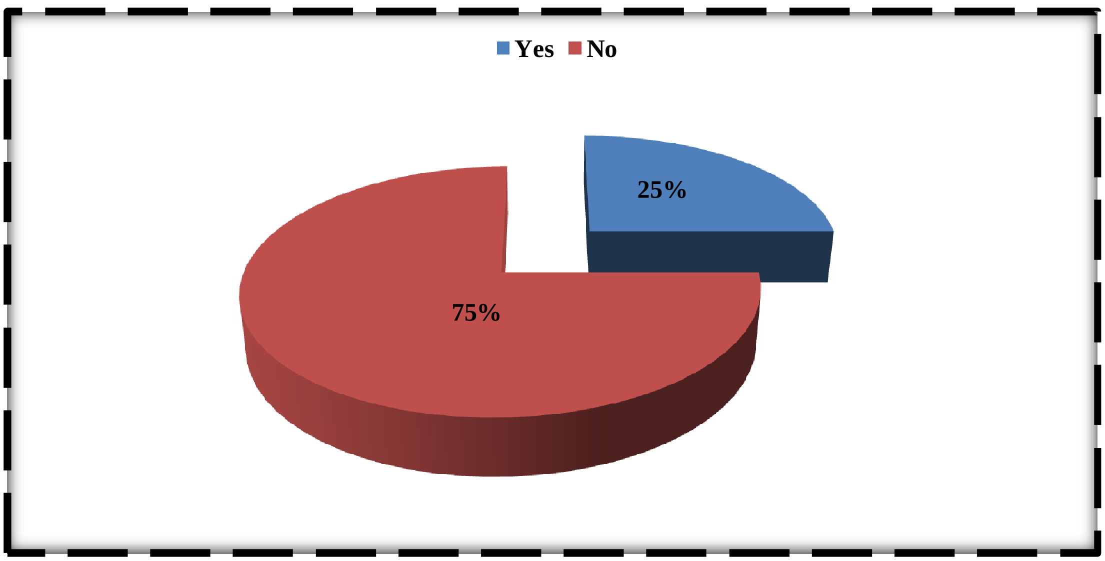

Figure (8): Satisfaction of monthly income in covering family requirements

Figure (9) shows that, 80% of the sources of food supporting is by relives, 15.5% sources of food supporting by relatives, 10% were supporting by charity or, organization and 5% by others.

FAO (2002) reported that millions of people in developing countries still need an emergency food assistance as a result of natural disasters.

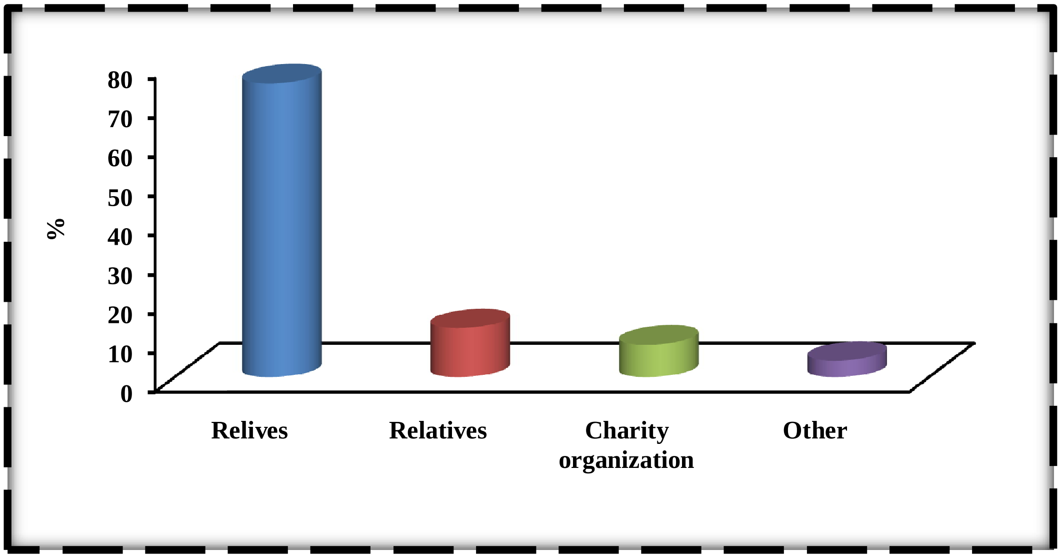

Figure (9): Sources of food supporting

The difference between the 3 meals (given meals, relives, processed foods) according to taste, easy to drink and preparing when compared with relive meals is difficult to be adapted according to the taste and flavor. When compared with processed food it may be inadequate and unsuitable for children because it contains food additives.

Table (5) shows that almost all children accepted the given meals. 20.8% showed increase in weight, 20.8% increase in activity, 50.0% showed increase in weight and activity and 8.4% showed other features such as bright eyes, shining of hair and soft of skin when there were positive changes of meals. 83.3% of the children preferred the given meals, 16.7%preferred the relives meals and non preferred the processed foods. 83.3% of children showed excellent task in sensory evaluation and 16.7 showed very good.

Table (5): Evaluation of the meals given to children at El- Fashir refugees campus

Parameter	Frequency	%	P-value
Acceptability to given meals:			
Acceptable	24	100	0.0*
Not acceptable	-	-	
Total	**24**	**100%**	
Positive changes of meals:			
Increase in weight	5	20.8	0.0128*
Increase activity	5	20.8	
Increase weight and activity	12	50.0	
Others (bright eyes, shining of hair and soft skin)	2	8.4	
Total	**24**	**100%**	
Preference of meals:			
The given meals	20	83.3	0.0049**
Relives	4	16.7	
Processed foods	-	-	
Total	**24**	**100%**	
Sensory evaluation of given meals:			
Excellent	20	83.3	0.0049**
Very good	4	16.7	
Good	-	-	
Accepted	-	-	
Not accepted	-	-	
Total	**24**	**100%**	

* significant P>0.01 - P<0.05 ** highly significant P<0.01

Figure (10) shows that 100% represented the acceptability to given meals. Which are suitable to treatment of P E M for children. These meals have high energy and different types of the food contents.

Figure (11) shows positive changes of meals during feeding period, 150% increase both weight and activity) using local food (millet cow milk and sesame cow milk). This practice is beneficial for treating P E M. About 25% increase in weight of the child was a dived according to the 20% increase in the activities of the children. This indicated that the physiological status will become more active, (10%) is others positive changes of meals.

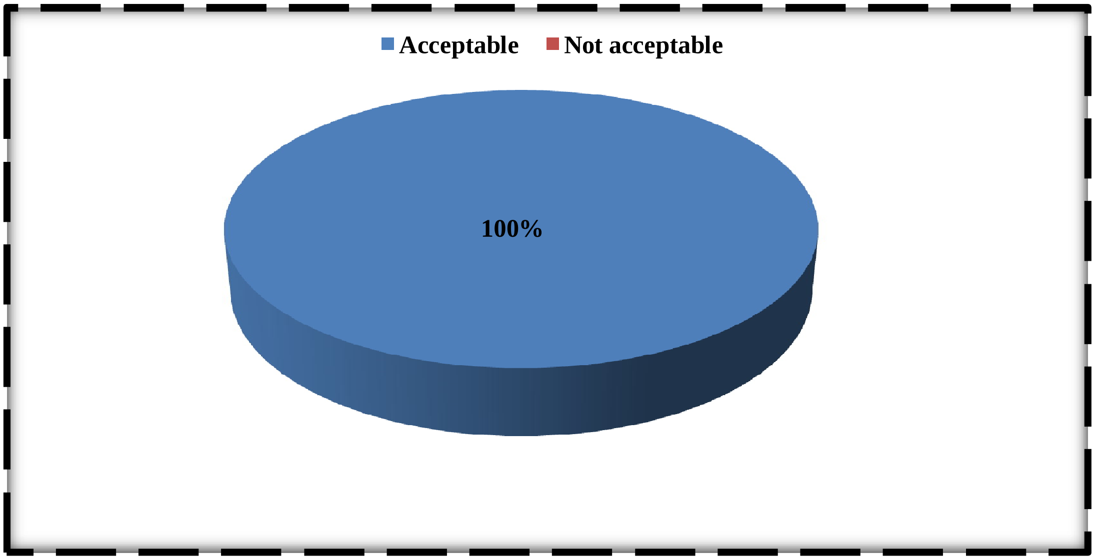

Figure (10): Acceptability to given meals

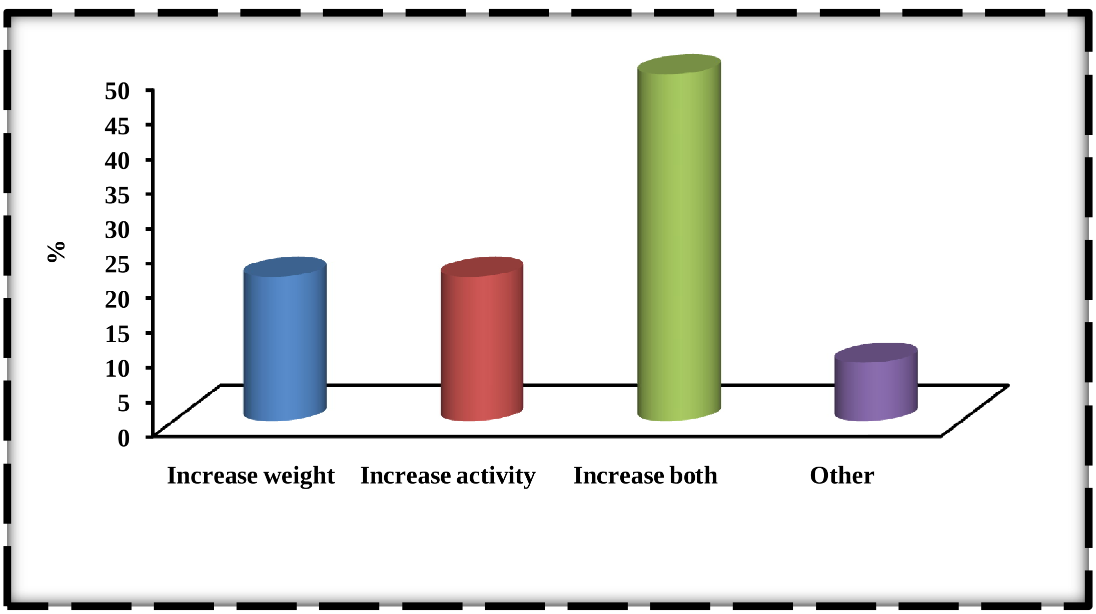

Figure (11): Positive changes of meals effect

Figure (12) shows that 83.3% of children like the meal and only 16.3% showed low sensory evaluation. Children desired meals according to taste and flavor.

Figure (13) shows the preference of given meals, 83.3% were excellent and 16.7% were very good that means all different types of the meals were accurate, easy for using and treated the malnourished children.

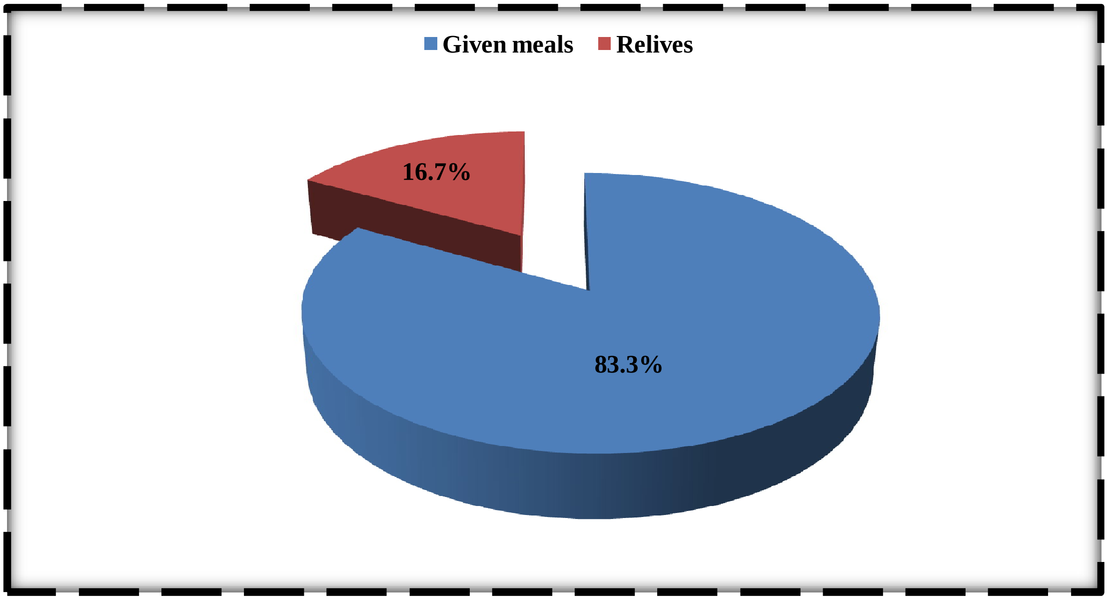

Figure (12): Preference of meals

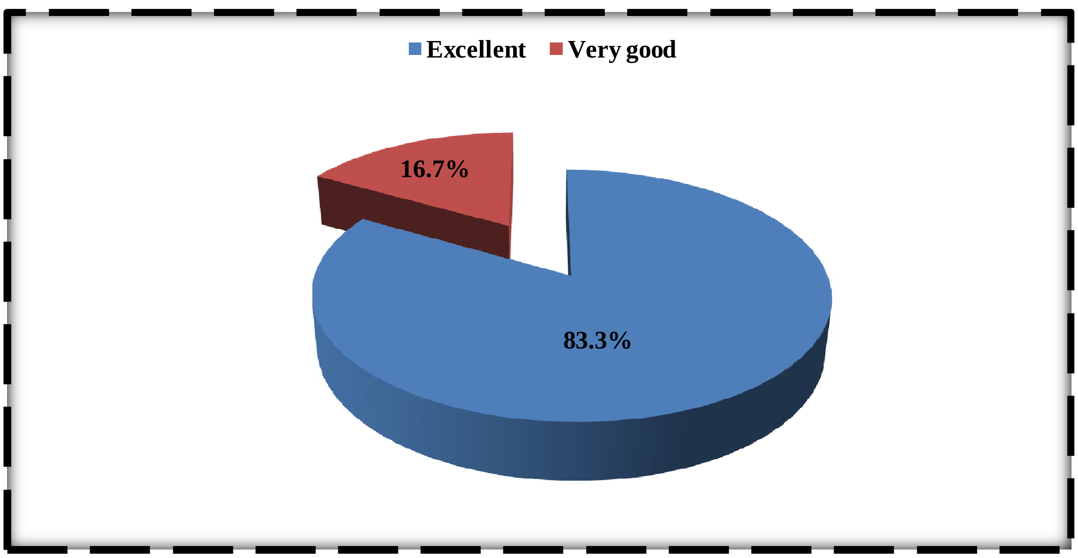

Figure (13): Sensory evaluation of meals

4.2 Proximate chemical composition of sesame, millet and cow milk:

4.2.1 Moisture content:

The moisture content in nutrient parameters for millet was 6.3%, in sesame 5.5% and in milk was 87.6% (table 6) and figure (14) moisture content of millet (6.3%) was same as Johnson *et al*. (1979), Iren Leader *et al*., (2014) and Richert *et al*. (1979)There is no difference according to climate, variety and type of soil.

4.2.2 Protein:

Protein content in sesame seed as in this study was 20.4% and in millet as was 11.9% and in milk as fresh was 4.1% (table 6 and figure 16).

4.2.3. Fat content:

Fat content for millet was 5.1%, in sesame was 43.8% and 3.8% for milk table 6 figure 15. This results was same as Reichert, (1979) there was no difference according to climate, variety and type of soil.

4.2.4 Ash content:

Ash content was 2.3%, 6.2% and 0.8% for millet, sesame and cow milk, respectively (table 6, figure 17).

4.2.5 Crude fibre:

Fibre content was 2.1% and 5.9% for millet and sesame, respectively (table 6, figure 18). This results was the same as results obtained from htt://www.Wikipedia, (2006).

4.2.6 Carbohydrates content:

Carbohydrates content was 72.2%, 18.1% and 4.2% for millet, sesame and cow milk, respectively. These results were different from that obtained from htt://www.Wikipedia (2006) which showed carbohydrates content for millet, sesame and cow milk were 67.5%, 18.1% and 4%, respectively.

4.3 Proximate composition of sesame, and millet meals:

Table (6) and fig 20-25 show the results of proximate composition (%) of sesame and millet meals (moisture content, crude protein, available carbohydrates, fat content, ash content and crude fibre). They were found to be ($26.50^{b} \pm 0.24$, $14.30^{a} \pm 0.12$, $14.70^{b} \pm 0.12$, $19.00^{a} \pm 0.15$, $7.40^{a} \pm 0.03$ and $18.10^{a} \pm 0.14$) for sesame meal respectively, and (35.10a ± 0.28, $7.70^{b} \pm 0.06$, $22.70^{a} \pm 0.18$, $15.00^{b} \pm 0.13$, $4.10^{b} \pm 0.03$ and $15.70^{b} \pm 0.13$ for millet meal, respectively. These results showed significant difference between the two meals.

Table (6): Nutrient parameters for millet, sesame and milk

Parameter / Sample	Moisture Content (%)	Fat Content (%)	Protein Content (%)	Ash Content (%)	Fiber Content (%)	CHO Content (%)
Millet	6.3	5.1	11.9	2.3	2.1	72.2
Sesame	5.5	43.8	20.4	6.2	5.9	18.1
Milk	87.6	3.8	4.1	0.8	-	4.2 (Lactose)

Table (7): Nutrient components of millet and sesame meals

Sample	Moisture content	Fat content	Crude protein	Ash content	Crude fibre	Available carbohydrates	Energy kcal/100g
Sesame meal	26.50^{b} ±0.24	19.00^{a} ±0.15	14.30^{a}±0.12	7.40^{a}±0.03	18.10^{a}±0.14	14.70^{b}±0.12	861
Millet meal	35.10^{a} ±0.28	15.00^{b} ±0.13	7.70^{b}±0.06	4.10^{b}±0.03	15.70^{b}±0.13	22.70^{a}±0.18	769.8
$Lsd_{0.05}$	8.126^{**}	3.942^{*}	6.974^{**}	3.215^{*}	3.846^{*}	7.511^{**}	
SE±	3.527	1.064	2.815	1.012	1.059	3.252	

Key :
Calorie = 4.184 Joules
K Joule = 1000 Joules
Mega Joule = 1000000 Joules
Stated by (Mattram, 1981)according to DMRT. * No significant different. ** Significant different.

Result of energy (kcal/ 100g) was 861 for sesame and 769.8 for millet. However, Mattram (1981) reported that recommended intake energy amount per day in Britain is (788.3, 1313.9 and 1743.9 k cal) for child of (0-1year, 1-3 years and 3-7 years old), respectively.

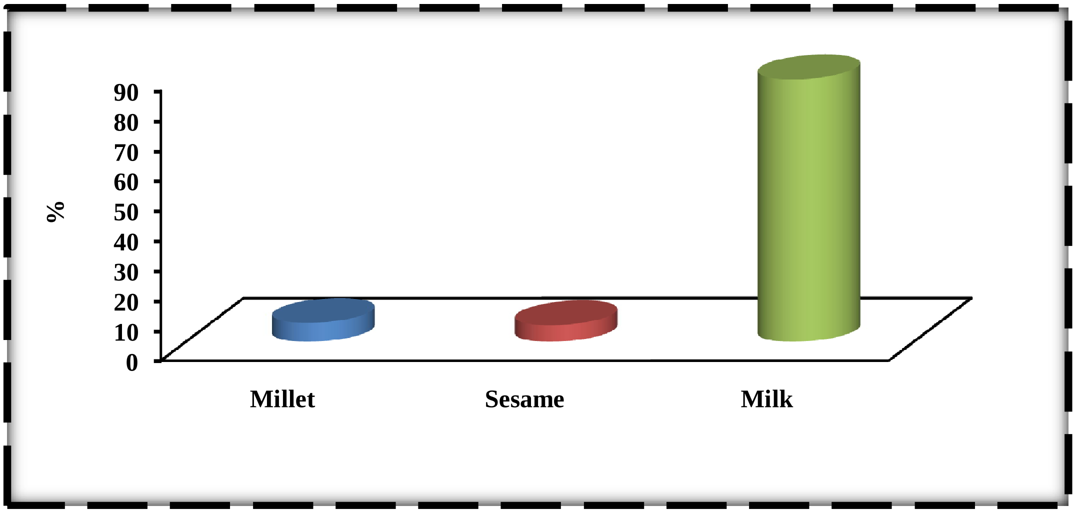

Figure (14): Moisture content of raw millet, sesame and milk

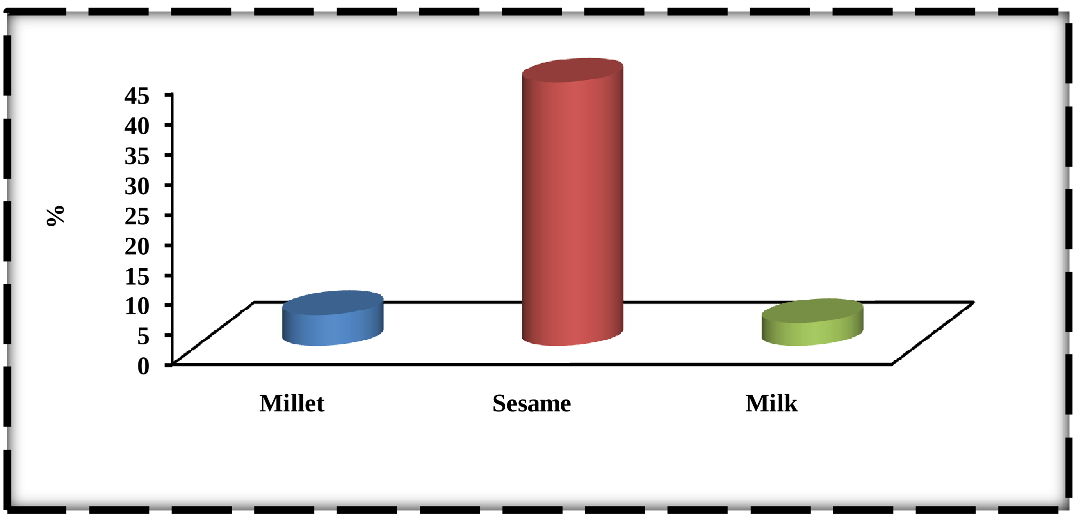

Figure (15): Fat content of raw millet, sesame and milk

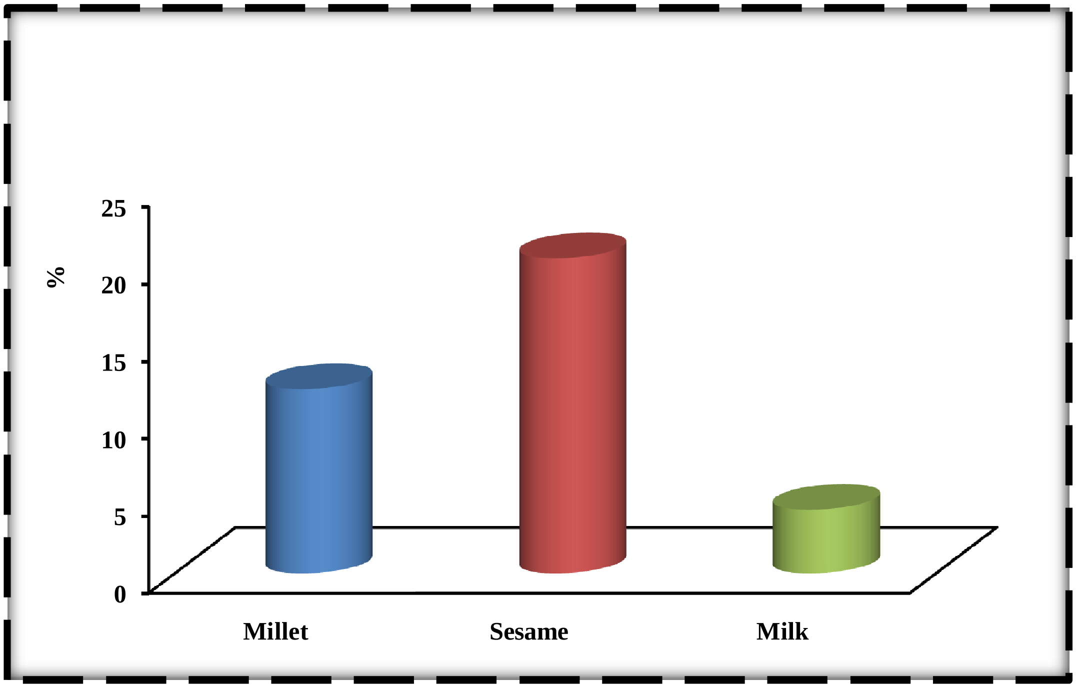

Figure (16): Crude protein of raw millet, sesame and milk

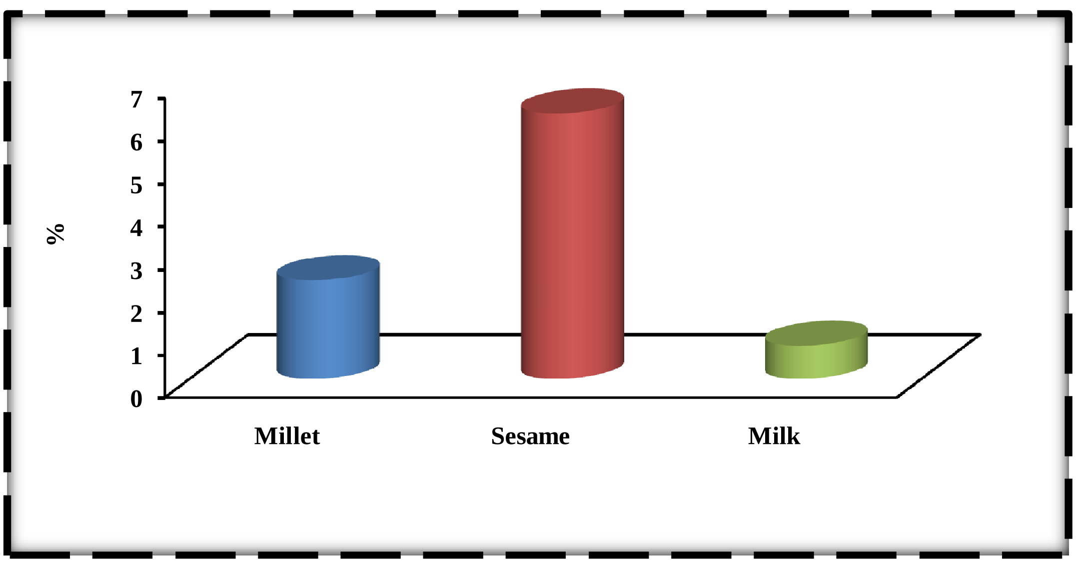

Figure (17): Ash content of raw millet, sesame and milk

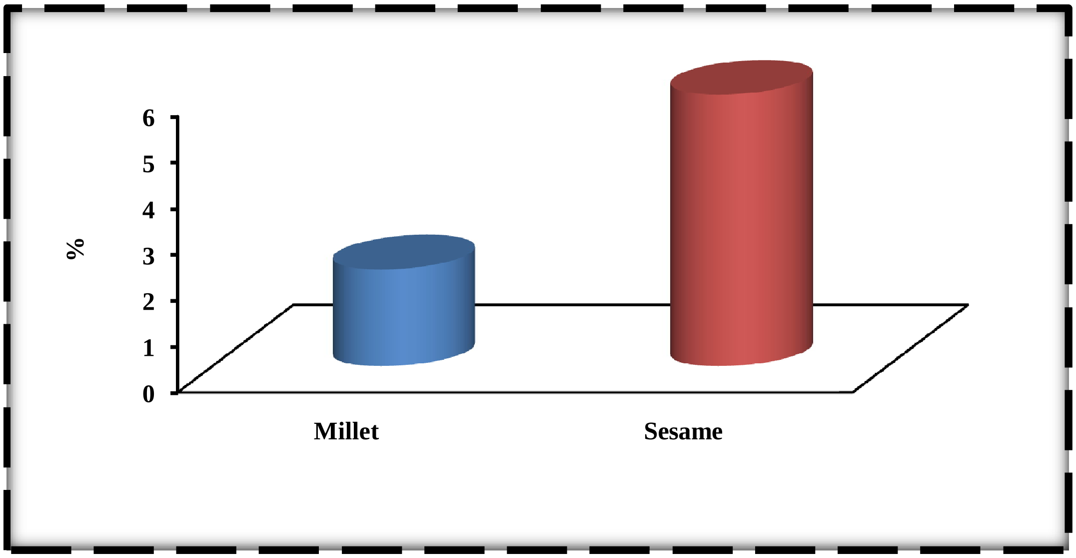

Figure (18): Crude fibre of raw millet and sesame

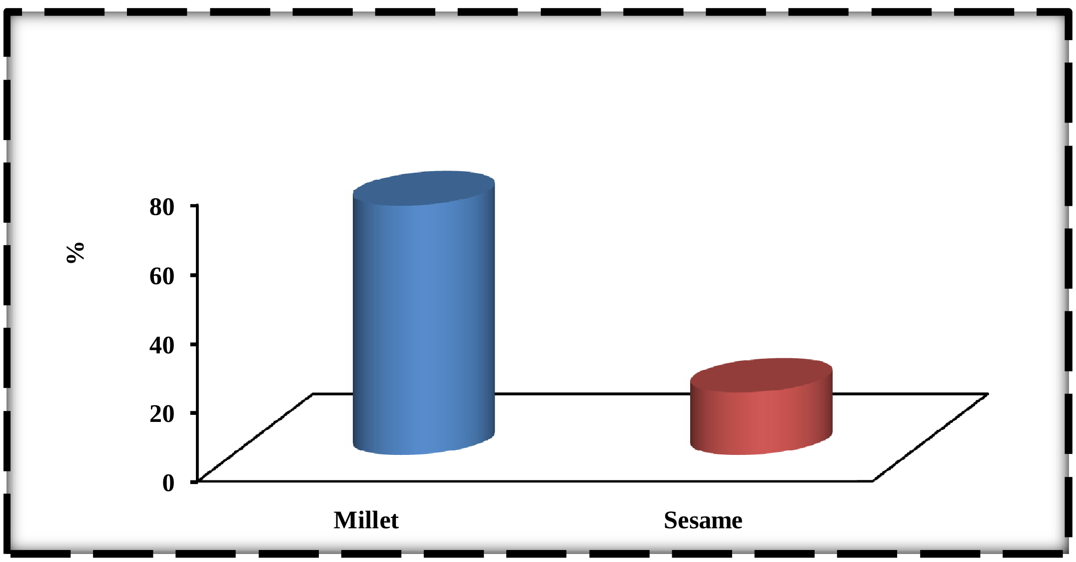

Figure (19): CHO of raw millet and sesame

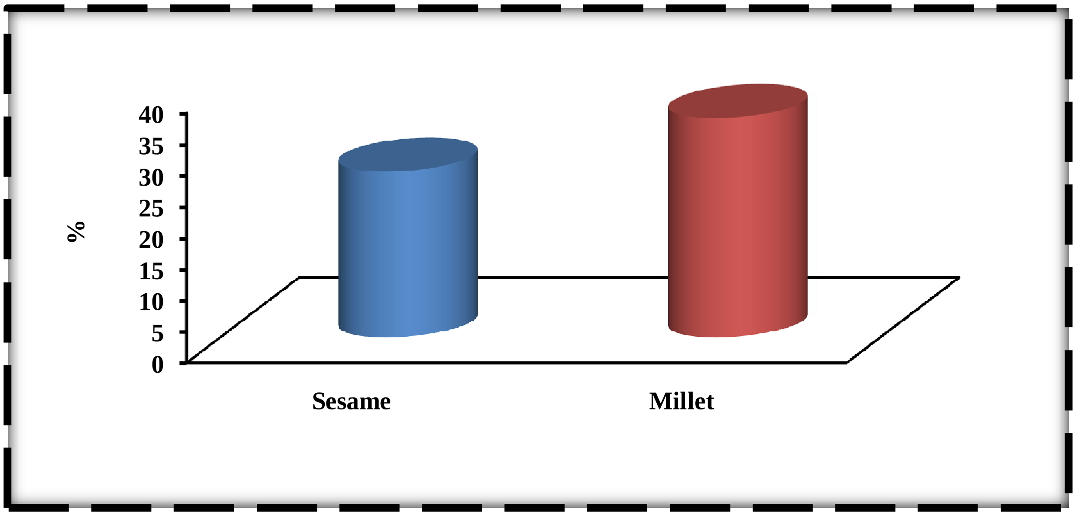

Figure (20): Moisture content of sesame and millet meals

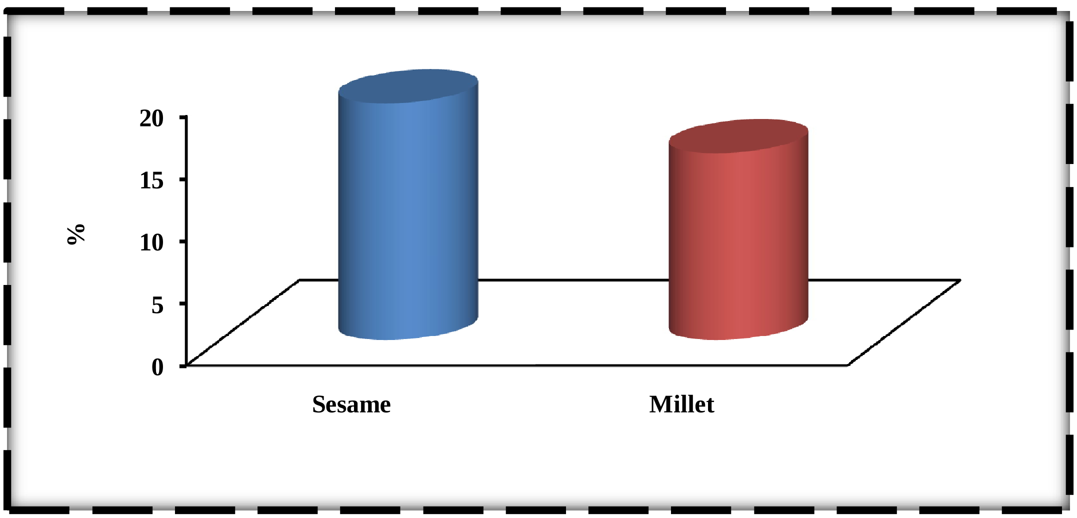

Figure (21): Fat content of sesame and millet meals

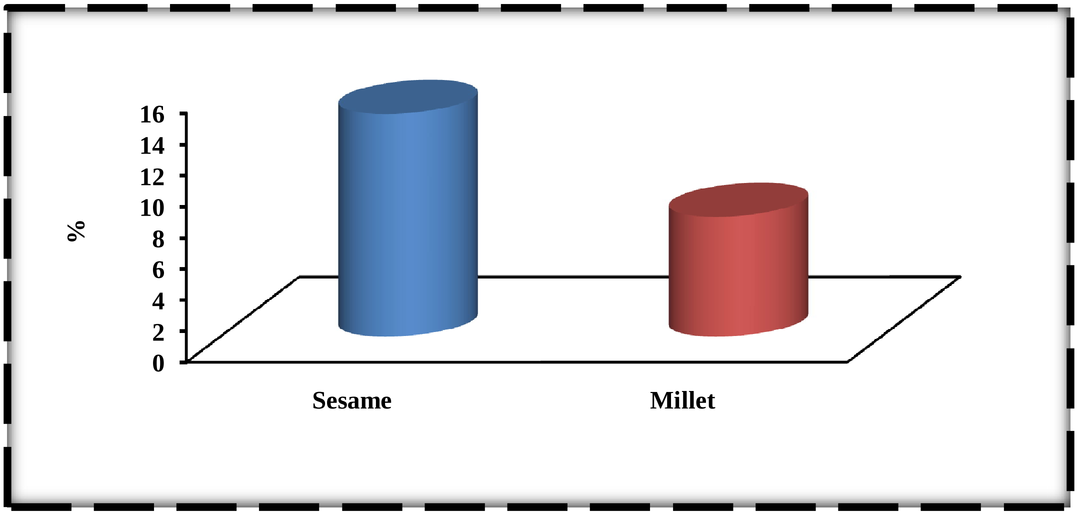

Figure (22): Crude protein of sesame and millet meals

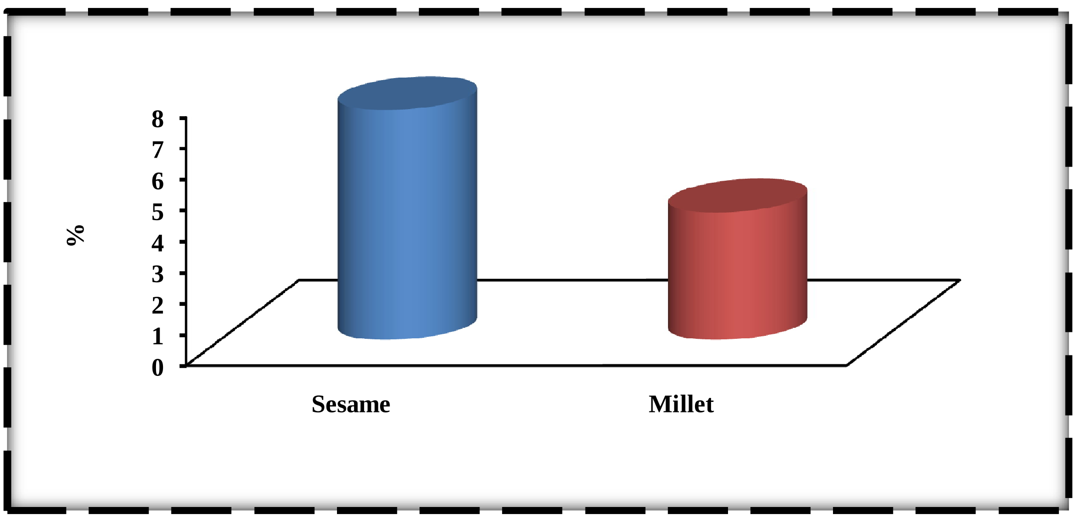

Figure (23): Ash content of sesame and millet meals

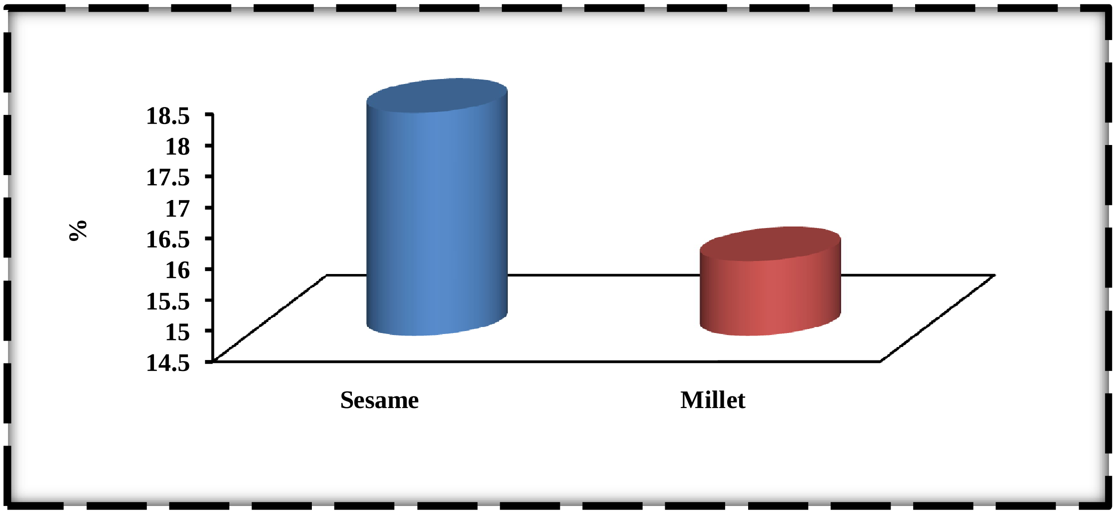

Figure (24): Crude fibre of sesame and millet meals

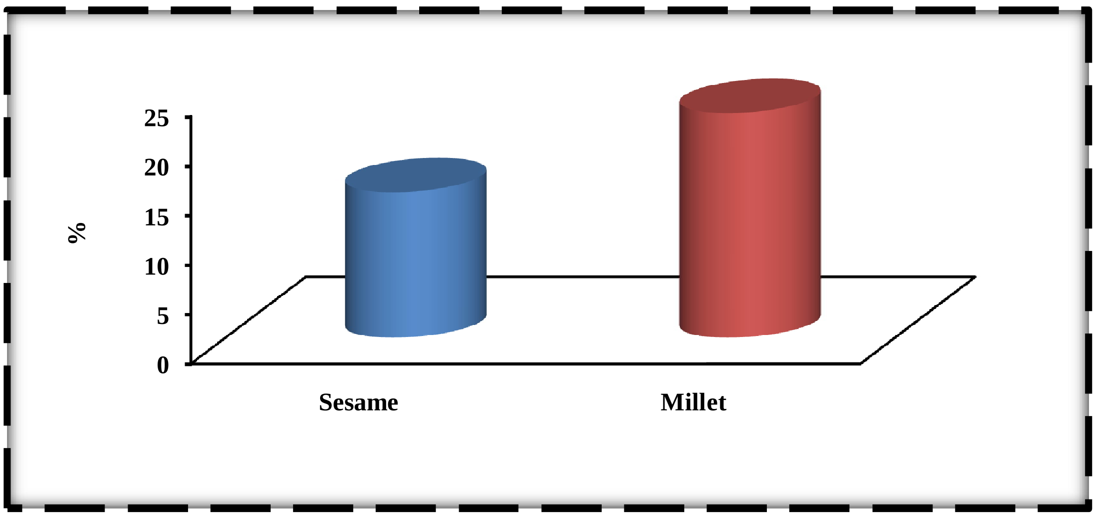

Figure (25): Carbohydrate content of sesame and millet meals

4.4 Amino acid of sesame and millet meals

Table (7) and figures (26- 38) show the results of amino acid content in sesame and millet meals. The amino acid {Isoleucine, Lysine, Methionene, Trypotophan, Valine, Casin, Histidine and Arginine} were found to be {(217.00^{a}±0.15, 213.00^{b} ±0.17), (268.00^{a} ±0.48, 264.00^{b} ±0.41, (158.00^{a} ±0.29, 151.00^{b} ±0.22), (61.00^{b} ±0.25, 64.00^{a} ±0.27), (303.00^{b} ±0.41, 310.00^{a} ±0.49), (274.00^{a} ±0.35, 266.00^{b} ±0.23), (1.10^{a} ±0.05, 1.20^{a} ±0.07) and (.70^{b} ±0.12, 2.80^{a} ±0.16)}mg/g, respectively. These results showed significant difference, while the others amino acids {Leucine, Cystine, Phenylealamine, Tryosine and Threonine} were found to be {(522.00^{a} ±0.76, 501.00^{b} ±0.69), (122.00^{a} ±0.16, 75.00^{b} ±0.09), (242.00^{a} ±0.76, 202.00^{b} ±0.58), (318.00^{a} ±0.28, 309.00^{b} ±0.21) and (170.00^{a} ±0.44, 162.00^{b} ±0.35)}, which were significantly different. Conventional proteins extraction techniques, when applied to sesame yield low quantities of protein amount with unknown amounts of phatate and oxalate that affect nutritional quality. (Lyon, 1972; FAO, 1977). Mattram (1981) recommended intake of amino acid amount mg/kg per day for a child in Britain ranges 17-160 and specially histidine is about 28 mg/kg per day.

Table (8): Amino acids of sesame and millet meals

Amino acid	Sesame	Millet	$Lsd_{0.05}$	SE±
Isoleucine (mg/g)	217.00^{a} ±0.15	213.00^{b} ±0.17	3.523^{*}	1.526
Leucine (mg/g)	522.00^{a} ±0.76	501.00^{b} ±0.69	17.451^{**}	7.058
Lysine (mg/g)	268.00^{a} ±0.48	264.00^{b} ±0.41	2.9648^{*}	0.967
Methionine (mg/g)	158.00^{a} ±0.29	151.00^{b} ±0.22	6.5461^{*}	2.345
Cystine (mg/g)	122.00^{a} ±0.16	75.00^{b} ±0.09	24.6318^{**}	9.8214
Phenylealamine (mg/g)	242.00^{a} ±0.76	202.00^{b} ±0.58	35.4017^{**}	12.057
Tyrosine (mg/g)	318.00^{a} ±0.28	309.00^{b} ±0.21	6.9745^{**}	2.487
Threonine (mg/g)	170.00^{a} ±0.44	162.00^{b} ±0.35	4.7892^{**}	1.528
Trypotophan (mg/g)	61.00^{b} ±0.25	64.00^{a} ±0.27	1.9846^{*}	0.701
Valine (mg/g)	303.00^{b} ±0.41	310.00^{a} ±0.49	5.0947^{*}	2.349
Casin (mg/100 ml)	274.00^{a} ±0.35	266.00^{b} ±0.23	3.0676^{*}	1.286
Histidine (mg/100 ml)	1.10^{a} ±0.05	1.20^{a} ±0.07	$0.2058^{n.s}$	0.015
Arginine (mg/100 ml)	1.70^{b} ±0.12	2.80^{a} ±0.16	0.9256^{*}	0.663

Values are mean±SD. Value(s) sharing same superscript(s) in a row are not significantly different (P>0.05) according to DMRT. * No significant different. ** Significant different.

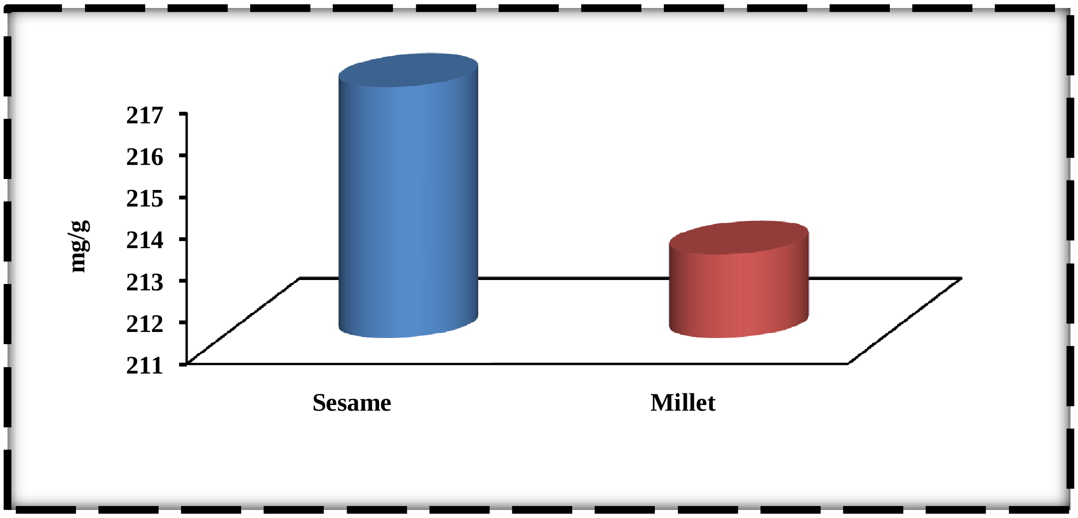

Figure (26): Isoleucine of sesame and millet meals

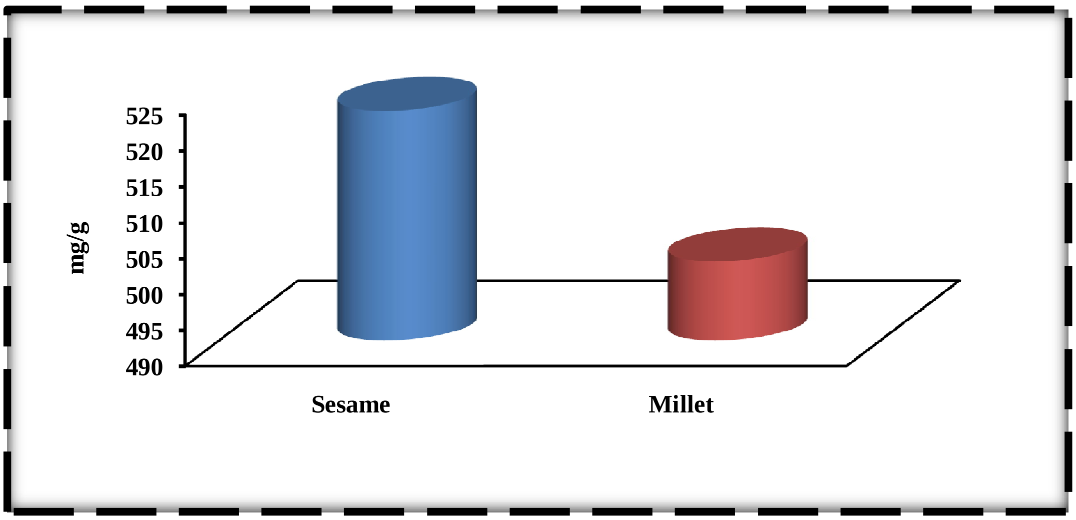

Figure (27): Leucine of sesame and millet meals

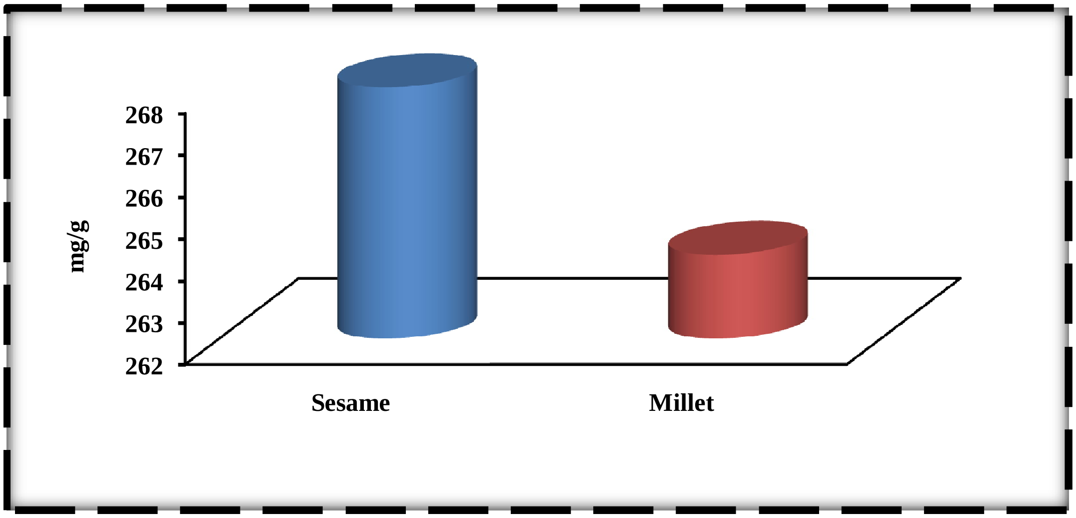

Figure (28): Lysine of sesame and millet meals

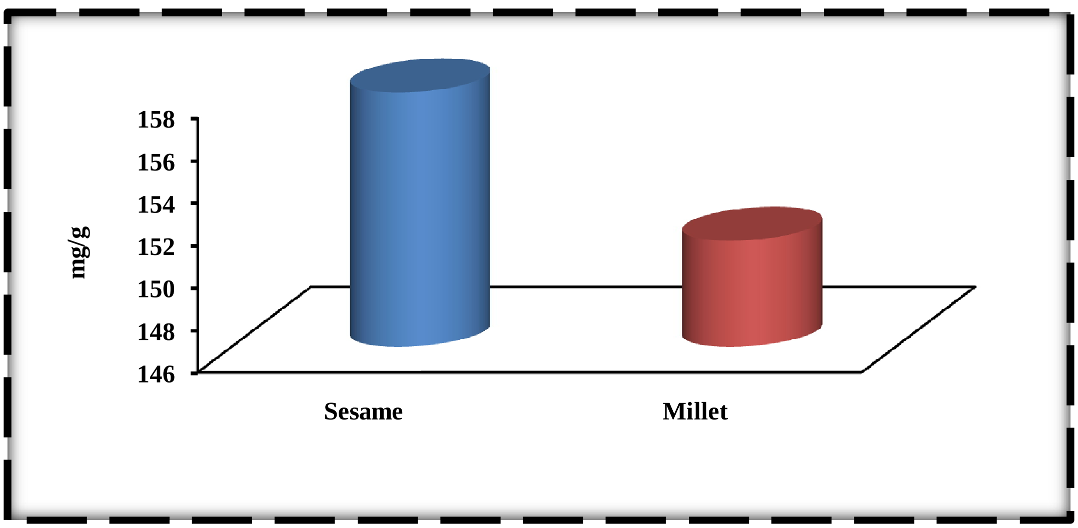

Figure (29): Methionine of sesame and millet meals

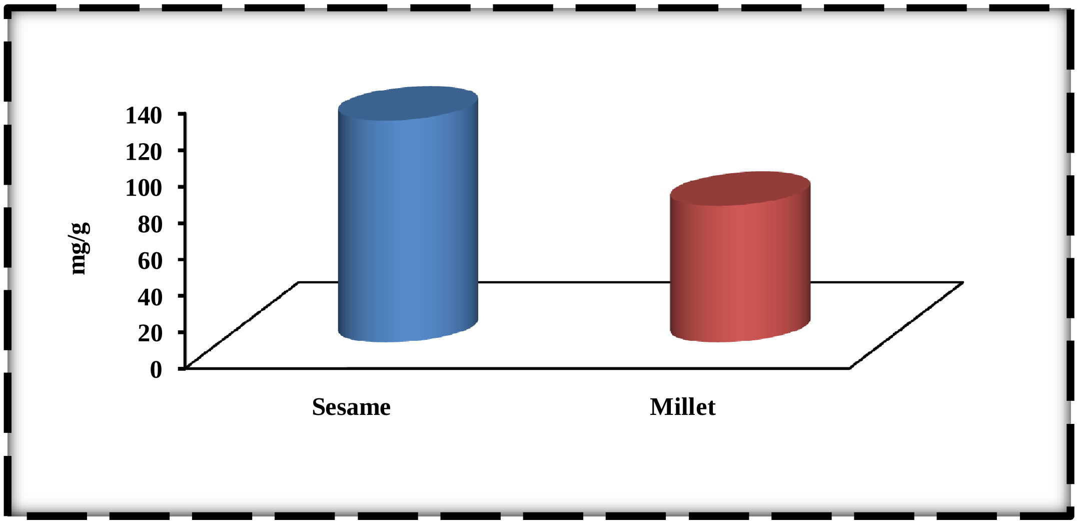

Figure (30): Cystine of sesame and millet meals

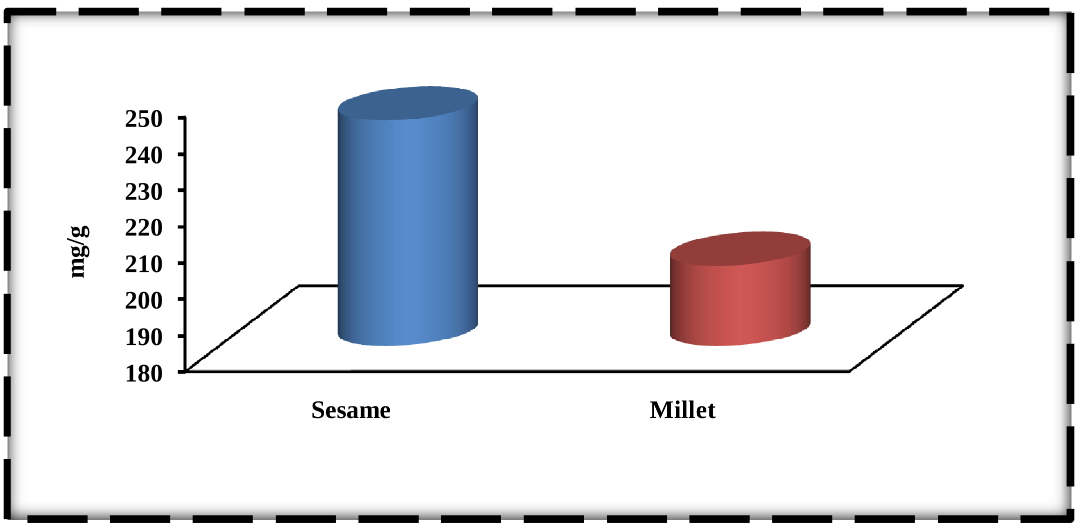

Figure (31): Phenylealamine of sesame and millet meals

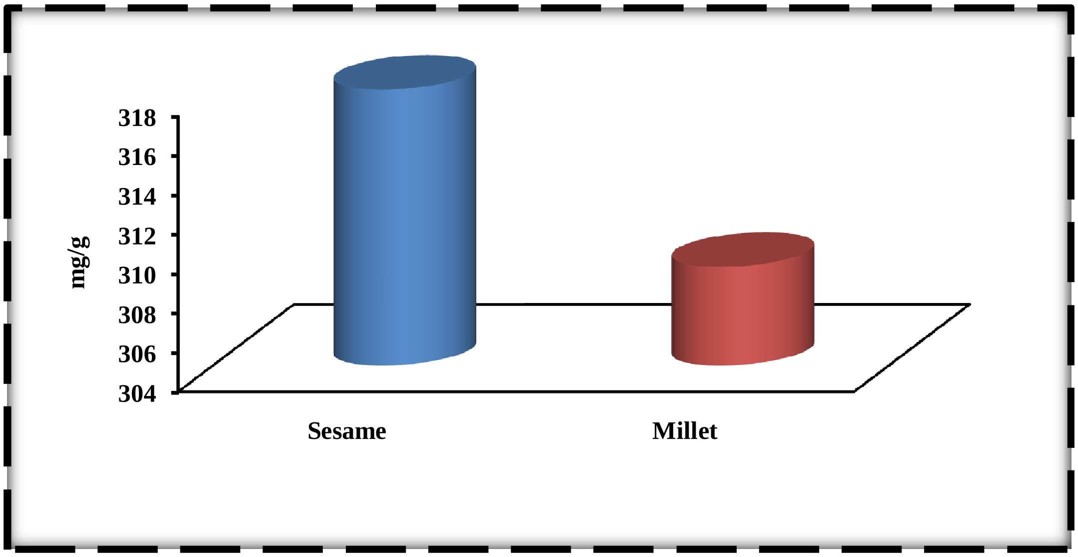

Figure (32): Tyrosine of sesame and millet meals

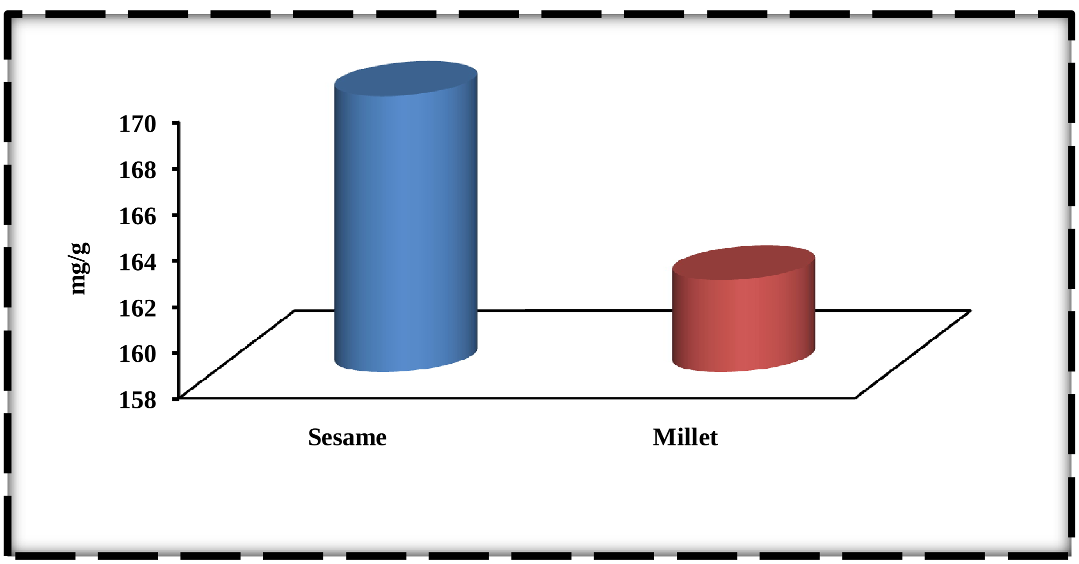

Figure (33): Threonine of sesame and millet meals

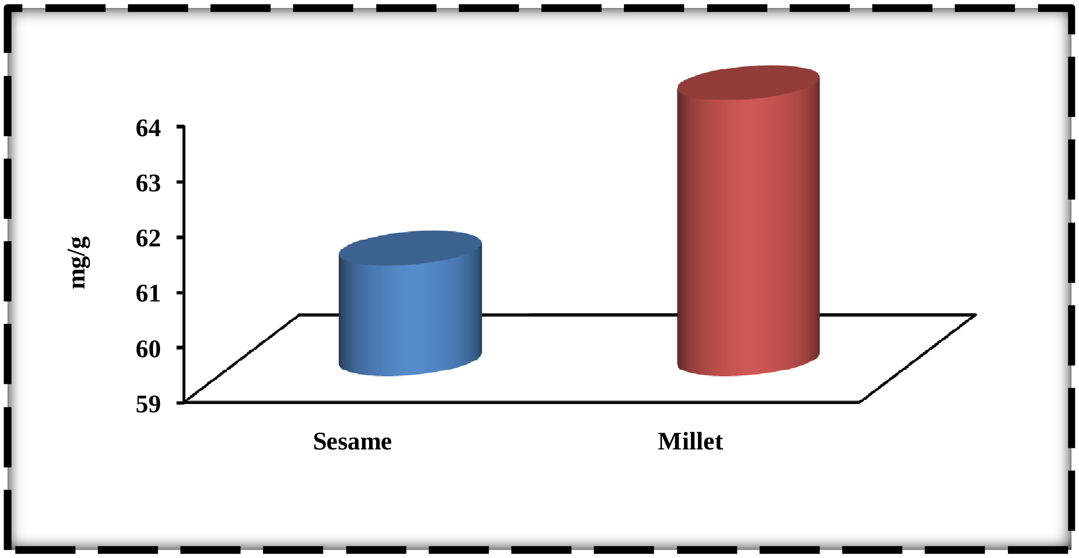

Figure (34): Trypotophan of sesame and millet meals

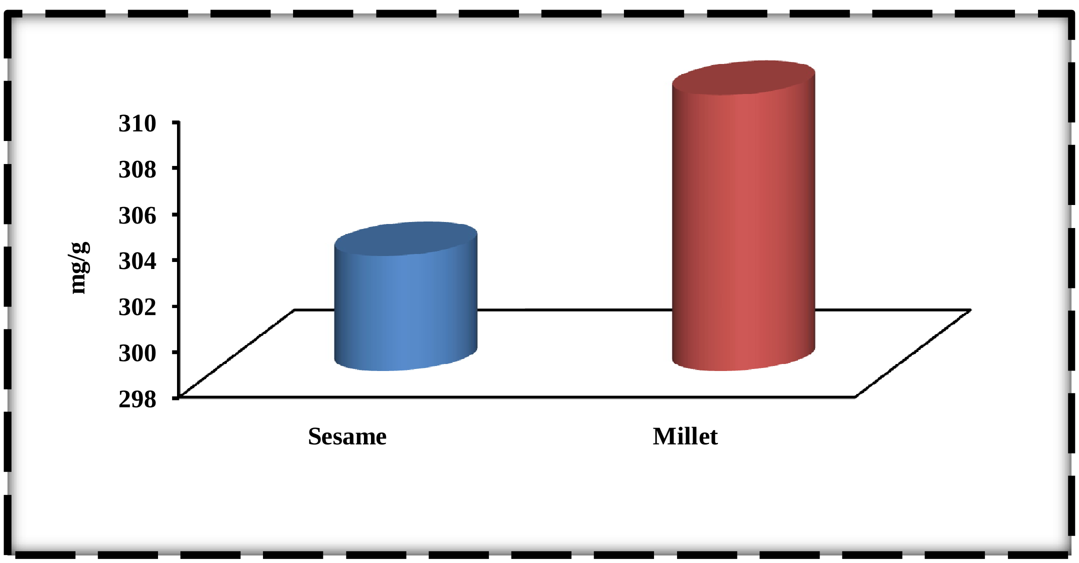

Figure (35): Valine content

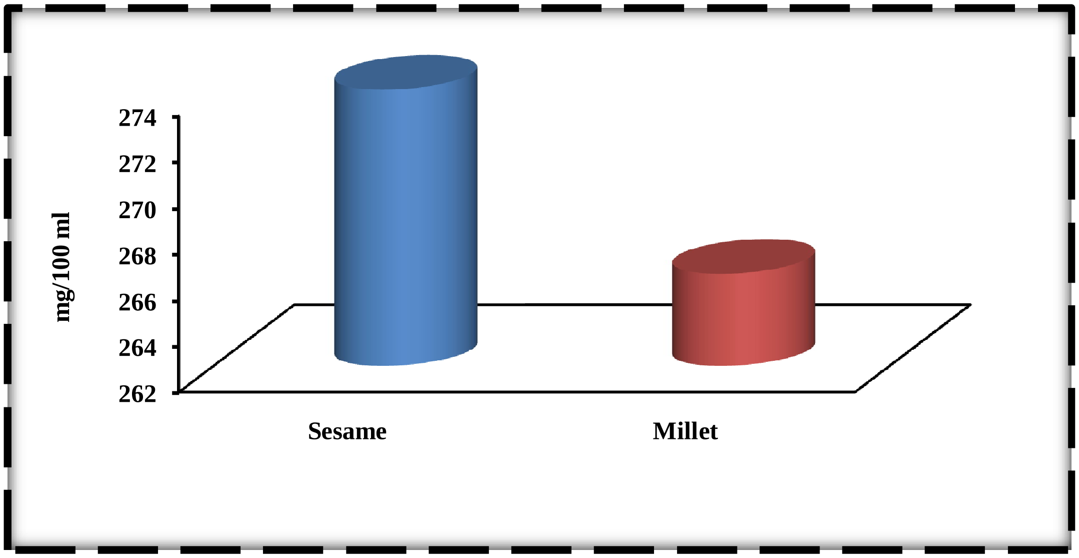

Figure (36): Casine of sesame and millet meals

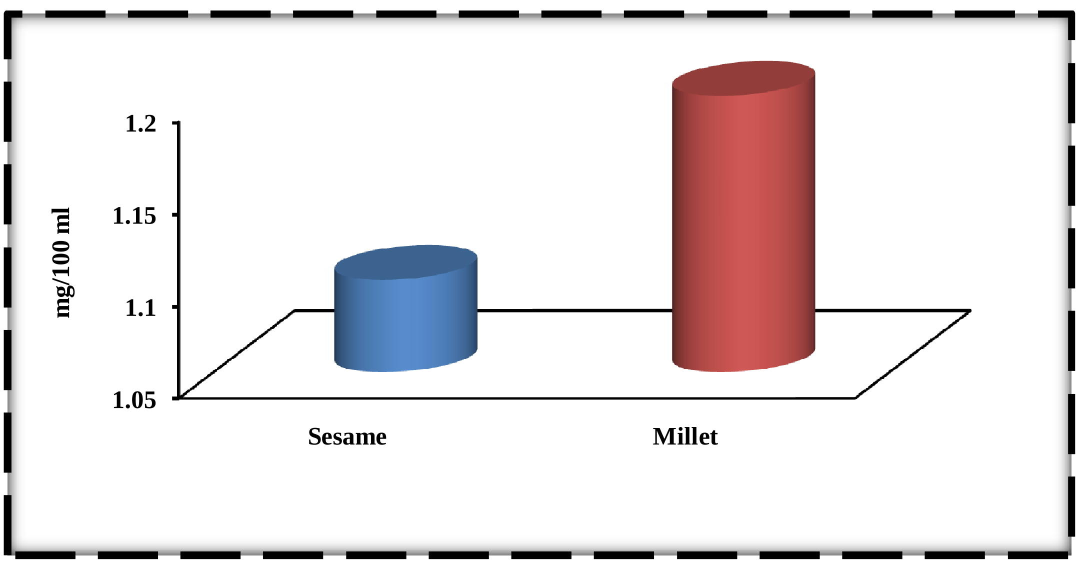

Figure (37): Histidine of sesame and millet meals

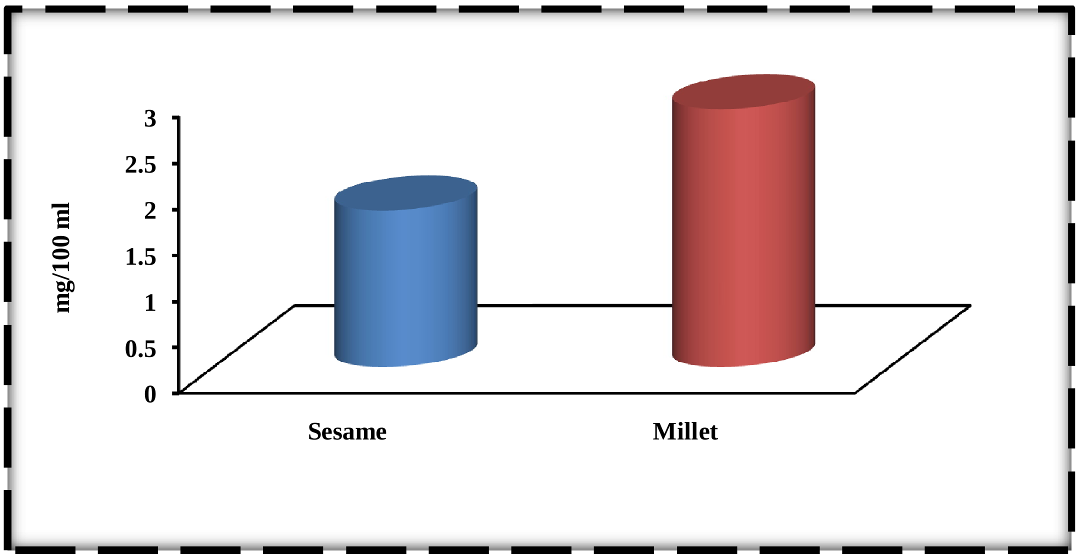

Figure (38): Arginine of sesame and millet meals

4.5 Body weight gain

Table 8 and 9 and fig. 39 show that the sesame and millet meals improved the child weight are highly significant for treating malnourished children.

Table (9): Weight of the children before and after given meals

No of Children	Age of Children	Wt before given meal	Wt of child frt. wk	Wt of child sec. wk	Wt of child thr. wk	Wt of child fru. wk	Wt of child fith wk	Wt of child six. wk	Wt of child sev. wk	Wt of child eght. wk
1	3	7	6.5	7	8	9	9.5	9.5	10	10.5
2	5	8.5	9	10	11	11.5	11.5	12	12.5	12.5
3	1	5.5	4	5	6	6.6	7	7.5	8	8.5
4	1	4.5	4.5	5	6	6.5	7	7.5	8	8.5
5	2	6	7	7.5	8	8.5	9	9	9.5	10
6	3	7	7.5	8	9	9.5	10	10	10.5	11
7	4	8	8.5	9	9.5	10	11	11	11.5	12
8	4	7.5	7.5	7.5	7.5	7.5	7.5	7.5	8	8.5
9	5	10	10.5	11	11.5	11.5	11	12.5	12.5	13
10	1	4	6	7	8	8.5	9	9	10	10.5
11	2	5	6	7	8	8.5	9	9	10	10.5
12	5	8	9	10	11	11	11.5	11.5	12	12.5
13	3	6.5	7	8	9	9.5	9.5	10	10.5	11
14	3	7	7.5	8	9	10	10	10.5	10.5	11
15	3	6	7	8	8.5	9	9.5	9.5	10	10
16	4	8	8	9	10	10.5	10.5	10	10.5	11
17	4	7.5	8	9	9.5	10.5	10	10	10.5	11
18	4	7.5	9	10	10.5	11.5	11.5	11.5	11.5	12
19	5	8	10	11	11.5	11.5	11.5	11.5	11.5	12
20	5	9	10	11	12	12.5	12.5	12	12	12.5
21	4	10	5	9	7	8	8	10	10	10.5
22	5	5	7	8	8.5	9	9	9	9	10
23	5	6	9	10	10.5	10.5	10.5	10.5	10.5	11
24	3	6.5	7	7.5	8	8.5	8.5	9	9	10

Table (10): Body weight gain of children

Weeks	Weight gain (kg)
Wk_1	0.52 ± 1.70^{c}
Wk_2	1.81 ± 1.74^{a}
Wk_3	2.06 ± 1.68^{a}
Wk_4	1.52 ± 1.60^{ab}
Wk_5	0.79 ± 1.55^{bc}
Wk_6	0.44 ± 1.45^{c}
Wk_7	0.83 ± 1.32^{bc}
Wk_8	0.83 ± 1.27^{bc}
Overall mean	1.10±0.18
$Lsd_{0.05}$	0.8805^{*}
SE±	0.3165

Values are mean±SD.

Means having different superscripts are significantly different ($P \leq 0.05$).

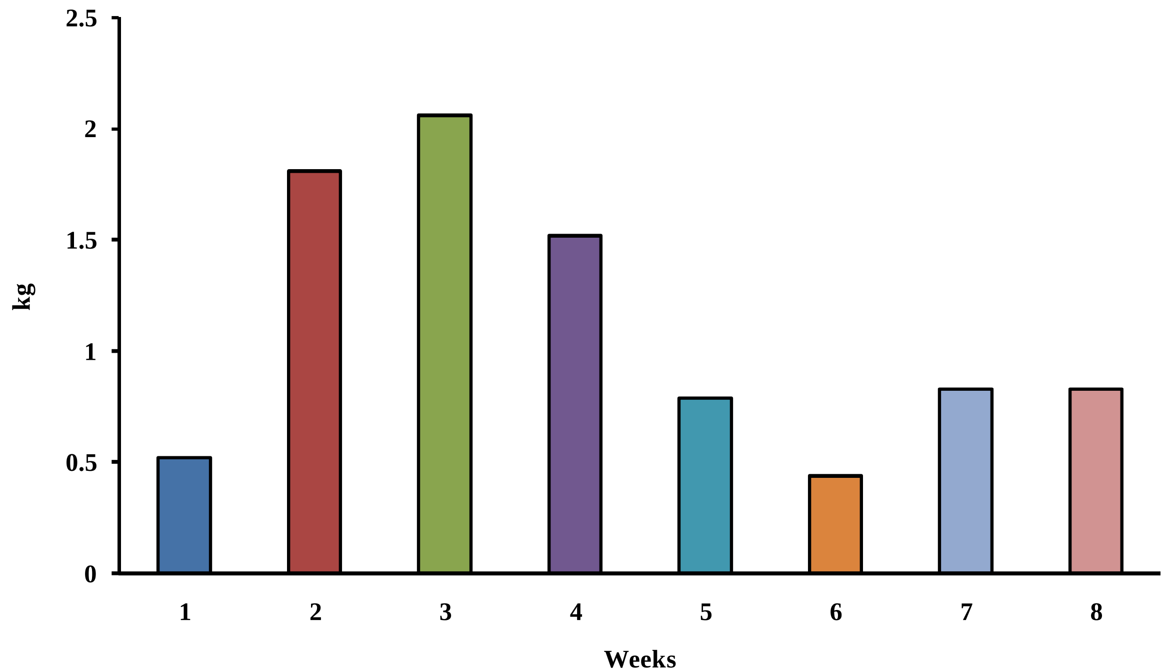

Figure (39): Body weight gain

CHAPTER FIVE

CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

1. The age group of all children in this study (1-5 years) represents the most vulnerable age at which the child exposed to different infections and leading causes of malnutrition.
2. Mostly, the families of the respondents live in low socioeconomic status, which indicated by low income, low education. Income and education are among the determinant factors of child's nutritional and health status.
3. Infections in clouding diarrhea, weight loss and gastrointestinal is as vomiting weight loss, which indicate eloge association to protein energy malnutrition and other types of nutritional disorders among the studied group.
4. Maternal illiteracy and poverty play a serious role in the health and nutrition problems.
5. The local meals from sesame, millet and milk gave an increase in weight and activity of the studied children

5.2 Recommendations

1. Improving mothers' knowledge about right practices on feeding infants and children of five years of age.
2. All types of local foods contain high nutrients value, to cover adequate of the food needed.
3. Investigating and evaluating some local foods can give a solution for protein energy malnutrition .
4. Collaboration between Environmental Health Sector and Nutrition Department should be strengthened to decrease the problems.

5. Further are needed in the traditional management of diseases to encourage and promote the good practices and discourage the bad ones.

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