

بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ



Sudan University of Science and Technology



College of Agricultural Studies

Department of Food Science and Technology

**Comparative study of some nutritive values between
Traditional and Commercial Gergoush**

دراسة مقارنة لبعض الصفات التغذوية بين القرقوش التقليدي و التجاري

A dissertation submitted in partial fulfillment of the requirements for the B. Sc. degree

Honors in Food Science and Technology

By :

Fatima Hassan Hamoda Abd-Allah

Rania Hassan Mohammed Othman

Zainab Mohammed El-Hassan Suliman Hashim

Supervisor: Professor: Ahmed El-Awad El-Faki

October 2016

الآية

قال تعالى:

(لِيَأْكُلُوا مِنْ ثَمَرِهِ وَمَا عَمِلَتْهُ أَيْدِيهِمْ أَفَلَا يَشْكُرُونَ)

صدق الله العظيم

سورة يس الآية (35)

Dedication

To our mothers, fathers and
brothers

To our extended family

To all our teachers and friends with
great regard and respect.

ACKNOWLEDGEMENTS

Unlimited thanks to **ALLAH** who helped and gave us health to complete this work.

We wish to express deepest gratitude and sincere thanks to our supervisor: **Professor: Ahmed El-Awad El-Faki** for his helpful and continuous advice.

We would like also to express our gratitude to all staff members of the Department of Food Science and Technology, Sudan University of Science and Technology.

Our deep thanks and gratefulness to **Mr: EL-Tegani AbdAllah** and our **families** for supporting us to complete this work.

ABSTRACT

This study was conducted to compare between the traditionally produced Gergoush and the commercially produced ones according to their chemical composition, minerals content and the consumer acceptability for the products.

The study reveals that proximate chemical composition of the traditional Gergoush for moisture, protein, fat, ash and fiber were 10.48% , 10.79% , 10.99% , 1.033 %and 4.87% respectively, commercially produced Gergoush of one of the Bakery's for moisture, protein, fat, ash and fiber were 5.64% , 8.30% , 7.77% , 0.967% and 2.67 % respectively , commercially produced Gergoush of other bakery's for moisture, protein , fat, ash and fiber were 10.53% , 10.54% , 9.28% , 1.100 and 0.933% respectively. The mineral content for Ca, Mg, Na, k and Fe for traditionally produced Gergoush were 38.20, 29.37, 2.00, 440.52 and 2.73 mg/100g respectively, commercially produced Gergoush for one of the Bakery's for Ca , Mg , Na , k and Fe were 20.60 , 22.20 , 1.80 , 350.75 and 1.63 mg/100g respectively, commercially produced Gergoush of one of the Bakery's for Ca , Mg , Na , k and Fe were 20.30 , 20.90 , 1.72 , 348.00 and 1.87 mg/100g respectively. The Sensory evaluation was conducted for the traditionally produced Gergoush and commercially produced Gergoush according to their color, flavor, taste, texture and the general acceptability. The result reveals that the traditionally produced Gergoush and the Gergoush from one of Bakery were of high acceptability according to the panelists compared to the Gergoush from the other Bakery. Also from the results we found that the traditionally processed Gergoush had high nutritional value compared to that of the commercially produced one.

أجريت هذه الدراسة لمقارنة القرقوش المصنع بالطريقة التقليدية مع القرقوش المصنع بالطرق التجارية السريعة في المخابز , من حيث الاختبارات الكيميائية ونسبة المعادن وقبول المستهلكين للمنتج .

حيث اظهرت الدراسة ان نسب التحليل الكيميائي التقريبي في القرقوش التقليدي من حيث الرطوبة , البروتين , الدهن , الرماد والالياف كما يلي 10.48% , 10.79% , 10.99% , 1.03% و 4.87% على التوالي . القرقوش التجاري من المخبز الاول ل الرطوبة , البروتين , الدهن , الرماد والالياف كما يلي 5.64% , 8.30% , 7.77% , 0.967% و 2.67% على التوالي , وللقرقوش التجاري من المخبز الثاني الرطوبة , البروتين , الدهن , الرماد والالياف كالآتي 10.53% , 10.54% , 9.28% , 1.2% و 0.933% على التوالي . اما بالنسبة للمعادن فكانت النسب لكل من الكالسيوم , الماغنيزيوم , الصوديوم , البوتاسيوم والحديد للقرقوش التقليدي 38.20 , 29.37 , 2.00 , 440.52 و 2.73 ملليجرام لكل 100 جرام على التوالي , وللقرقوش التجاري من المخبز الاول كانت 20.60 , 22.20 , 1.80 , 350.75 و 1.63 ملليجرام لكل 100 جرام على التوالي , وللقرقوش التجاري من المخبز الثاني فكانت 20.30 , 20.90 , 1.72 , 348.00 و 1.87 ملليجرام لكل 100 جرام على التوالي . كما اجري تقييم حسي لتلك العينات التي ذكرت من حيث اللون , النكهة , المذاق , القوام والقبول العام , واطهر التقييم ان القرقوش التقليدي والقرقوش من الخبز الاول افضل من القرقوش من المخبز الثاني .

ايضا و من هذه النتائج وجد ان القرقوش التقليدي اعلى من حيث القيمة الغذائية من القرقوش المحضر بالطرق السريعة التجارية .

Table of Contents

Title	Page No.
الآية	I
Dedication	II
ACKNOWLEDGEMENTS	III
Abstract	IV
الملخص	VI
Table of Contents	VII
List of Tables	VIII
CHAPTER ONE	
1.INTRODUCTION	1
CHAPTER TWO	
2.LITERATURE REVIEW	
2.1 Fermented Food	3
2.1.1 Definition of Fermented Food	3
2.2 Wheat	4
2.2.1 Classification	4
2.2.2 Importance, Production and Consumption of Wheat in Sudan	5
2.2.3 Wheat Kernel Structure	5
2.2.4 Wheat composition	6
2.2.4.1 Moisture Content	6
2.2.4.2 Ash Content	6
2.2.4.3 Protein Content	7
2.2.4.4. Fat Content	8
2.2.4.5 Crude Fiber Protein	8
2.2.4.6 Enzymes	9
2.2.5 Nutritive Value of Wheat	9
2.2.6 Wheat Utilization	10
2.3 Gergoush	11
2.3.1 Preparation of the Starter	12
2.4 Milk	13
2.4.1 Importance of Milk	13
2.4.2 Chemical Composition of Milk	13
2.4.3 Nutritive Value of Milk	14
2.5 Lentil	14
2.5.1 Utilization	14
CHAPTER THREE	
3. MATERIALS AND METHODS	

3.1 Materials	16
3.2. Methods	16
3.2.1 Gergoush processing method and recipe	16
3.2.2 Proximate chemical analysis	20
3.2.2.1 Moisture content	20
3.2.2.2 Crude protein content	20
3.2.2.3 Fat content	22
3.2.2.4 Crude fiber content	23
3.2.2.5 Ash content	24
3.2.2.6 Minerals content	24
3.2.3 Sensory Evaluation	25
3.2.4 Statistical analysis	25
CHAPTER FOUR	
4. RESULTS AND DISCUSSION	
4.1 Proximate chemical composition of Gergoush	26
4.1.1 Moisture	26
4.1.2. Crude protein	26
4.1.3. Fat content	26
4.1.4. Ash content	27
4.1.5. Crude fiber content	27
4.2. Minerals content of Gargoush sample	29
4.2.1. Ca	29
4.2.2. Mg	29
4.2.3. Na	29
4.2.4. K	30
4.2.5. Fe	30
4.3. Sensory evaluation of Gergoush	32
CHAPTER FIVE	
5. CONCLUSION AND RECOMMENDATIONS	
5.1. Conclusion	34
5.2. Recommendations	34
References	35
Appendices	39

List of Tables

Title	Page No.
Table (1): Average composition (%) of cow milk	13
Table (2): Proximate composition of Gergoush samples	28
Table (3): Minerals content of Gergoush samples	31
Table (4): General acceptability of Gergoush samples	33

CHAPTER ONE

1. INTRODUCTION

Wheat is one of the most important staple food for humans (**Akhtar *et al.*, 2008**). The kernel consists of the wheat germ and the endosperm, which is full of starch and protein (**Mannay and Shadaksharaswany, 2005**). Usually the whole grain is milled to leave just the endosperm for white flour, while the by-products of bran and germ are discarded. It has been shown that the whole grain is a concentrated source of essential nutritional components such as vitamins, minerals, protein, fat and fibre while the refined grain is mostly starch (**Potter and Hotchkiss, 2006; Bakke and Vickers, 2007**). Wheat therefore, is perhaps the most popular energy grain for the production of confectionary products, because of the unique properties of its protein (gluten) which combines strength and elasticity required to produce bread, cookies, cakes and pastries such as spaghetti, macaroni and noodles of desirable texture and flavour (**Potter and Hotchkiss, 2006; Akhtar *et al.*, 2008**).

Formulation of foods from low-lysine staples such as grains fortified with legumes has been proposed as a practical and sustainable approach to improving the protein nutritional value of foods for vulnerable people in developing countries (FAO/WHO, 1994; Zhu *et al.*, 2005) and especially in famine and war situations where there is the need to provide a one stop whole meal with all the required nutritional components that will cater for dire nutritional needs of both the young and elderly victims.

Snack food consumption has been on the increase as a result of urbanization and increase in the number of working women. Food

based industry can exploit this development by fabricating nutritious snack foods.

The indigenous fermented foods of the Sudan are numerous and varied. The raw materials from which they are made include conventional sources like sorghum, millet, dates, legumes, etc., as well as non-conventional sources such as wild plants and food leftovers.

Gergoush is one of these traditional fermented foods produced mainly in the Northern States of the Sudan at household level and for family consumption only. It is a snack made from wheat flour and preferably eaten with the early morning tea. No scientific investigations seem to be done on process of Gergoush production (**Sherfi,Hamad 2000**).

Main objective

To evaluate some of the nutritive value of traditional and commercial Gergoush.

Specific objectives

1. To determine the proximate chemical composition of the products.
2. To determine the minerals content of the products.
3. To determine the general acceptability of the products.

CHAPTER TWO

2. LITERATURE REVIEW

2.1 Fermented Food

2.1.1 Definition of Fermented Food

Campbell-Platt (1987) has defined fermented foods as those foods which have been subjected to the action of micro-organisms or enzymes so that desirable biochemical changes cause significant modification to the food .However, to the microbiologist, the term "fermentation" describes a form of energy-yielding microbial metabolism in which an organic substrate, usually a carbohydrate, is incompletely oxidized, and an organic carbohydrate acts as the electron acceptor (**Adams, 1990**).

Cereal grains are considered to be one of the most important sources of dietary proteins, carbohydrates, vitamins, minerals and fiber for people all over the world. Fermentation can be defined as a desirable process of biochemical modification of primary food matrix brought about by microorganisms and their enzymes.

Fermentation of cereals leads to a general improvement in the shelf life, texture, taste and aroma, nutritional value and digestibility and significantly lowers the content of anti-nutrients of cereals products. Lactic acid fermentation of cereals is a long-established processing method and is being used in Asia, Africa and other countries for the production of foods in various forms, also fermented food can be defined as foods in which microbial activity plays an essential role in conferring the required stability, safety and sensory properties to the properties to the product.

In Sudan fermentation plays a very important part in food processing and preparation. There are more than 80 different fermented products (**Dirar,**

1993). Most of the staple food is consumed as fermented dishes. Especially meals made of grains are hardly eaten unfermented. Fermentation results in a lower proportion of dry matter in the food and the concentrations of vitamins, minerals and protein appear to increase when measured on a dry weight basis (**Adams, 1990**).

2.2 Wheat

2.2.1 Classification

Kingdom: plantae

Division: Magnoliophyta

Class: Liliopsida

Order: poales

Family: poaceae

Subfamily: pooideae

Tribe: triticeae

Genus: *triticum*

Species:

T.aestium, *T.aethiopicum*, *T.areraticum*, *T.boeoticum*,
T.carthlicum, *T.compactum*, *T.dimitrium*, *T.dicoccoides*,
T.dicoccum, *T.durum*, *T.ispahanicum*, *T.karamyshevii*, *T.macha*,
T.militinae, *T.monococum*, *T.polonicum*, *T.spelta*,
T.sphaerococum, *T.timopheevii*, *T.turanicum*, *T.turgium*,
T.turgivum, *T.urartu*, *T.vaviiiovii*, *T.zhukovsky*.

Wheat is one of the most important crops in the world, and its distribution, cultivation area, and total trade all occupy the first rank of crops. The chemical composition of wheat is related to varieties, cultivation soil, and climate based on geographical origin, so that quality and commercial Value are somewhat different according to their growing conditions (**Wikipedia, 2011**).

2.2.2 Importance, Production and Consumption of Wheat in Sudan

In Sudan wheat has become the stable food of the majority of Sudanese societies than sorghum, and wheat is getting more important as one of the main cereal food (**EL-awad, 1978**).

Wheat consumption in the Sudan has been sharply increasing from about 1052,000 tons in 1990 to 1426,000 million tons consumption (**Ministry of Agriculture and forests, 2005**).

-Wheat in Sudan is grown under irrigation during the dry comparatively cool winter season which extends from November to February. The potential yield is limited by day temperature above 35c at any stage of crop development. The season with acceptable heat limits ranged between 90-110 days (**Ishag and Ageeb 1991**).Wheat production was confined to the northern Sudan along with the Nile bank; the growing area extended southward to the warmer central and Eastern Sudan.

Technologies development and policy strategy help wheat production to increase and follow the growth in wheat consumption.

2.2.3 Wheat Kernel Structure

Wheat kernel is the seed of the plant, has three main parts: the endosperm, the germ, and the bran, while whole wheat flour contains all three parts of the kernel.

The bran contains several layers of protective outer coverings, it comprises 13-17% of the weight of the wheat and the germ composing 2-3% of the wheat kernel.

2.2.4 Wheat composition

The composition of wheat flour varies considerably according to the class of wheat, it's originated the proportion of outer part.

2.2.4.1 Moisture Content

Moisture content is not only of significance but important in regard to its keeping qualities and its behavior on Wheat of very low moisture content is brittle and gives rise percentages of broken kernals

On other hand, wheat of high moisture content (<13.5%) have a tough character. Wheat contains about 14% moisture resulting in ambient relative humidity is suitable to the growth of insects and other microorganisms (**Ishag and Ageeb, 1991**).

2.2.4.2 Ash Content

The ash content of the flour is directly related to the amount of bran particles in the flour. High extraction flour generally has high ash content. Which ensures the presence of minerals that cause the gluten formed to be more tensile.

Zeleny (1971) mentioned that ash content of whole wheat flour ranged between 1.4 and 2% - Ash content of Sudanese wheat cultivars ranged between 1.38 and 1.84%. *Badi et al* (1978) and *Ahmed* (1995) reported that ash content of whole flour of several Sudanese cultivars ranged between (1.03 and 1.24%) . *Mohammed* (2000) showed that ash content

of whole wheat flour of Sudanese cultivars Debaira ,Elneelin , Condor and Saeraib ranged from 1.35 to 1.52%

2.2.4.3 Protein Content

Wheat is considered superior compared to other cereal because of its nutritional value of wheat grain protein. Black man and Payne (1987) reported that wheat is an important source of protein for people of the developing countries.

The endosperm contains about 80percent of the total amount of protein in the whole kernel. Giliadin and Glutanin make up most of this and usually present in equal proportions (internet report, 2001)

A little of the flour protein is soluble in water or salt – water and these kinds of proteins are called albumins and globulines. Galiadin has property, peculiar among proteins, of dissolving in 70% alcohol, where as glutenin is insoluble.

There are certain characteristic properties of gluten which make it suitable for its purpose. It swells and holds water it stretches but in somewhat elastic, and sticky (**Cowley and Howarth , 2006**).

Haldor *et al* (1982) reported that protein content of whole wheat flour ranges between 10 and 16% while **Ahmed (1995)** reported that the protein content of four Sudanese cultivars(Condor, Debera, Elneilein and Nasser) ranges between 8,21and 12,26%.**Mohammed (2000)**showed that the protein content of the whole and white flour of different Sudanese cultivars ranged between 12,5 and 13.85.

2.2.4.4. Fat Content

The germ contains 6-11% lipids, the bran 3-5% and the endosperm 1, 5 % (**kent, 1975**)

The germ is readily separated from the endosperm by milling; it is an important dietary supplement providing a rich source of vitamin E. The fats limits the keeping the quality of wheat flour (**Anon, 1987**).

Abdulla (2002) reported that the fat content of Sudanese cultivars ranges between 2,740 and 2,373.

2.2.4.5 Crude Fiber Protein

Numerous studies have demonstrated the beneficial effects of fiber consumption in protection against heart disease and cancer, normalization of blood lipids, regulation of glucose absorption and insulin secretion and prevention of constipation and diverticular disease (**Sramkova et al 2009**).

Crude fiber consists largely of the cellulose together with a proportion of the lignin and hemicellulose content of the sample (**Egan et al, 1981**). The fiber content increases with the amount of branny matter present. Fiber is the indigestible carbohydrate in food which acts like broom to sweep out the digestive tract.

Egan et al (1981) found that the fiber percentage in whole wheat flour ranges between 1.8 and 2.5% and of white flour (72% extraction rate) ranges between .1 and .3% while **Ahmed (1995)** showed that the fiber content of Sudanese wheat cultivars ranged between 1.72 and 2.34% for whole wheat flour and between 0.30 and 0.48% for white flour (72% extraction rate).

2.2.4.6 Enzymes

Enzymes are biochemical proteins that act as catalysts, meaning that have the ability to instigate chemical changes without themselves being changed.

They are located in the outer layer of the grain kernel; several enzymes are present in wheat what is important in regard to the properties of the flour and its utilization. Wheat flour contains enzymes, including alpha – and beta – amylases, proteases, lipases, phosphatases and oxidases **(Reed and Thorn, 1971)**.

2.2.5 Nutritive Value of Wheat

The nutritional value of wheat is extremely important as it takes an important place among the few crop species being extensively grown as staple food sources. The importance of wheat is mainly due to the fact that its seed can be ground into flour, semolina, etc., which form the basic ingredients of bread and other bakery products, as well as pastas, and thus it presents the main source of nutrients to the most of the world population.**(Sramkova et al 2009)**

Wheat and wheat foods are major sources of nutrients for people in many regions of the world. Although often seem mainly as a source of carbohydrate.

The nutritive value of 100% whole meal is the same as that of wheat because whole meal must contain the whole of the products derived from the milling of clean wheat. Flour of lower extraction rate differs from wheat in nutritive value because of the removal of varying amounts of bran, germ and endosperm containing higher concentration of protein, minerals and vitamins **(Kent, 1975)**.

Increasing proportions of germ tend to be included in the main product when extraction rate rises from 75 to 85% and hence the curve for the vitamin B , which is concentrated mainly in the scutellnm part of the germ , increasing proportion of bran are included at extraction rate between 85 and 100% and hence curves for the fiber (mainly in the pericarp) and nicotinic acid (concentrated in the aleurone layer) tend to decrease below 85% but rise steeply at extraction rate between 85 and 100% (**Kent , 1975**).

The National Research in USA had recommended that Thiamine (vitamin B1) Niacin (Nicotinic Acid) m Riboflavin and Iron , four nutrients conspicuously lacking in the diet could be restored and made available to all income groups by adding them to white flour (**Kent , 1975**).

2.2.6 Wheat Utilization

Close to 80% of world production is consumed in the country in which it is grown .Utilization or disappearance of wheat can break down into four categories food , feed , seed and other (mainly industrial)

Wheat is consumed as food in numerous from all of which involve some degree of processing. Product such as breakfast cereals generally make use of the whole kernel, but the majority of wheat for food is first milled into flour to be used for break, nodules, biscuits, cake ... est., (**Bushuk 1994**).

As feed grain wheat has averaged 104MMT OR 20% of total consumption over the past ten years. Also it is excellent for poultry and is equivalent to corn for many classes of lives stock. The use of wheat for feed tends to be highly variable and is depending on the price relationship between wheat and other feed grains as well as the quality of

the wheat crops in any given years. Also offers wheat to feed farm animals when they are feeding by the economic (**Harlan 1975**).

Other mainly industrial use of wheat account for about 6% of disappearance. This included the processing of wheat into starch and gluten , which had wide range of food and other use such as protein enrichment of flour , binding of strengthening agent in some processed food product and the production of ethyl alcoholic , plastic , vanishes , soup , rubber , cosmetic , ... etc (**Bushuk 1994**.)

2.3 Gergoush

The indigenous fermented foods of the Sudan are numerous and varied. The raw materials from which they are made include conventional sources like sorghum, millet, dates, legumes, etc., as well as non-conventional sources such as wild plants and food leftovers.

Gergoush is one of these traditional fermented foods produced mainly in the Northern States of the Sudan at household level and for family consumption only. It is a snack made from wheat flour and preferably eaten with the early morning tea. No scientific investigations seem to be done on process of Gergoush production (**Sherfi, Hamad 2000**).

There are three steps in the process of Gergoush making. In the first step a starter is prepared from a legume and milk. From the beginning of this step conditions are made selective for the growth of the anaerobic or facultative anaerobic thermotolerant bacteria that naturally contaminate the legume ingredient of Gergoush. This is affected by first boiling milk and then adding the legume to it immediately after removal from fire. About one weight legume, e.g. lentils is added to about three volumes milk in a container. The container is well closed, placed in a warm and dark room and left to ferment for 12 to 15 h. This produces what is

referred to in this study as *the primary starter*. In the second step, the filtrate of the primary starter is used to inoculate wheat flour dough to prepare the adapted starter. The ratio is about one volume filtrate to five weights flour and 4.5 volumes water. The resulting dough is put in a container with a loose cover and left to ferment under the sun for 1 to 2 h. This step can be regarded as an adaptation stage to prepare the bacteria for the dough-raising step, and hence this product is referred to in this study as *the adapted starter*. In the third step the adapted starter is used to raise the final dough in two successive fermentations. In the first fermentation, the adapted starter, wheat flour and water are mixed in a flat container. Salt, cooking oil and spices (mainly the cumin). Are added and the mixture is kneaded into a dough and left to ferment under the sun for about 30 min. In the second fermentation, the dough is moulded into elongated small about 30 g. pieces, put in a tray and left to ferment for another 30 min before bringing into the oven for baking (Sherfi, Hamad 2000).

2.3.1 Preparation of the Starter

The most interesting aspect of Gergoush making is preparation of a special starter called berbassa. Milk is over boiled to a condensed form. Meanwhile, a few beans or seeds of white beans, faba beans or lentils are well washed. The clean legumes are thrown in to the hot milk after the latter has been taken off the fire. The milk, containing the legumes, is placed in a small metal can and, after closing it tightly, the can is buried in a heap of sorghum or wheat grains in a barrel or a sack. The preparation is thus incubated for 15-20 hours. By this time, gaseous fermentation would have taken place.

2.4 Milk

2.4.1 Importance of Milk

Milk is normal product of mammary gland secretion, it is a complex nutritious product, that contains more than 100 substances, that are either in solution, suspension in water (**Oberman,1985**).

2.4.2 Chemical Composition of Milk

The vital factor and health value of milk results from the optimal balance of its component (**Oberman,1985**).

FAO (1997) reported that, the composition of milk varies considerably depending on species, breed, feeding, health status and stage of lactation. The average composition of cow milk reported by **FAO (1997)** was shown in table 1.

Table 1. Average composition (%) of cow milk

Main constituents	Average (%)	Mean (%)
Water	85.5 – 89.5	87.5
Total solids	10.5 – 14.5	12.5
Fat	2.9 – 5	3.9
Protein	1.5 – 6.0	3.8
Lactose	3.6 – 5.5	4.6
Minerals	0.6 – 0.9	0.8

Source: **FAO (1997)**

2.4.3 Nutritive Value of Milk

Milk is an excellent source of high biological value protein because it contains, in varying amounts, all essential amino acids that human body cannot synthesize and in proportion, resembling amino acids requirement. Milk and milk product provide significant amount of protein and most micronutrients ; including : Calcium , B-group vitamins , (particularly riboflavin and B12 , also thiamin , niacin and B6), vitamin A , Iodine , Magnesium , Phosphorus , Potassium and Zinc (**Miller, 2000**).

Although, the salts of milk are quantitatively minor constituents, they are of major significance to its technological properties, specially to the stability and properties of the milks protein system. Milk lipids are considered to be one of the outstanding milk constituents with respect to presence of lipid classes, variety and number of identified fatty acid (**Fox and Mc Weeny , 1998**).

2.5 Lentil

The lentil is one of the most ancient food crops, and has been cultivated since at least 6700 BC in the eastern Mediterranean. The red pottage of lentils for which Esau sold his birthright was probably made from the red Egyptian lentil. A number of different types of lentils are now growing in large areas in warm temperature and subtropical regions, and in the tropics as cool season crop or at high altitudes. (**Tony, 2006**).

2.5.1 Utilization

- Lentils are not only highly containing about 25% protein, 1% fat and 56% carbohydrate; they are also more easily digested than most of the other legumes, and so can be invaluable in emergency feeding programmes. The split seed, known as dhal, is normally

eaten in soups and porridges. Lentils are also a good source of Vitamin A (up to 200IU/100g), Vitamin B₁ and B₂, iron (7mg/10g) and phosphorus.

- The grain is a source of commercial starch, used in textiles and printing.
- The flour can be mixed with cereal flours to make cake or bread, or invalid and baby food.
- The young pods are sometimes eaten a vegetable, in India for example.
- The crop can be grown as a green manure, enriching the soil with Nitrogen and organic matter.
- The straw, or haulm, is a very nutritious animal food, being richer in proteins and lower in fiber than other legumes. **(Tony, 2006)**

CHAPTER THREE

3. MATERIALS AND METHODS

3.1 Materials

Lentils, wheat flour, cow milk and spices (Canella, Cardamom and Cumin) used in this work were purchased from the local market in Khartoum.

3.2.Methods

3.2.1Gergoush processing method and recipe

There are three steps in the process of Gergoush making Fig. (1) In the first step a starter is prepared from a legume and milk. From the beginning of this step conditions are made selective for the growth of the anaerobic or facultative anaerobic thermotolerant bacteria that naturally contaminate the legume ingredient of gergoush. and then adding the legume to the boiled milk immediately after removal from fire. About one weight legume, e.g. lentils is added to about three volumes milk in a container. The container is well closed, placed in a warm and dark room and left to ferment for 12 to 15 h. This produces what is referred to as the primary starter. In the second step, the filtrate of the primary starter is used to inoculate a wheat flour dough to prepare the adapted starter. The ratio is about one volume filtrate to five weights flour and 4.5 volumes water. The resulting dough is put in a container with a loose cover and left to ferment under the sun for 1 to 2 h. This step can be regarded as an adaptation stage to prepare the bacteria for the dough-raising step, and hence this product is referred to as the adapted starter. In the third step the adapted starter is used to raise the final dough in two successive fermentations. In the first fermentation, the adapted starter, wheat flour and water are mixed in a flat container. Salt, cooking oil and spices (mainly the cumin) are added and the mixture is kneaded into a dough and left to ferment under the sun for

about 30 min. In the second fermentation, the dough is moulded into elongated pieces, put in a tray and left to ferment for another 30 min before bringing into the oven for baking.

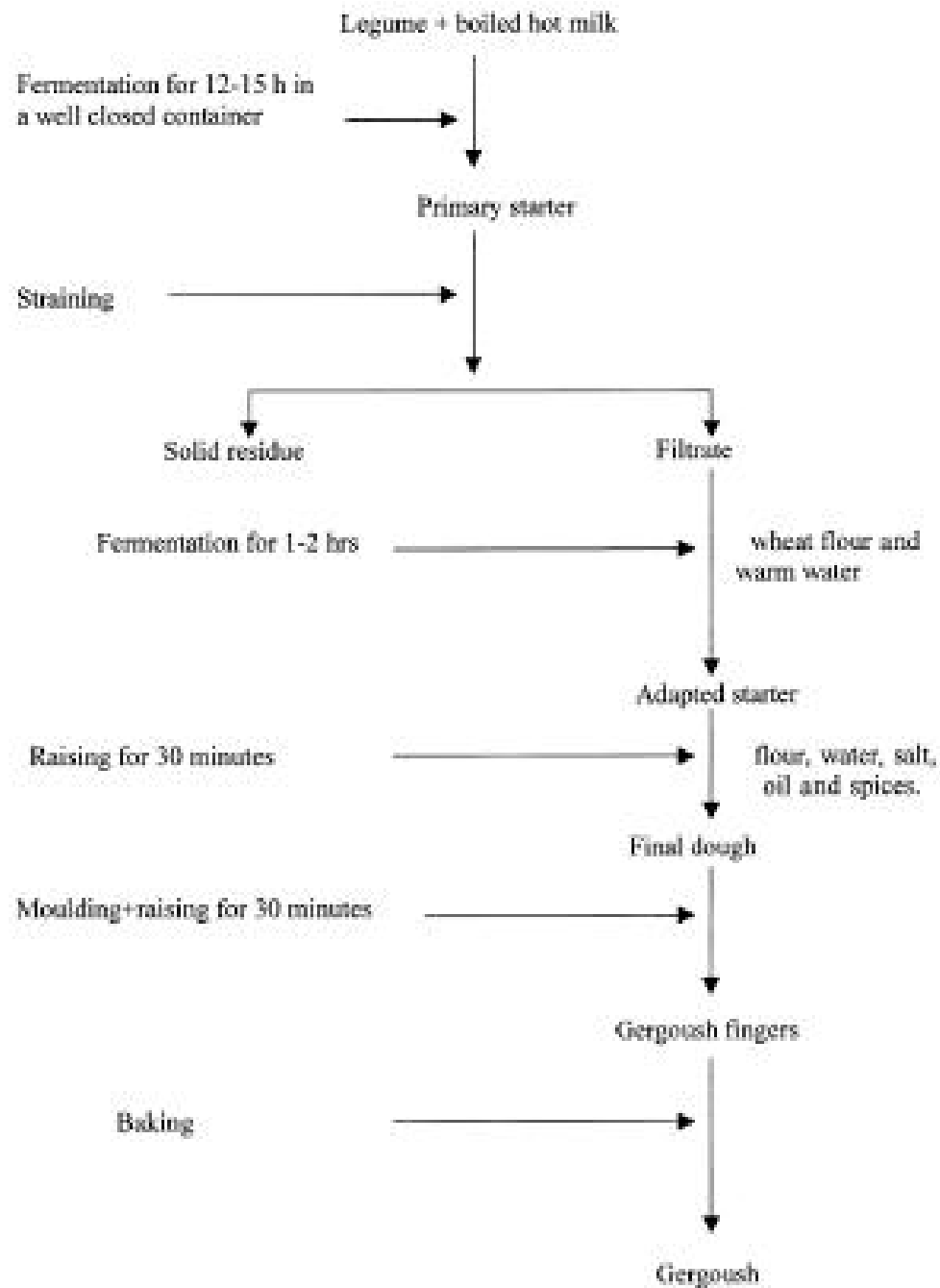


Fig.1. Flow diagram for the process of Gergoush-making



Plate (1): Gergoush starter



Plate (2): the final product of Gergoush

3.2.2 Proximate chemical analysis

3.2.2.1 Moisture content

The moisture content was determined according to the standard method of the Association of Official Analytical Chemists (**AOAC, 2003**).

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

Procedure: A sample of 2 g ±1 mg was weighed into a pre-dried and tarred dish. Then, the sample was placed into an oven (No.03-822, FN 400, Turkey) at 105 ± 1 °C until a constant weight was obtained. After drying, the covered sample was transferred to desiccators and cooled to room temperature before reweighing. Triplicate results were obtained for each sample and the mean value was reported to two decimal points according to the following formula:

Calculation

$$\text{Moisture content (\%)} = \frac{(\text{Ws} - \text{Wd})}{\text{Sample weight (g)}} \times 100\%$$

Where:

Ws = weight of sample before drying.

Wd = weight of sample after drying.

3.2.2.2 Crude protein content

The protein content was determined in all samples by micro-

Kjeldahl method using a copper sulphate-sodium sulphate catalyst according to the official method of the **AOAC (2003)**.

Principle: The method consists of sample oxidation and conversion of its nitrogen to ammonia, which reacts with the excess amount of sulphuric acid forming ammonium sulphate. After that, the solution was made alkaline and the ammonia was 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). The protein content is calculated by multiplying the total N % by 6.25 as a conversion factor for protein.

Procedure: A sample of two grams (2 gm) was accurately weighed and transferred together with, 4g NaSO₄ of Kjeldahl catalysts (No. 0665, Scharlauchemie, Spain) and 25 ml of concentrated sulphuric acid (No.0548111, HDWIC, India) into a Kjeldahl digestion flask. After that, the flask was placed into a Kjeldahl digestion unit (No.4071477, type KI 26, Gerhardt, Germany) for about 2 hours until a colorless digest was obtained and the flask was left to cool to room temperature.

The distillation of ammonia was carried out into 25ml boric acid (2%) by using 20 ml sodium hydroxide solution (45%). Finally, the distillate was titrated with standard solution of HCl (0.1N) in the presence of 2-3 drops of bromocresol green and methyl red as an indicator until a brown reddish color was observed.

Calculation

$$\text{Crude Protein (\%)} = \frac{(\text{ml Hcl sample} - \text{ml Hcl blank}) \times N \times 14.00 \times F}{\text{Sample weight (g)} \times 1000} \times 100\%$$

Where:

N: normality of HCl.

F: protein conversion factor = 6.25

3.2.2.3 Fat content

Fat content was determined according to the official method of the **AOAC (2003)**.

Principle: The method determines the substances which-are soluble in petroleum ether (65-70 °C) and extractable under the specific conditions of Soxhlet extraction method. Then, the dried ether extract (fat content) is weighed and reported as a percentage based on the initial weight of the sample.

Procedure: A sample of $5\text{g} \pm 1\text{ mg}$ was weighed into an extraction thimble and covered with cotton that previously extracted with hexane (No.9-16-24/25-29-51, LOBA Cheme, India). Then, the sample and a pre-dried and weighed extraction flask containing about 100 ml hexanes were attached to the extraction unit (Electrothermal, England) and the extraction process was conducted for 6 hrs. At the end of the extraction period, the flask was disconnected from the unit and the solvent was redistilled. Later, the flask with the remaining crude ether extract was put in an oven at 105 °C for 3 hrs , cooled to room temperature in a desiccators, reweighed and the dried extract was registered as fat content according to the following formula;

Calculation

$$\text{Fat content (\%)} = \frac{(W_2 - W_1) \times 100}{W_3} \%$$

Where;

W_2 =Weight of the flask and ether extract

W_1 =Weight of the empty flask

W_3 =initial weight of the sample

3.2.2.4 Crude fiber content

The crude fiber was determined according to the official method of the AOAC (2003). **Principle:** The crude fiber is determined gravimetrically after the sample is being chemically digested in chemical solutions. The weight of the residue after ignition is then corrected for ash content and is considered as a crude fiber.

Procedure: About $2\text{g} \pm 1\text{ mg}$ of a defatted sample was placed into a conical flask containing 200 ml of H_2SO_4 (0.26 N). 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 porcelain filter crucible (No.3). After that, the precipitate was repeatedly rinsed with distilled boiled water followed by boiling in 200 ml NaOH (0.23 N) solution for 30 minutes under reflux condenser and the precipitate was filtered, rinsed with hot distilled water, 20ml ethyl alcohol (96%) and 20 ml diethyl ether.

Finally, the crucible was dried at 105°C (overnight) to a constant weight, cooled, weighed, ashed in a Muffle furnace (No.20. 301870, Carbolite, England) at $550\text{-}600^\circ\text{C}$ until a constant weight was obtained and the difference in weight was considered as crude fiber.

Calculation

$$\text{Crude fiber (\%)} = \frac{(\text{W1} - \text{W2})}{\text{Sample weight (g)}} \times 100\%$$

Where:

W_1 = weight of sample before ignition (g).

W_2 = weight of sample after ignition (g).

3.2.2.5 Ash content

The ash content was determined according to the method described by the **AOAC (2003)**.

Principle: The inorganic materials which are varying in concentration and composition are customary determined as a residue after being ignited at a specified heat degree.

Procedure: A sample of $5g \pm 1$ mg was weighed into a pre-heated, cooled, weighed and tarred porcelain crucible and placed into a Muffle furnace (No.20. 301870, Carbolite, England) at 550 to 600 °C until a white gray ash was obtained. The crucible was transferred to a desiccator, allowed to cool to room temperature and weighed. After that, the ash content was calculated as a percentage based on the initial weight of the sample.

Calculation:

Ash (%) = $\frac{[(\text{Wt of crucible + Ash}) - (\text{Wt of empty crucible})]}{\text{Initial weight (Wt)}} \times 100 \%$

Initial weight (Wt)

3.2.2.6 Minerals content

Ten milliliters (10 ml) of HCL (2N) were added to the remaining ash sample and placed in a hot sand bath for about 10-15 min. Then, the sample was diluted to 100 ml in a volumetric flask and filtered. Sodium (Na) and potassium (K) were determined by using Flame Photometer

(Model PEP7 JENWAY). While, calcium (Ca), magnesium (Mg) and Iron (Fe) were determined as described by **Chapman and pratt (1961)**.

3.2.3 Sensory Evaluation

The evaluation of sensory properties and consumer acceptance was done by 15 panelists (8 female, 7 male), their ages were ranged between 18-36 years. Including students from Sudan University of Science and Technology and trained panelist from National Food Research Center. The evaluation was done for five sensory properties which were:

Colour, Flavour, Taste, Texture and General acceptability. using the following scales : 1= excellent, 2= very good, 3= good. 4= acceptable, 5= poor in quality.

3.2.4 Statistical analysis

The results were subjected to Statistical Analysis System (SAS) by using One-Factor Analysis of Variance (ANOVA). The Mean values were also tested and separated by using Duncan's Multiple Range Test (DMRT) as described by **Steel, *et. al.* (1997)**.

CHAPTER FOUR

4. RESULTS AND DISCUSSION

4.1 Proximate chemical composition of Gergoush

4.1.1 Moisture

Table (2) shows the moisture content of Gergoush. From the table the results of moisture content of traditional Gergoush , Gergoush from local market-1 and Gergoush from local market-2 were 10.48% , 5.64% and 10.53 % , respectively . **Joel *et al.* (2014)** reported that the moisture content of cookies was 9.85%. This result was in agreement with traditional Gergoush and Gergoush from local market-2, while in disagreement with Gergoush from local market-1. These variations may be due to the differences of the added ingredients or conditions of storage.

4.1.2. Crude protein

Table (2) shows the protein content of Gergoush. From the table the results of protein content of traditional Gergoush , Gergoush from local market-1 and Gergoush from local market-2 were 10.79% , 8.30% and 10.54 % , respectively. **Joel *et al.* (2014)** reported that the protein content of cookies was 8.75%. This result was in agreement with Gergoush from local market-1, while in disagreement with traditional Gergoush and Gergoush from local market-2. These variation may be due to the differences of added ingredients.

4.1.3. Fat content

Table (2) shows the fat content of Gergoush. From the table the results of fat content of traditional Gergoush , Gergoush from local market-1 and Gergoush from local market-2 were 10.99% , 7.77% and 9.28 % ,

respectively. **Joel et al. (2014)** reported that the fat content of cookies was 4.50%. This result was in disagreement with traditional Gergoush, Gergoush from local market-1 and Gergoush from local market-2. These variation may be due to the quantity of added oil.

4.1.4. Ash content

Table (2) shows the ash content of Gergoush. From the table the results of ash content of traditional Gergoush , Gergoush from local market-1 and Gergoush from local market-2 were 1.133% , 0.967% and 1.000 % , respectively. **Joel et al. (2014)** reported that the ash content of cookies was 2.1%. This result was in disagreement with traditional Gergoush, Gergoush from local market-1 and Gergoush from local market-2. These variation may be due to the differences of type of wheat.

4.1.5. Crude fiber content

Table (2) shows the fiber content of Gergoush. From the table the results of fiber content of traditional Gergoush , Gergoush from local market-1 and Gergoush from local market-2 were 4.87% , 2.67% and 0.933 % , respectively. **Joel et al. (2014)** reported that the ash content of cookies was 3.29%. This result was in disagreement with traditional Gergoush, Gergoush from local market-1 and Gergoush from local market-2. These variation may be due to the differences of added ingredients.

Table (2): Proximate composition of Gergoush samples

Parameter (%)	Samples			Lsd _{0.05}	SE±
	A	B	C		
Moisture content	10.48 ^a ±1.28	5.64 ^b ±0.03	10.53 ^a ±0.66	1.664 ^{**}	0.481
Crude protein	10.79 ^a ±0.06	8.30 ^c ±0.01	10.54 ^b ±0.14	0.1672 ^{**}	0.0483
Fat content	10.99 ^a ±0.50	7.77 ^c ±0.71	9.28 ^b ±0.14	1.007 ^{**}	0.291
Ash content	1.133 ^a ±0.06	0.967 ^a ±0.06	1.000 ^a ±0.10	0.1548 ^{ns}	0.04472
Crude fiber	4.87 ^a ±0.21	2.67 ^b ±0.15	0.933 ^c ±0.12	0.3283 ^{**}	0.09487

Values are mean±SD

Mean(s) having different superscript(s) in a row are significantly different (P≤0.05) according to DMRT

Key

A = Traditional Gergoush prepared from milk and lentil

B = Commercial Gergoush obtained from local market-1

C = Commercial Gergoush from local market-2

4.2. Minerals content of Gergoush sample

4.2.1. Ca

Table (3) shows the calcium content of Gergoush. From the table the results of calcium content of traditional Gergoush , Gergoush from local market-1 and Gergoush from local market-2 were 38.20 , 20.60 and 20.30 mg/100g, respectively . These results were in disagreement with those reported by **Joel *et al.* (2014)**. Who reported that the calcium content of cookies was 30.48mg/100g. These variation may be due to the differences of added ingredient (milk) and the use of whole wheat.

4.2.2. Mg

Table (3) shows the magnesium content of Gergoush. From the table the results of magnesium content of traditional Gergoush , Gergoush from local market-1 and Gergoush from local market-2 were 29.37 , 22.20 and 20.90 mg/100g, respectively . These results were disagreement with those reported by **Joel *et al.* (2014)**. Who reported that the magnesium content of cookies was 31.21mg/100g. These variation may be due to the type of wheat.

4.2.3. Na

Table (3) shows the sodium content of Gergoush. From the table the results of sodium content of traditional Gergoush , Gergoush from local market-1 and Gergoush from local market-2 were 2.00 , 1.80 and 1.72 mg/100g, respectively . These results were in agreement with those reported by **Joel *et al.* (2014)**. Who reported that the sodium content of cookies was 1.98mg/100g.

4.2.4. K

Table (3) shows the potassium content of Gergoush. From the table the results of potassium content of traditional Gergoush , Gergoush from local market-1 and Gergoush from local market-2 were 440.52 , 350.75 and 348.00 mg/100g, respectively . These results were in disagreement with those reported by **Joel *et al.* (2014)**. Who reported that the potassium content of cookies was 412.47mg/100g. These variation may be due to the differences of added ingredients.

4.2.5. Fe

Table (3) shows the iron content of Gergoush. From the table the results of iron content of traditional Gergoush , Gergoush from local market-1 and Gergoush from local market-2 were 2.73 , 1.63 and 1.87mg/100g, respectively . These results were in disagreement with those reported by **Joel *et al.* (2014)**. Who reported that the iron content of cookies was 2.10mg/100g. These variation may be due to the differences of added ingredients (lentil).

Table (3): Minerals content of Gergoush samples

Mineral (mg/100g)	Samples			Lsd_{0.05}	SE_±
	A	B	C		
Calcium-Ca	38.20 ^a ±0.17	20.60 ^b ±0.00	20.30 ^b ±0.00	0.1998 ^{**}	0.05774
Magnesium-Mg	29.37 ^a ±0.06	22.20 ^b ±0.00	20.90 ^c ±0.00	0.06318 ^{**}	0.01826
Sodium-Na	2.00 ^a ±0.00	1.80 ^b ±0.00	1.72 ^b ±0.00	0.0006318 ^{**}	0.0001826
Potassium-K	440.52 ^a ±0.00	351.75 ^b ±0.00	348.91 ^c ±0.00	0.0006318 ^{**}	0.0001826
Iron-Fe	2.73 ^a ±0.00	1.63 ^b ±0.00	1.87 ^b ±0.00	0.0006318 ^{**}	0.0001826

Values are mean±SD

Mean(s) having different superscript(s) in a row are significantly different (P≤0.05) according to DMRT

Key

A = Traditional Gergoush prepared from milk and lentil

B = Commercial Gergoush obtained from local market-1

C = Commercial Gergoush from local market-2

4.3. Sensory evaluation of Gergoush

Table (4) shows the sensory evaluation of Gergoush, samples. From the color of the sample (A) has a good degree of acceptance by the panelist then the sample (B) and (C). Concerning the flavor the sample (B) then (A) and (C) and the taste sample (A) then (B) and (C) while the texture the sample (A) then (C) and (B).

The general acceptability according to the panelist has been given to the sample (A) and (B) then (C).

Table (4): Sensory Evaluation of Gergoush samples

Quality attributes (scores)	Samples			Lsd _{0.05}	SE±
	A	B	C		
Colour	3.33 ^a ±0.98	1.93 ^b ±0.96	1.87 ^b ±0.64	0.6433 ^{**}	0.2254
Flavour	2.87 ^a ±1.13	3.00 ^a ±1.31	1.87 ^b ±0.92	0.8314 [*]	0.2913
Taste	2.73 ^a ±1.03	2.53 ^a ±1.06	2.00 ^a ±0.93	0.7428 ^{ns}	0.2603
Texture	3.20 ^a ±0.94	2.60 ^a ±1.24	2.73 ^a ±1.22	0.8428 ^{ns}	0.2953
General acceptability	2.73 ^a ±1.10	2.73 ^a ±1.22	2.07 ^a ±0.70	0.7612 ^{ns}	0.2667

Values are mean±SD

Mean(s) having different superscript(s) in a row are significantly different (P≤0.05) according to DMRT

Key

A = Traditional Gergoush prepared from milk and lentil

B = Commercial Gergoush obtained from local market-1

C = Commercial Gergoush from local market-2

CHAPTER FIVE

5. CONCLUSION AND RECOMMENDATIONS

5.1. Conclusion

From the results obtained in this study it can be concluded that traditionally processed Gergoush has high nutritive value and appreciable amount of Ca, Mg, Na, K, and Fe and highly accepted by the panelists in comparison with the commercially processed Gergoush.

5.2. Recommendations

1. To use whole wheat flour in the production of commercially processed Gergoush.
2. To use natural adequate fortifiers such as lentil and milk for making Gergoush.
3. Further researches are needed.

References

- Abdallah, A. M. A, (2002).** Characterization and utilization millet wet – milling protein in bread system. M. Sc. Thesis, Fac. Of Agric., University of Khartoum, sudan.
- Adams, M. R. (1990).** Topical aspects of fermented foods. Trends in food science and technology 1, 141- 144.
- Ahmed, E. S. (1995).** Proximate composition and flour quality of wheat cultivars grown in the sudan. M. Sc. Thesis, Fac. Of Agric, university of Khartoum, sudan.
- Akhtar S, Anjum F, Rehman S, Sheikh M and Farzena K. (2008).** Effect of fortification on the physico-chemical and microbiological stability of whole wheat flour. *Food Chem.*, 112:156-163
- Anon(1987).** Wheat Facts. In "official publication of the National Association of Wheat Growers" 10:7.
- AOAC (2003).** Association of Official Analytical Chemists. Official Methods of Analysis, 17th ed., Arlington, Virginia, USA.
- Badi, S:M; EL Faki , H.A. and perten, H (1978).** Evaluation of Sudanese wheat Varieties , sud . J . Fd .sci . Technol ., 10:50.
- Black man, J. A. and payne, p. l. (1987).** In "wheat Breeding its scientific Bases". Lupton. F. G. H. (ed). PP 455-465 chap man an Hall. London.
- Bakke A and Vickers Z. (2007).** Consumer liking of refined and whole wheat breads. *J. Food Sci.* 72: 473-480.

Bushuk, w. and Hlyka,l. (1994). Water as a constituent of flour, dough and bread. Baker's Dig., 38(6):43.

Campbell –platt, G. (1987). Fermented foods of the world – a dictionary and guide. London,England.

Cawley, R. W. and Howarth, D. T. (2006). The wheat industry,. [http : // www. Nzic. Org. nz/ chem. Processes / food/ 6c. pdf.](http://www.Nzic.Org.nz/chem.Processes/food/6c.pdf)

Dirar. H.D (1993). The Indigenous Foods of The Sudan . Astudy in African Food and Nutrition . Faculty of Agriculture . University of Khartoum. Sudan

Egan, H; kirik, R. and sawyer, (1981). Person's chemical analysis of food. 8th edition. Long man Scientific and Technical, London.

Elawad, F.A. (1987) The story of raria yoghurt. Paper presented at the UNESCO Regional Traning Course on Fermented Food in Arab World. Food Research Centre, shampat, Sudan.

FAO, (1997). Milk testing and quality control. Milk Processing Guide Rome, Italy. 2: 2.

FAO/WHO/UNU Expert Consultation (1994). Food Nutrients Requirements, Report of a Joint FAO/WHO/UNU Expert Consultation. World Health Organization Technical Report Series 724. Geneva: WHO

Fox,P.F. and McSweeney, P.L.H.(1998)Dairy chemistry and Biochemistry. Blackie academic and professional imprint of chapman and Hall,London.

Haldor, H.; Norman, E. B. and Anderson, R. G (1982). Wheat in the third world. Werlevleur press, Boudier, colorado.

Harlan, J.R., DeWet, J.M.J. and Stemler, A. (1975) Plant domestication and indigenous African agriculture. In: Harlan, J.R., DeWet, J.M.J. and Stemler, A.B.L. (eds). *Origins of African Plant Domestication*. Mouton Publishers, the Hague, Paris, pp.3-19.

Internet report. (2001). Wheat and Grain flours. [http // media – wiley. Com/ product – data / excerpt / 69/ 0471405469 – pdf.](http://media-wiley.com/product-data/excerpt/69/0471405469.pdf)

Ishag, H. M. and Ageeb, O. A. (1991). The physiology of grain yield wheat in an irrigated tropical environment., 27:71-77.

Kent, N. L. (1975). Technology of cereals with special reference to wheat, 2nd edition. Publication of Pergamon Press Ltd.

Mannay S, Shadaksharaswamy C.M (2005). Foods: Facts and Principles. (2nd ed.). New Age International Ltd. Publishers. New Delhi, India.

Miller, G.D. (2000). Hand book of Dairy Nutrition. New York. C.R.C. Press. U.S.A

Ministry of Agriculture and Forests (2005). Khartoum . Sudan..

Mohammed, E.A (2000). Evaluation of four local wheat cultivars with special emphasis on protein fractions, M. Sc. Thesis, Fac. Of Agric university of Khartoum, Sudan.

Nadife, J. Kida, F . and Fegbmi, S. (2014). Production and quality assessment of enriched cookies from whole wheat and full fatsoya. European Journal of Food Science and Technology. Nigeria.

Oberman, H. (1985). Fermented milks. In: Microbiology of fermented foods. Vol. (1) Edited by Wood, B.J.B. Elsevier Applied Science publishers, London.; pp. 167-195.

Potter N, Hotchkiss J (2006). Food Science. 5th ed. CBS Publishers and Distributors. Daryangaji, New Delhi, India

Reed, G. and Thom, J. A. (1971). Enzymes. In:Wheat chemistry and technology. 2nd ed. Vol. 3. Y. Pomeranz, Ed. Am, Assoc. cereal Chem. St. Paul, MN. Pages 453-491.

Sherfi, S, A, and Hamad, S, H. (2000). International Journal of food Microbiology. Faculty of agriculture, University of Khartoum, Khartoum, sudan.

Sramkova. Z, Gregova.E. and Sturdic. E. (2009). Chemical composition and nutritional quality of wheat grain.

Steel, R. D. G; Torrie, T. H. and Dickey, D. A. (1997). Principles and Procedures of Statistics: In : A Biometrical Aproach. 3rd ed., Published by McGraw- Hill, New York, USA, P. 666.

Tony.W. (2006). Growing food, Aguide to food production. Harfard. Uk.

WWWwikipedia.com(2011)

Zeleny, L. (1971) In : Wheat chem.. Andtch, promeranz, Y. (ed). 2^{ed} Edition pp 19-40. Am, ASSOC of cereal chem.

Zhu D, Hettiarachchy N, Horax R and Chen P (2005). Isoflavone contents in germinated soybean seeds. *Plant Foods Hum. Nutr.*, 60: 147-151.

Appendices

