بسم الله الرحمن الرحيم

SUDAN UNIVERSITY OF SCINCE AND TECHNOLOGY

COLLEGE OF AGRICULTURAL STUDIES

DEPARTMENT OF FOOD SCIENCE AND TECHNOLOGY

Supplementation of Bread Flour by Moringa Leave (*moringaoleifera)*

A Dissertation Submitted to Sudan University of Science

and Technology in Partial Fulfillment for the Degree of

B.SC. in Food Science and Technology.

By

Hadeel Dafallah Hamed

Heba Ahmed Abass

Magdolin Hassan Mohamed

Supervisor:

Dr. MahaFadul Mohammed

Department of Food Science and Technology

College of Agricultural Studies

Sudan University of Science and Technology

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DEDICATION

To our family's,

friends

and teachers…..

With respect and love.

ACKNOWLEDGEMENTS

We deeply appreciate our supervisor **Dr. Maha Fadul** for her continuous assistance, valuable advices, patience and encouragement throughout the duration of our study.

Our thanks and appreciations are extended to Department of food Science and Technology , College of Agricultural Studies and Sudan University of Science and Technology . Also ~~thanksextended~~thanks extended to Department of cereal in the Food Research Centre .

Also I wish to thank Mr. Babiker , Mr.Algiely and Mr. Ehab, ~~forsupporting~~for supporting me throughout the study .

We would like to thank our parents, for their continuous encouragement and assistance.

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List of Contents

Content **Page No.**

DEDICATION I
ACKNOWLEDGEMENTS II
List of Contents III
List of Tables .... VIII~~VI~~
List of Figures .... IX~~VII~~
List of Plates .... XI~~VIII~~
English Abstract .... XII~~IX~~
Arab Abstract .... XIII~~X~~
CHAPTER ONE 1
INTRODUCTION 1
CHAPTER TWO 3
LITERATURE REVIEW 3
2.1 Importance of Cereals 3
2.2 Wheat Classification 3
2.2.1 Hard Red Spring Wheat 4
2.2.2 Hard Red Winter Wheat 4
2.2.3 Soft Red Winter Wheat 4
2.2.4 Durum Wheat 4
2.2.5 White Wheat 4
2.3 Nutrition Value of Wheat 5
2.4 Importance and use of wheat in the world 5
2.5 Importance, production and consumption of wheat in Sudan 6
2.6 Wheat kernel structure .... 7~~6~~
2.7 Wheat composition 7

Formatted: No underline, Font color: Auto

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2.7.1 Moisture content 7
2.7.2 Ash content 7
2.7.3 Protein content 7
2.7.4 Fat content...8
2.7.5 Crude fiber content 8
2.8 Botanical Description and Background of MoringaOleifera Trees8
2.9 History Background of moringa 13
2.10 Etymology of moringa: 13
2.11 Developing the moringa value chain in Sudan: 13
2.12 Nutritional value of Moringa tree 14
2.13 A cornucopia of vitamins, minerals and proteins 15
2.14 Traditional Uses of moringa: 16
2.15 Modern Uses of moringa..17
2.16 Harvesting of Moringa 17
2.17 Bread 17
CHAPTER THREE 18
MATERIALS AND METHODS..18
3.1 Materials:..18
3.2 Methods:..18
3.2.1Preparation of moringaleave powder 18
3.2.2 Blends of moringa leave powder and Wheat Flour: 18
3.3 Making of bread...18
3.4 Analytical Methods..19
3.4.1 Proximate Composition...19
3.4.1.1Moisture content 19
3.4.1.2 Ash content 20
3.4.1.3 Oil content.. 21~~20~~
3.4.1.4 Protein 21
3.4.1.5 Carbohydrate..22

3.5Farinograph 22
3.6 Extensograph..23
3.7 Bread Weight ....24~~23~~
3.8 Bread Volume ....24~~23~~
3.9 Bread Specific Volume 24
3.10 Sensory Evaluation of Loaf Bread 24
3.11Statistical Analysis 24
CHAPTER FOUR..25
RESULTS AND DISCUSSION 25
4.1 Chemical composition of wheat flour, Moringaoleifera leaves powder: 25
4.1.1 Moisture Content 25
4.1.2 Ash Content ....26~~25~~
4.1.3 Protein Content 26
4.1.4 Fat Content ....27~~26~~
4.1.5 Crude fibrecontent 27
4.1.6 Carbohydrates Content 27
4.2 Farinograph Results...30~~29~~
4.5 Extensograph results...37~~36~~
4.6 Bread Specific Volume ....41~~40~~
4.7 Sensory Evaluation:..44~~43~~
CHAPTER FIVE ....46~~45~~
CONCLUSION AND RECOMMENDATIONS ....46~~45~~
5.1 Conclusion...46~~45~~
5.2 Recommendations ....46~~45~~
REFRENCES ....47~~46~~
~~DEDICATION~~..
~~ACKNOWLEDGEMENTS~~..
~~List of Contents~~...
~~List of Tables~~ ....

~~List of Figures~~ ....
~~List of Plates~~ ....
~~English Abstract~~ ....
~~Arab Abstract~~ ....
~~CHAPTER ONE~~ .... ~~1~~
~~INTRODUCTION~~ .... ~~1~~
~~CHAPTER TWO~~ .... ~~3~~
~~LITERATURE REVIEW~~ .... ~~3~~
~~2.1 Importance of Cereals~~ .... ~~3~~
~~2.3 Wheat Classification~~ .... ~~3~~
~~2.3.1 Hard Red Spring Wheat~~ .... ~~4~~
~~2.3.2 Hard Red Winter Wheat~~ .... ~~4~~
~~2.3.3 Soft Red Winter Wheat~~ .... ~~4~~
~~2.3.4 Durum Wheat~~ .... ~~4~~
~~2.3.5 White Wheat~~ .... ~~4~~
~~2.2 Nutrition Value of Wheat~~ .... ~~5~~
~~2.4 Importance and use of wheat in the world~~ .... ~~5~~
~~2.5 Importance, production and consumption of wheat in Sudan~~ .... ~~6~~
~~2.6 Wheat kernel structure~~ .... ~~6~~
~~2.7 Wheat composition~~ .... ~~7~~
~~2.7.1 Moisture content~~ .... ~~7~~
~~2.7.2Ash content~~ .... ~~7~~
~~2.7.3 Protein content~~ .... ~~7~~
~~2.7.4 Fat content~~ .... ~~8~~
~~2.7.5 Crude fiber content~~ .... ~~8~~
~~2.8 Botanical Description and Background of MoringaOleifera Trees~~ .... ~~8~~
~~2.9 History Background of moringa~~ .... ~~13~~
~~2.10 Etymology of moringa:~~ .... ~~13~~
~~2.11 Developing the moringa value chain in Sudan:~~ .... ~~13~~
~~2.12 Nutritional value of Moringa tree~~ .... ~~14~~

~~2.13 A cornucopia of vitamins, minerals and proteins......15~~

~~2.14 Traditional Uses of moringa:......16~~

~~2.15 Modern Uses of moringa......17~~

~~2.16 Harvesting of Moringa......17~~

~~2.17 Bread......17~~

~~CHAPTER THREE......18~~

~~MATERIALS AND METHODS......18~~

~~3.1 Materials:......18~~

~~3.2 Methods:......18~~

~~3.2.1Preparation of moringaleave powder......18~~

~~3.2.2 Blends of moringa leave powder and Wheat Flour:......18~~

~~3.3 Making of bread......18~~

~~3.4 Analytical Methods......19~~

~~3.4.1 Proximate Composition......19~~

~~3.4.1.1Moisture content......19~~

~~3.4.1.2 Ash content......20~~

~~3.4.1.3 Oil content......21~~

~~3.4.1.4 Protein......21~~

~~3.4.1.5 Carbohydrate......22~~

~~3.5 Farinograph......22~~

~~3.6 Extensograph......23~~

~~3.7 Bread Weight......23~~

~~3.8 Bread Volume......24~~

~~3.9 Bread Specific Volume......24~~

~~3.10 Sensory Evaluation of Loaf Bread......24~~

~~3.11 Statistical Analysis......24~~

~~CHAPTER FOUR......25~~

~~RESULTS AND DISCUSSION......25~~

~~4.1 Chemical composition of wheat flour, Moringaoleifera leaves powder:......25~~

~~4.1.1 Moisture Content~~ .... ~~25~~
~~4.1.2 Ash Content~~ .... ~~25~~
~~4.1.3 Protein Content~~ .... ~~26~~
~~4.1.4 Fat Content~~ .... ~~26~~
~~4.1.5 Crude fibrecontent~~ .... ~~27~~
~~4.1.6 Carbohydrates Content~~ .... ~~27~~
~~4.2 Farinograph Results~~ .... ~~29~~
~~4.5 Extensograph results~~ .... ~~36~~
~~4.6 Bread Specific Volume~~ .... ~~40~~
~~4.7 Sensory Evaluation:~~ .... ~~43~~
~~CHAPTER FIVE~~ .... ~~45~~
~~CONCLUSION AND RECOMMENDATIONS~~ .... ~~45~~
~~5.1 Conclusion~~ .... ~~45~~
~~5.2 Recommendations~~ .... ~~45~~
~~REFRENCES~~ .... ~~46~~

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List of Tables

Title. ____ **Page No.**

Table 4.1: Chemical Composition of Wheat Flour and Moringa Leaves Powder Blends .... 29~~2828~~
Table 4.2: Farinograph redangs of bread flour blends .... 31~~3030~~
Table 4. 3: Extensograph of bread samples .... 38~~3737~~
Table 4.4: Specific volume of bread sample: .... 41~~4040~~
Table 4.5: Sensory Evaluation .... 44~~4343~~

List of Figures

Title. Page No.

Fig. 1: Water absorption (corrected for 500 FU) of bread samples.............. 32~~31~~
Fig. 2: Water absorption (corrected to 14.0%) of bread samples................. 32~~31~~
Fig. 3: Development time of bread samples.. 33~~32~~
Fig. 4: Stability of bread samples .... 33~~32~~
Fig. 5: Degree of softening (10 min after begin) of bread samples.............. 34~~33~~
Fig. 6: Farinograph quality number of bread samples .... 34~~33~~
Fig. 7 :Farinogrph of dough prepared from control wheat flour .... 35~~34~~
Fig. 8: Farinogram of dough prepared from10% Morenga leaves powder... 35~~34~~

Fig. 9: Farinogram of dough prepared from20%Morenga leaves powder.... 36~~35~~
Fig. 10: Farinogram of dough prepared from30%Morenga leaves powder.. 36~~35~~
Fig. 11: Extensogram of dough prepared from control wheat flour............. 39~~38~~
Fig. 12: Extensogram of dough prepared from10%Morenga leaves powder 39~~38~~
Fig. 13: Extensogram of dough prepared from20%Morenga leaves powder 40~~39~~
Fig. 14: Extensogram of dough prepared from30%Morenga leaves powder 40~~39~~
Fig. 15: Specific volume cm3/g of bread samples .... 42~~41~~
Fig. 16: Organoleptic Quality of Bread Samples... 45~~44~~

List of Plates

Title. **Page No.**

Plate 1: Moringa Tree 10
Plate 2: Moringa Pods..11
Plate 3: Moringa seeds...11
Plate 4: Moringa leaves 12
Plate 5: Moringa leaves Powder 12
Plate 6: Bread samples containing moringa leaves powder. .... 43~~42~~

English Abstract

This study was carried out to evaluate the effect of supplementation with different levels of moringa leaves powder (10, 20, 30%) on rheological properties of wheat dough and nutritional quality of bread. Proximate composition of moringa leaves, gluten quality and falling number of wheat flour were determined. Moreover, the rheological quality of different formulation of moringa supplemented dough and nutritional quality of the produced bread were also determined.

Supplementation with moringa leaves improved the properties of wheat flour, particularly, water absorption and gluten quality. However, there were decreases in falling number, energy, extensibility and resistance as compared with wheat dough without moringa leaves. On the other hand, the nutritional analysis of the bread showed significant improvements ($P \leq 0.05$) on protein, ash and fat content of bread due to supplementation with moringa leaves. Therefore, it is possible to produce bread with high protein and acceptable sensory characteristics.

~~bs~~

ملخص الأطروحة

~~أجريت هذه الدراسة لتقييم أثر التدعيم بمستويات مختلفة (10,20 ,30%) من مسحوق اوراق المورنقاعلي الخواص الريولوجية والقيمة الغذائية للخبز .~~

~~أجري التحليل التقريبي لعينة القمح , جودة وكمية القلوتين ورقم السقوط , ثم تمت دراسة الخواص الريولوجية للعجينة بنوعيها – معاملة وغير معاملة – بأستخدام الفارينوقراف والاكستنسوقراف .~~

~~أظهرت النتائج فروقاً معنوية ($P \leq 0.05$) في خصائص جودة الدقيق المعامل والخبز الناتج , حيث انخفض رقم السقوط للعينات المعاملة بزيادة نسبة مسحوق المورينقا المضافة.~~

~~وفي نتائج التحليل الريولوجي ازدادت نسبة امتصاص الماء ورقم جودة الفارينوقراف بازدياد نسبة مسحوق التدعيم , كما انخفضت كل من الطاقة والمطاطية والمقاومة للعجينة وازداد الـــ (Ratio Number Max) بأضافة مسحوق التدعيم عند قياسه بجهاز الاكستنسوقراف .~~

وقد أجريت هذه الدراسة لتقييم تأثير المكملات باستخدام بدرة أوراق المورينقا بمستويات مختلفة (10، 20، 30٪) على الخصائص الريولوجية لعجينة القمح والجودة الغذائية للخبز. وتم التحليل للمكونات التقريبية لأوراق المورينجا، وجودة الغلوتين ورقم السقوط لدقيق القمح. وعلاوة على ذلك، تم تحديد الجودة الريولوجية للعجينة المضاف إليها التراكيب المختلفة من المورينقا.

المكملات باستخدام أوراق المورينجا حسنت خصائص دقيق القمح، وخاصة، امتصاص الماء وجودة الغلوتين. ومع ذلك، كان هناك انخفاض في رقم السقوط والطاقة والتمدد والمقاومة مقارنة مع عجينة القمح دون أوراق المورينجا. من ناحية أخرى، أظهر التحليل التغذوي للخبز تحسينات واضحة ($P \leq 0.05$) في البروتين والرماد ومحتوى الدهون للخبز وذلك يرجع للمكملات باستخدام أوراق المورينجا. وبالتالي، فمن الممكن أن ينتج الخبز بنسبة عالية من البروتين وذو خصائص حسية مقبولة.

~~وأظهرت نتائج القيمة الغذائية زيادة في نسبة كل من البروتين والرماد والدهن بزيادة مسحوق التدعيم.~~

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CHAPTER ONE

INTRODUCTION

Cereals are the major source of energy for most people of the world. They provide 50% of the calories of human diet (Mitchell, *et al*., 1976).

Among cereals, wheat (*Triticumaestivum*L.) is the most worldwide cultivated crop. Used for bread making and baking , Its production needs fertile, well-drained soil with rain during growth period and sunny droughts at ripening time (Boumans, 1985). In Sudan, Wheat consumption in Sudan has been sharply increasing recent years . The increase in consumption was due to both population growth and rising per capita consumption of food in addition to incorporation of wheat into addition food products. It is considered important source of protein for the most people of developing countries.

Among cereals, Wheat is unique because it contains gluten which has the characteristic of being elastic when mixed with water and retains the gas developed during dough fermentation and baking. Wheat produced in different parts of the world differ greatly in their intrinsic protein qualities and quantities, the quantity is influenced mainly by environmental factors, but the quality of protein is mainly a heritable characteristic.

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Wheat is favored for bread baking, which is means to present wheat flours in attractive palatable and digestible forms. Bread is made by baking fermented dough which formulated from different main ingredients including wheat flour, water, yeast and salt.

The leaves of moringaoleifera are a good source of Protein, Vitamin A, B and C and minerals such as calcium and iron (Dahot, 1988).The leaves, fruit, flowers, and immature pods of this three are edible and they from a parts of traditional diets in many countries of the tropics and sub-tropics areas (Siddhuraju and Becker, 2003; Anhwange *et al.*, 2004).

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The use of moringa leaves powder for supplementation of bread is of potential. Moringa natural, available and cheep source of protein.

Objectives of this Study area:

1. To investigate the effect of Moringa leaves supplementation on nutritional quality
2. To determine the effect of moringa leaves powder on the doughrheological properties of both Moringa leaves powder and wheat flour.
3. To study the effect of moringa leaves flour on the qualityof bread produced.
4. to study the effect of moringa leaves on the sensory characteristic of bread.

CHAPTER TWO

LITERATURE REVIEW

2.1 Importance of Cereals

The demand for cereals as food and feed is increasing due to population Explosion and short falls in cereal production In several developed countries. It is well established that the majority of the people in the developing countries depend mainly on cereal grains as their stable food due to limited income and high prices of animal foods .Cereals generally provide Almost 50% the total Caloric for the people of the world (Henery and Kettlewel, 1996).

2.~~3~~ 2 Wheat Classification

Generally bakers classify wheat by the hardness of the kernel, that is, by whether the kernel is hard or soft. Hard wheat kernels are high in protein ;Soft wheat kernels are low in protein .hard wheat kernels feel harder than soft ones because protein in these kernels forms large ,hard chunks. strong flours usually have a high water –absorption value and require a longer mixing time to fully develop , but they are tolerant of over mixing. The strength of flour depends largely upon the gluten it contains , which gives to bread its elastic quality and its ability to absorb water (Blackman and Payne ,1987). Strong flours are typically used in yeast-raised products ,like breads , rolls . soft wheat flours typically from weak gluten that tears easily, and are sometimes called weak flours , and this is desirable for many cakes, cookies ,and pastries. (Kipps, 1970) reported that wheat is a group classify according to, color, texture and year seasons as follows:

2.~~3~~2.1 Hard Red Spring Wheat

This class of wheat is noted for its high protein content and excellent bread making characteristics .it is used extensively for blends with weaker wheat throughout the world .hard red spring and hard red winter wheat contain an average of about 11 to 15 percent protein,(Kipps,1970).

2.~~3~~2.2 Hard Red Winter Wheat

The grain is hard and generally high in protein content. As bread wheat , it ranks second only to hard red spring wheat in quality, protein content usually averaging 11 – 12% ,(Kipps,1970).

2.~~3~~2.3 Soft Red Winter Wheat

Most of the wheat of this region has grain of low–protein content, which produces flour most satisfactory for pastries, such as cakes, cookies and pies. Soft wheat contains 8 to 11 percent protein and the soft red winter wheat verities were in general high in starch and low in protein, ,(Kipps,1970).

2.~~3~~2.4 Durum Wheat

The kernels of this wheat are the hardest known and for this reason are often called “hard” wheat, the hardness of durum wheat semolina, combined with its high protein content, yellow color and nutty taste makes it suitable for making pasta of consistent cooking quality. The high gluten content also results in a dough that is stiff and extrudes easily through metal discs to make more than 350 shapes of pasta,(Kipps,1970).

2.~~3~~2.5 White Wheat

The white wheat is mainly used for pastry purposes, but some of them go into shredded wheat and bread,,(Kipps,1970).

2.~~2~~3 Nutrition Value of Wheat

Wheat and wheat foods are major source of nutrients for people in many regions of the world. Wheat is a source of carbohydrate, proteins, vitamins and minerals when consumed as a major component of the diet.

Consist mainly of starch and significant proportion of many minerals and vitamin. Nutrients are generally found in the highest concentrations in the germ and in the aleurone cells surrounding the starchy endosperm. Significant quantities of minerals and vitamins are lost when whole wheat is milled to produce white endosperm flour because the outer layer of bran are removed along with aleurone cells and germ. extraction flour of(72-75)% contains from as little as 20%to about 60%of the BBvitamins originally present in whole-wheat flour (FAO,1970).

2.4 Importance and use of wheat in the world

Wheat (*Triticumspp*) continuos to be one of the world most important grains, especially as food, where the unique properties of its products can be utilizesd to advantage (Inglett,1974).

The cultivation of wheat, reach far back in history, and the crop was predominant in antiquity as a source of human food. Wheat is a major cereal produced, imported and exported, its most important use is in the manufacture of all breads, biscuits and pastry products.

Whilst, all the cereals can be ground into flour or meal, only wheat and rye …… contain the type of protein that will enable them to be baked into bread (Cowley and Howarth, 2006).

It contains gluten protein, which enables leavened dough to rise by forming minute gas cells that hold carbon dioxide during fermentation (Quisenberrg and Reitz, 1967).

The soft wheat is used extensively for crackers, pastries and cookies and hard wheat is use usually to make bread (Wilson, 1998).

Bread and cereals contain protein and complex carbohydrate and B group vitamins and iron (Inglett, 1974).

2.5 Importance, production and consumption of wheat in Sudan

In many African , eating habits have changed in favor for wheat away from other cereals since the 1970s , when food aid in the form of wheat was introduced (Pomeranz, 1988).

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, and varieties grown are mainly used for bread making (E1 – Faki *et al*, 1978).

Wheat in Sudan is grown under irrigation during the dry and comparatively cool winter season which extends from November to February (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 Estern Sudan (Ageeb, 1994).

In term of cultivated area, in average, 96% of the area cultivated with wheat fell within the irrigated sector during the period between 2008 and 2013 and it recorded a high share of 98% during the 2014/2015 season (Al-Feel and Al-Basheer, 2012).

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

2.6 Wheat kernel structure

Wheat kernel is the seed of the plant, has three main parts: the endosperm , the , the germ , and the bran , while whole wheat flour contains all three parts of the kernel, white flour is milled from the endosperm only the bran consists of several layers of protective outer coverings, it comprises 13-17% of the weight of wheat kernel , the endosperm composes 80 – 85% of the grains weight and the germ composing 2-3 % of wheat kernel weight (Internet report, 2001).

2.7 Wheat composition

The composition of wheat flour varies considerably according to the class of wheat, its origin and the proportion of outer part removed by particular milling process.

2.7.1 Moisture content

Moisture content of wheat is to only of economic significance , but is important in regard to its keeping qualities and its behavior on storage.

Basdi *et al*, (1978) mentioned that moisture & content of Sudanese wheat flour, Moisture content of different Sudanese wheat cultivar varies from about 6.33 to 8.87% (Ahmed , 1995).

2.7.2 Ash content

High extraction flour generally has high ash content. (Zeleny,1971) mentioned that ash content of whole wheat flour ranged between 1.4 and 2 %.

Reported that Ash content of whole flour of several Sudanese cultivars ranged between (1.03 and 1.24%) (Badi *et al*., 1978) and (Ahmed 1995).

2.7.3 Protein content

Wheat is considered superior compared to other cereals 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 contain about 80 percent of the total amount of proteins in the whole kernel.

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 wheat cultivars (Condor, Debra, Elneilein and Nasser) ranges between 8.21 and 12.26%.

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2.7.4 Fat content

The germ contains 6 –11 lipids, the bran 3 –5% and the endosperm 0.8 - 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 limit the keeping quality of wheat flour (Anon, 1987). Fat content of the whole white flour of Sudanese wheat Cultivars Depra, Elneelain, Condor, Sasarib., were found to be in the range of 2.15 to 2.35 and 1.33 to 1.93%, respectively.

2.7.5 Crude fiber content

The fiber content increase with the amount of branny matter present. Fiber is the indigestible carbohydrate in food which acts like a brome to sweep out the digestive.

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).

2.8 Botanical Description and Background of MoringaOleifera Trees

Kingdom: plantae
Family: moringaceae
Genus :moringa
Species: *moringaoleifera*
The name of moringa are miracle tree , Horseradish Tree. Ben oil Tree …etc

The Moringaceae is a single_genus family of oilseed trees with 14 known species. Of these, *Moringaoleifera*, which ranges in height from 5 to 10 m, is the most widely known and utilized (morton.1991; sengupta and Gupta, 1970).

Today moringa is widely cultivated in central Africa and south America, Srilanka, India, Mexico, Malaysia and the Philippines.

Moringaoleiferais esteemed as a versatile plant due to its multiple uses.

The leaves, fruit , flowers , and immature pods of this three are edible and they from a parts of traditional diets in many countries of the tropics and sub-tropics (Siddhuraju and Becker, 2003; Anhwange *et al.* , 2004).

The leaves of *moringaoleifera* are a good source of Protein, Vitamin A, B and C and minerals such as calcium and iron (Dahot , 1988).The origin of moringaoleifera is South Africa. It is wide spared in India, The east and west Indies, the other tropical countries and Europe.

The tree was introduced to Sudan during British rule as ornamental tree in Gezira proince and Kordofan (Elsham , M . 2002).

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Moringaoleifera which is locally known as Rawag is the most widely known and utilized species of the genus moringaceae (Wickens, 1988).

The moringa tree originated in India, people brought it to Africa from Asia who used it as source of food and for medicinal purposes.

The moringa tree likes sun shine and can grow best on dry sandy soil and can withstand drought condition. It grow quickly from seeds or cuttings, can reach a height of twelve feet within the first year and regenerates itself even after the most severe pruning (Mustafa, *et al* . 1999).

The following plates (1,2,3,4 and 5) show Moringa tree, Moringa pods, Moringa seeds, Moringa leaves, Moringa d leaves powder respectively.

Plate 1:Moringa Tree

Plate 2: Moringa Pods

Plate 3: Moringa seeds

Plate 4: Moringaleaves

Plate 5: Moringa leaves Powder

2.9 History Background of moringa

Moringaoleifera is the best known of the thirteen species of the genus moringaceae .Moringa was highly valued in the ancient world .

The Romans ,Greeks and Egyptians extracted edible oil from the seeds and used it for perfume and skin lotion . In 19th century , plantations of Moringa in the West India exported the oil to Europe for perfumes and lubricants for machinery .people in the Indian sub-continent have long used Moringa pods for food~~-~~. ~~the~~ The edible leaves are eaten throughout West Africa and parts of Asia(Adedapo *et al*, 2009).

2.10 Etymology of moringa:

Moringa derives from the Tamil word, murungai or Malayalam word, murinna (alternately muringa). Numerous other common names for moringa exist in different languages worldwide.

Moringaoleifera is the most widely cultivated species of the genus Moringa, which is the only genus in the family Moringaceae. English common names include: moringa, drumstick tree (from the appearance of the long, slender, triangular seed-pods), horseradish tree'2' (from the taste of the roots, which resembles horseradish), ben oil tree, or benzoic tree'2' (from the oil which is derived from the seeds).

2.11 Developing the moringa value chain in Sudan:

It is a sun-loving ,fast-growing tree, which tolerates poor soils and long spells of dry weather. Rich in vitamins, minerals and protein, it is a versatile source of food for humans, while as fodder it benefits livestock farmers by increasing milk and meat production. It yields edible oil and biofuel, and is used to purify water and combat land degradation. It is even said to work health and cosmetic wonders such as preserving the youthful appearance of the human skin. And while its long slender pods gave it its unpretentious name of the "drumstick tree", it is frequently – and more fittingly – called the "miracle tree" and the "tree of life" (Aljozoli, 2007)

Native to the southern foothills of the Himalayas in north-western India, *moringaoleifera* is the most widely grown species of the genus Moringa. This robust tree is cultivated in arid, semiarid as well as tropical and subtropical regions, and it grows best in dry sandy soil. It is occurs as a wild plant and is cultivated in Central America and the Caribbean, South America, Oceania, and many African countries(Aljozoli, 2012).

2.12 Nutritional value of Moringa tree

Moringa tree have been used to combat malnutrition, especially among infant and nursing mothers. Three non –governmental organizations in particular-three for life, church world service and Educational concerns for Hunger Organization -have advocated Moringa as "natural nutrition for the tropics. " Leaves can be eaten fresh, cooked, or stored as dried powder for many months without refrigeration, and reportedly without loss of nutrition value. Moringa is especially promising as a food source in the tropics because the tree is in full leaf at the end of the dry season when other foods are typically scarce (Aljozoli, 2012) .

The leaves are the most nutritious part of the plant, being a significant source of B vitamins, vitamin C, provitamin A as beta- carotene, vitamin K, manganese, and protein, among other essential nutrients.'23''24' When compared with common foods particularly high in certain nutrients per 100 g fresh weight, cooked moringa leaves are considerable sources of these same nutrients. Some of the calcium in moringa leaves is bound as crystals of calcium oxalate'251 though at levels 1 /25th to 1 /45th of that found in spinach, which is a negligible amount. The leaves are cooked and used like spinach and are commonly dried and crushed into a powder used in soups and sauces.

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The comparison in nutrition value between different items and moringa leaves is contain more Vitamin A than carrots, more calcium than milk, more iron than spinach, more Vitamin C than oranges, and more potassium than banana,"

2.13 A cornucopia of vitamins, minerals and proteins

While moringa is regarded as one of the world's most valuable multi-purpose trees, it is its nutritional value that has received the greatest attention from researchers and food product developers. Leaves, pods, flowers and roots are all edible. Moringa leaves contain more vitamin A than carrots, more iron than spinach, more calcium than milk, more vitamin C than oranges, and more potassium than bananas, are rich in omega oils and antioxidants, and their protein quality rivals that of milk and eggs (Aljozoli, 2012).

As a source of nutritious food, moringa is seen as a particularly important crop for African countries plagued by drought, povertyand rudimentary agricultural infrastructure. During the last three decades, significant efforts have been made to promote the cultivation and processing of moringa in Africa to combat malnutrition, especially among infants and nursing mothers, and to contribute to food security in arid and semiarid environments, where moringa thrives during dry seasons when little else can grow and provide food.

Sudan is among the countries that face these challenges and at the same time are striving to develop capabilities to harvest the benefits of the tree of life.

Rural communities in Sudan have used moringa for hundreds of years, mostly as a food source, but also as a medicinal plant and to purify the turbid water of the Nile.

2.14 Traditional Uses of moringa:

For centuries , people in many countries have used Moringa leaves as traditional medicine for common ailmens . Clinical studies have to suggest that at least some of these claims are valid . with such great medicinal value being suggested by traditional medicine, further clinical testing is very much needed . India: Traditionally used for anemia, anxiety, asthma, blackheads, blood impurities, bronchitis, catarrh, chest congestions, cholera , Conjunctivitis, cough, diarrhea, eye & ear infections, fever, glandular swelling, headaches, abnormal blood pressure , hysteria , pain in joints,Pimples, psoriasis, respiratory disorders, scurvy, semen deficiency ,Sore throat, sprain, tuberculosis (Adedapo*etal*, 2009).

2.15 Modern Uses of moringa

Over the past two decades, many reports have appeared in mainstream scientific journals describing its nutritional and medicinal properties . its utility as a non-food product has also been extensively Described. Every part of Moringa tree is said to have beneficial properties that can serve humanity. People in societies around the word have made use of these properties (Adedapo *et al*, 2009).

2.16 Harvesting of Moringa

Two harvests of seed pods can e produce in one year .and the Moringa leaves tend to appear toward the end of dry season when few other sources of green leafy vegetables are available (Mustafa, *etal*.1999). Fruit or other parts of the plant usually harvested as desired according to some authors but in India fruiting may peak between March and April and again in September and October. (Bur kill, 1966).

2.17 Bread

All over the world, bread means food and life. it requires no further preparation once purchased. bread, a nutritionally dense food, is high in complex carbohydrates, which give the body a sustained energy (Bennion, 1967). Herbs, 1995 reported that bread is a staple since prehistoric times .it has originated in Egypt about 3500 BC as reported by (Joswellman, 2003). The migration from countries site inward the urban has Imposed the spread out of the habit of eating bread and thus increase the consumption (Deny , 1992) the large consumption of bread led to the development of a well-organized baking industry. Bread acts as a vehicle forprotein and vitamin –rich materials such as meat and cheese. In addition to that the solid state of bread facilities its transportation.

CHAPTER THREE

MATERIALS AND METHODS

3.1 Materials:

Wheat bread flour was obtained from sigamills(Khartoum).

Moringa leaves was obtained from different areas (shambat, Omdurman).Other food materials(salt,oil,yeast,sugar).were purchased from the local market (Omdurman). All chemicals and reagents were of analytical grade.

3.2 Methods:

3.2.1Preparation of moringaleave powder

Samples were collected from different areas (Shambat, Omdurman). The collected leaves were washed with tap water and dried at room temperature (60°C) for 3 ouars, then grinded and stored at 4°C.3 samples (90%- 80% -70%) wheat flour to (10%- 20% -30%) moringa.

3.2.2 Blends of moringa leave powder and Wheat Flour:

Five blends of wheat flour (WF) and Moringa leaf powder (MLP) were then formulated in the following ratios,

90: 10 , 80 :20 and 70 :30from which dough were prepared for production of the bread samples, with 100% WF control.

3.3 Making of bread

Bread preparation was carried out according to badi *et al*.(1978) method Bread formula:

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Flour	250gm
Yeast	3gm
Salt	2gm
Ascorbic acid	80 ppm
Oil	20gm
Water	160ml

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Control bread and mixed with dry ingredients (yeast ,Salt, Sugar and Ascorbic acid) using Mono. Universal

Dough Mixer, water was added (based on the Farinograph optimum absorption) and mixed, the dough was allowed to rest for 10 minute at room temperature (38±2ºC), scaled to three portions of 120g each, molded into and transferred into the fermentation cabinet for 45 min.

The fermented dough were then backed in Simon Rotary baking oven at 250ºc for 30 – 55 min.

3.4 Analytical Methods

3.4.1 Proximate Composition

The analytical work was carried out of *Moringa Oleifera* leaves powder , wheat flour and the composite flour were determined, with will mixing of the samples.

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The determination of moisture and ash were carried out on the samples according to AACC (2000) methods.

3.4.1.1Moisture content

Determination of Moisture Content

The main steps were as follows according to the method described by AOAC (2002).

Three grams of well-mixed samples were weighed accurately in clean preheated moisture dish of known weight by using sensitive balance.

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The uncovered dish with the sample were kept in an air oven provided with a fan at 130°C for 1 hour. The dish was then covered and transferred to desicator and weighed after cooled to room temperature.

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

Moisture content % = $\frac{Wt1 - Wt \times 100}{\text{Sample wt.}}$ $\cancel{Wt1 - Wt \times 100}$

~~Sample wt.~~

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Where:

Wt_1 = Weight of sample + dish before oven dry.

Wt_2 = Weight of sample + dish after oven dry.

3.4.1.2 Ash content

Determination of Ash

The steps were as follows according to AOAC (2002).

Three grams were weighed in empty crucible of known weight. The sample was heated in a Muffle-Furnace at 550°C until its weight is stable. The residue is cooled to room temperature after removed from a Muffle-furnace and placed in a desicator then weighed. The process was repeated until constant weight was obtained.

% Ash content was calculated using the following equation:

Ash content % = $\frac{(Wt1 - Wt2)\ x\ 100X100}{\text{Sample wt.x } (100-\text{m})}$ $\cancel{(Wt1 - Wt2)\ x\ 100X100}$

~~Sample wt.x (100-m)~~

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Where:

Wt_1 = Weight of crucible with ash sample.

Wt_2 = Weight of empty crucible.

m=%moisture

3.4.1.3 Oil content

Determination of fat content

Crude fat was determined according to the standard method of AOAC (1990). A sample of 3 g was weighed into an extraction thimble and covered with cotton; that was previously extracted with hexane (BP60-70°C), and then the sample and a pre-dried and weighed Erlenmeyer flask containing about 50 ml were attached to extraction unit for 45 minutes. At the end of distillation period, the solvent was recovered from the oil. Later, the flask with the remaining crude hexane extract was put in an oven at 105 °C for about an hour. Cooled in a desiccator, reweighed and dried extract was recorded as crude fat% (DM) according to the following formula:

Crude fat % (DM) =

$$\frac{Dry\ extract\ w.t\ (g)\ x\ 100\ x\ 100}{\text{Wt.sample}\ (100 - \%\ \text{moisture})}\ \cancel{Dry\ extract\ w.t\ (g)\ x\ 100\ x\ 100}$$

~~Wt. sample (100 - % moisture)~~

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3.4.1.4 Protein

Determination of Crude Protein

The determination of crude protein was carried out on the samples according to AOAC (1984) methods.

The steps were as follows:

A 0.2 gram of sample, plus 0.4 gram catalyst mixture (potassium sulfate + cupric sulfate 10:1 by wt), and 7 ml concentrated nitrogen free sulfuric acid, were mixed in a small Kjeldahl flask (100 ml).The mixture was digested for two hours, then cooled, diluted, and placed in the distillation apparatus. Fifteen milliliters of 40% NaOH solution were added and mixturewas heated and distilled until 50 ml were collected in a 100 ml conical flask. The ammonia evolved was received in 10 ml of 2% boric acid solution plus 3-4 drops of universal indicators (methyl red and bromo cresol green).

The trapped ammonia was titrated against 0.02N Hcl. The percentage (g/100) of protein was calculated by using an empirical factor to convert nitrogen into protein as follows:

Nitrogen content % = $\frac{TV \times N \times 14.00 \times 100}{1000 \times \text{wt.of sample}}$ ~~TV × N × 14.00 × 100~~

~~1000 × wt. of sample~~

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Protein content % = (nitrogen content %) X F

Where:

TV = Actual volume of HCL used for titration (ml HCL – ml blank).

N = Normality of HCL.

14.00 = Each ml of HCL is equivalent to 14 mg nitrogen.

1000 = To convert from mg to gm.

6.25 = Constant factor for sorghum and legumes.

5.7 = constant factor for wheat flour.

3.4.1.5 Carbohydrate

Determination of Carbohydrates

The carbohydrates were calculated by difference. The sum of moisture, fat, protein and ash contents was subtracted from 100 as it was described by West *et al.* (1988).

3.5 Farinograph

Brabenderfarinograph method was carried on wheat flour with and without chickpea according to AACC (2000).

Brabenderfarinograph was operated as described in AACC method (2000). Titration curve was used for the assessment of the water-absorption for each flour sample. A sample of 300 gram (14% moisture) was weighed and transferred into a cleaned mixer. The farinogragh was switched on 63 rpm for one minute, then the distilled water was added from especial burette (the correct water absorption can be calculated from the deviation, 20 units deviation correspond to 0.5% water, if the consistency, is higher than 500 F. U. more water is needed and vice-versa). When the consistency is constant, the instrument was switched off and the water drawn from the burette indicates water absorption of the flour in percentage.

The standard curve the measuring mixer was thoroughly cleaned. A sample of 300 g was weighed, and then introduced into the mixer; the farinogragh was switched on such as before. The water quantity, which is determined by the titration curve, was fed at once. When an appreciable drop on the curve was noticed, the instrument was run further 12 minutes, and then shut off.

3.6 Extensograph

Extensograph method was used according to ICC (2001). The extensograph and farinograph were set and operated at 30°C. The dough for extensograph was prepared as for the farinograph, but the amount of water used for mixing was 2%less due to the addition of 2% salt and the dough was mixed for 5 min. only. Three pieces of dough (150 g each) were weighed, molded on the balling unit, rolled with dough roller into cylindrical test pieces, fixed in the dough holder, and stored in the rest cabinet for 45 min. The dough piece was placed on the balance arm of extensograph and stretched by stretching hook until it broke. During the period of stretching the behavior of the dough was recorded on a curve via extensograph. This test was performed at 45, 90, and 135min intervals.

3.7 Bread Weight

The weight of the loaf was taken in g.

3.8 Bread Volume

The loaf volume was determined by the seed displacement methodaccording to Pyler (1973). The loaf was placed in a container of known volume into which small seeds (millet seeds) were run until the container is full. The volume of seeds displaced by the loaf was considered as the loaf volume.

Bread volumeThe loaf volume was determined by the seed displacement methodaccording to Pyler (1973). The loaf was placed in a container of known volume into which small seeds (millet seeds) were run until the container is full. The volume of seeds displaced by the loaf was considered as the loaf volume.

3.9 Bread Specific Volume

The specific volume of the loaf was calculated according to the AACC method (2000) by dividing volume (CC) by weight (g).

3.10 Sensory Evaluation of Loaf Bread

The loaves were sliced with an electric knife and prepared for sensory evaluation same day. The sensory evaluation of bread samples (aroma, taste, crumb texture, crumb color, crumb cell uniformity, general acceptability) was carried out by 10 semi trained panelists. The surrounding conditions were kept the same all through the panel test (see Appendix 2).

3.11Statistical Analysis

The analysis of variance was performed to examine the significant effect in all parameters measured. Duncan Multiple Range Test was used to separate the means.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 Chemical composition of wheat flour, Moringaoleifera leaves powder:

Chemical composition of wheat flour, Moringaoleifera leaves powder and there blends were shown in table 1.

4.1.1 Moisture Content

Analysis of variance showed significant differences($P \leq 0.05$) among Moringaoleifera leaves powder, wheat flour and supplemented samples in moisture content .

Moisture content of Moringaoleifera leaves powder was 4.53 % , moisture content of wheat flour was 10% . Results of supplemented samples were 9.79, 8.88And 8.24 ,for 10, 20,and 30% respectively.

These results were in agreement with jaffar and Hala, 2012) who reported that the moisture content of wheat flour was10.7% and 10.80, 10.50,10.71 for 2.5, 5 , 7.5 for supplemented samples respectively, and 7.64 for moringa .

4.1.2 Ash Content

Analysis of variance showed significant differences ($P \leq 0.05$) in ash content among Moringaoleifera leaves powder, wheat flour samples was 0.393, 1respectively . And the results for supplemented samples were 2.95 , 3.88 and 11.71% for 10, 20, and 30% respectively , results shows significantly increased in ash content30 % of Moringa leaves powder which gained the highest value 11.71% .

In table (4.1): These results were in agreement with (Jaffar and Hala, 2012) who reported that the ash content of wheat flour 0.70% and the results for supplemented samples were 0.91 , 1.14, 1.41 for 2.5, 5 , 7.5 respectively, for moringa 9.20.

4.1.3 Protein Content

Analysis of variance showed significant differences ($P \leq 0.05$) among Moringa leaves powder, wheat flour and levels of Moringa leaves powder in protein content .

Content of Moringa leaves powder was 5.37%, protein content of Moringa leaves powder incorporated wheat flour with different level 10 , 20 and 30 % was increased with. increasing the level of Moringa leaves powder from 14.13, to 6.04 and 8.10respectively. Compared with control was 13.7 %, these due to Moringa leaves powder the highest percentage of protein content 5.37% .

In table (4.1): These results were in agreement with (Jaffar and Hala, 2012) who reported that the protein content of wheat flour 11.31% and the results for supplemented samples were 12.48, 26.71, 28.13 for 2.5, 5 , 7.5 respectively, for moringa 36.08.

4.1.4 Fat Content

Analysis of variance showed significant differences (P≤0.05) among *Moringaoleifera* leaves powder in wheat flour and its levels in *Moringaoleifera* leaves powder in fat content of Moringa leaves powder 7.51 and for wheat flour is 1.8 and its 3.14 , 3.89 and 7.51 for 10, 20 and 30% respectively.

In table (4.1): These results were in agreement with (Jaffar and Hala, 2012) who reported that the fat content of wheat flour 2.22% and the results for supplemented samples were 2.79, 2.22, 2.37 for 2.5, 5 , 7.5 respectively, for moringa 5.86.

4.1.5 Crude fibrecontent

Analysis of variance showed significant differences (P≤0.05) among Moringaoleifera leaves powder in wheat flour and its levels in Moringaoleifera leaves powder in fat content of Moringa leaves powder 5.58 and for the flour is 0.9 and its 10 , 20 and 30% for 1.48, 2.82 and 3.58 respectively.

4.1.6 Carbohydrates Content

Carbohydrate content decrease with increase supplementation of moringaleaves powder levels.72.6 for wheat flour, and 57.9 for moringa leaves, and 73.5 ,78.40, 71.31 for the samples 10,20,30 respectively.

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These results were in agreement with (Jaffar and Hala, 2012) who reported that the CHO content of wheat flour were 75% and the results

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Table 4.1: Chemical Composition of Wheat Flour and Moringa Leaves Powder sample Blends

Bread sample	Moisture content	Ash content	Oil content	Crude protein	Crude fiber	Available carbohydrates
A	10[a] ±0.11	1[e] ±0.09	1.8[d] ±0.04	13.7[b] ±0.12	0.9[e] ±0.01	72.6[a] ±0.09
B	4.53[e] ±0.11	11.71[a] ±0.15	8.70[a] ±0.17	5.37[e] ±0.15	11.82[a] ±0.28	57.95[b] ±0.45
C	9.79[b] ±0.05	1.14[d] ±0.11	3.14[cd] ±0.15	14.13[a] ±0.17	1.48[d] ±0.02	73.57[a] ±5.72
D	8.88[c] ±0.07	2.95[c] ±0.07	3.89[c] ±0.11	6.04[d] ±0.09	2.82[c] ±0.10	78.40[a] ±5.07
E	8.24[d] ±0.11	3.88[b] ±0.13	7.51[b] ±1.07	8.10[c] ±0.10	3.58[b] ±0.11	71.35[a] ±4.03
$Lsd_{0.05}$	0.1726*	0.2074*	0.8987*	0.2372*	0.2573*	7.042**
SE±	0.05477	0.06583	0.2852	0.07528	0.08165	2.235

Values are mean ±SD

Mean(s) sharing same superscript(s) in a column are not significantly (P>0.05) different according to DMRT.

Key:

A ≡ wheat flour free addition (control)

B ≡ sample containing 10% Moringa + 90% wheat flour

C ≡ sample containing 20% Moringa + 80% wheat flour

D ≡ sample containing 30% Moringa + 70% wheat flour

4.2 Farinograph Results

farinograph results of wheat flour supplemented with Moringa leaves are shown in table (4.3) fig (1,2,3,4)

The water absorption of incorporation of Moringa leaves powder with different levels ranged 66.6 , 68.4 and 70.5 for 10 , 20 and 30 % respectively

The highest value observed in (30 %) moringa leaves powder it is obvious that water absorption increase with increasing the addition of Moringa leaves powder .

Dough development time increased with the increase of powder of Moringa leaves at 10 , 20 and 30 % leaves from 5.5 , 5.7 , 7.2 respectively .

Dough stability decreased with the addition of Moringa leaves powder with all leaves from 4.4 , 5.1 and 6.3 for control , 10 , 20, 30% respectively.

Table 4.2: Farinographredangs of bread flour blends

Bread sample	Water absorption (corrected for 500 FU)	Water absorption (corrected to 14%)	Development time (min)	Stability (min)	Degree of softening (10 min after begin)	Degree of softening (ICC/12 min after max	Farinograph quality number
A	58.40^{c} ±0.10	57.70^{a} ±0.10	2.20^{d} ±0.10	7.00^{a} ±0.10	52.00^{c} ±1.00	64.00^{d} ±1.00	47.00^{d} ±1.00
B	57.70^{c} ±0.44	61.80^{a} ±0.10	5.50^{c} ±0.10	4.40^{d} ±0.10	95.00^{a} ±1.00	129.00^{a} ±1.00	67.00^{c} ±1.00
C	68.60^{ab} ±0.10	63.60^{a} ±0.10	5.70^{b} ±0.10	5.10^{c} ±0.10	73.00^{b} ±1.00	110.00^{b} ±1.00	72.00^{b} ±1.00
D	70.80^{a} ±0.10	65.40^{a} ±0.10	7.20^{a} ±0.10	6.30^{b} ±0.10	40.00^{d} ±1.00	97.00^{c} ±1.00	95.00^{a} ±1.00
Lsd$_{0.05}$	6.063**	0.1883**	0.1883*	0.1883*	1.883**	1.883**	1.883**
SE±	1.859	0.05774	0.05774	0.05774	0.5774	0.5774	0.5774

Values are mean ±SD

Mean(s) sharing same superscript(s) in a column are not significantly (P>0.05) different according to DMRT.

Key:

A ≡ wheat flour free addition (control)

B ≡ Moringa leaves

C ≡ sample containing 10% Moringa + 90% wheat flour

D ≡ sample containing 20% Moringa + 80% wheat flour

E ≡ sample containing 30% Moringa + 70% wheat flour

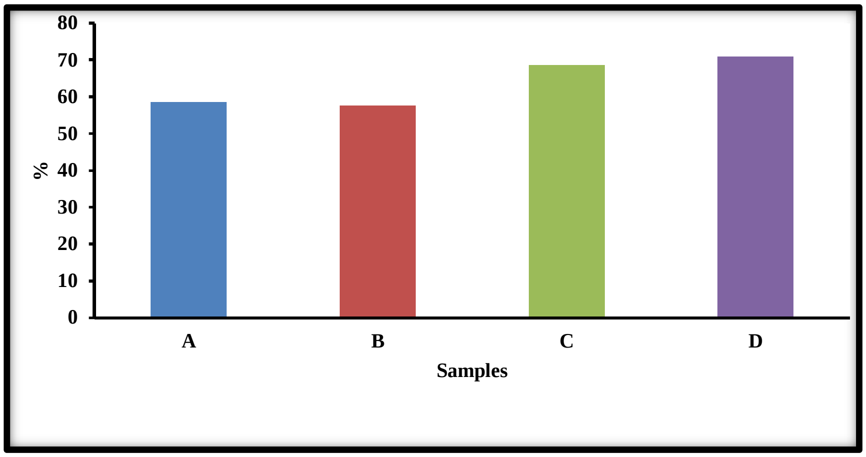

Fig.1: Water absorption (corrected for *500 FU*) of bread samples

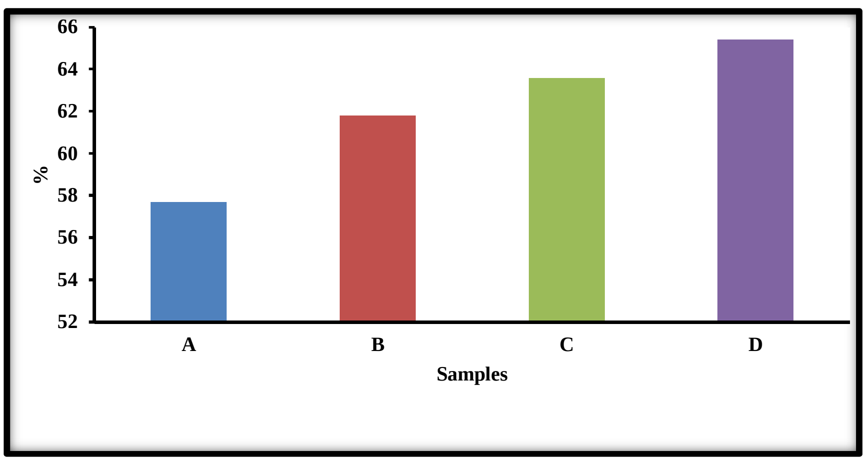

Fig.2: Water absorption (corrected to 14.0%) of bread samples

<u>Key:</u>

A ≡ wheat flour free addition (control)

B ≡ sample containing 10% Moringa + 90% wheat flour

C ≡ sample containing 20% Moringa + 80% wheat flour

D ≡ sample containing 30% Moringa + 70% wheat flour

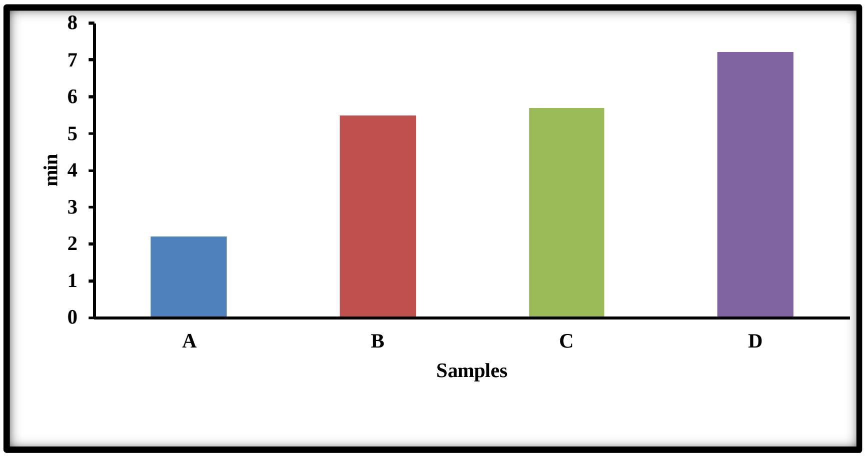

Fig.3: Development time of bread samples

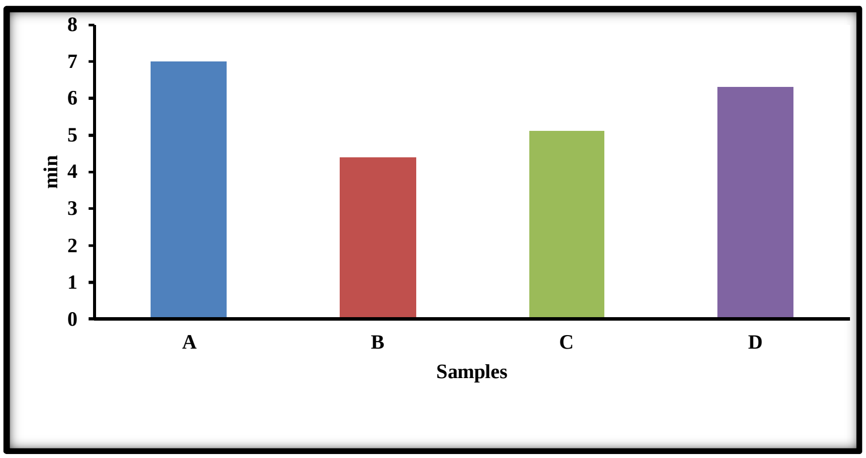

Fig.4: Stability of bread samples

Key:

A ≡ wheat flour free addition (control)

B ≡ sample containing 10% Moringa + 90% wherat flour

C ≡ sample containing 20% Moringa + 80% wheat flour

D ≡ sample containing 30% Moringa + 70% wheat flour

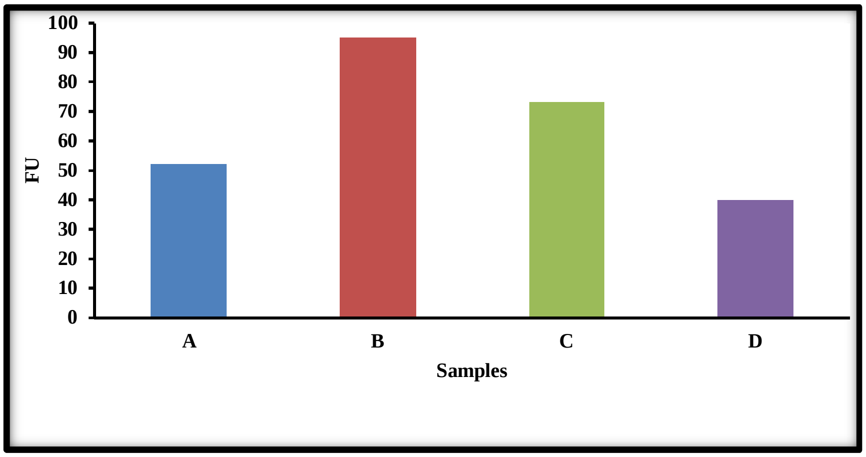

Fig.5: Degree of softening (10 min after begin) of bread samples

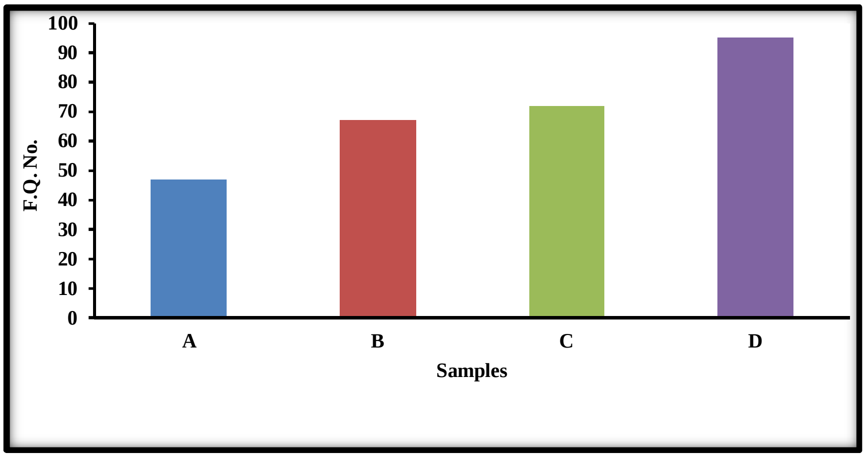

Fig.6: Farinograph quality number of bread samples

KEY;

A ≡ wheat flour free addition (control)

B ≡ sample containing 10% Moringa + 90% wheat flour

C ≡ sample containing 20% Moringa + 80% wheat flour

D ≡ sample containing 30% Moringa + 70% wheat flour

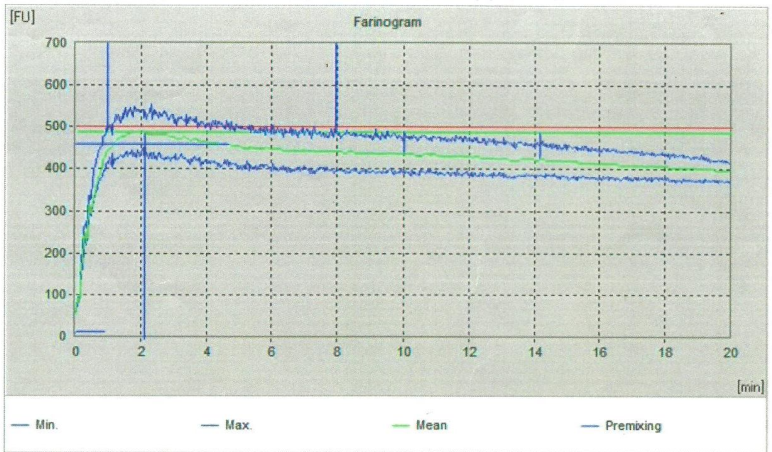

Fig.7 :Farinogrph of dough prepared from control wheat flour

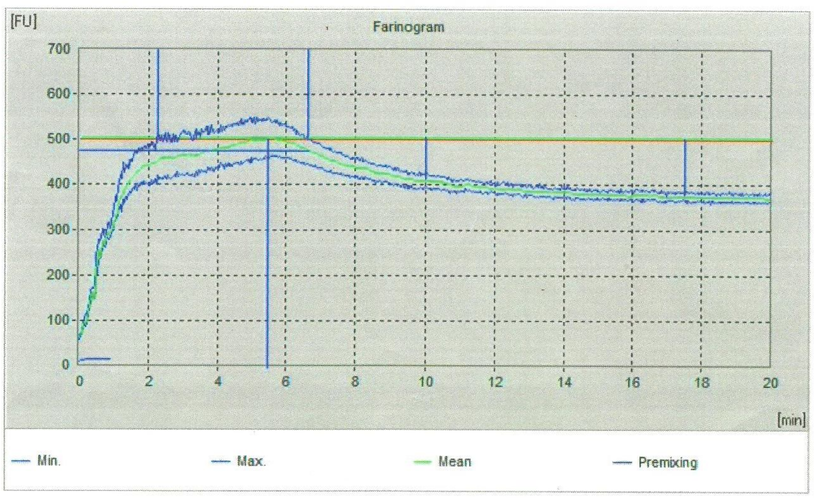

Fig.8: Farinogram of dough prepared from10% Moringa leaves powder

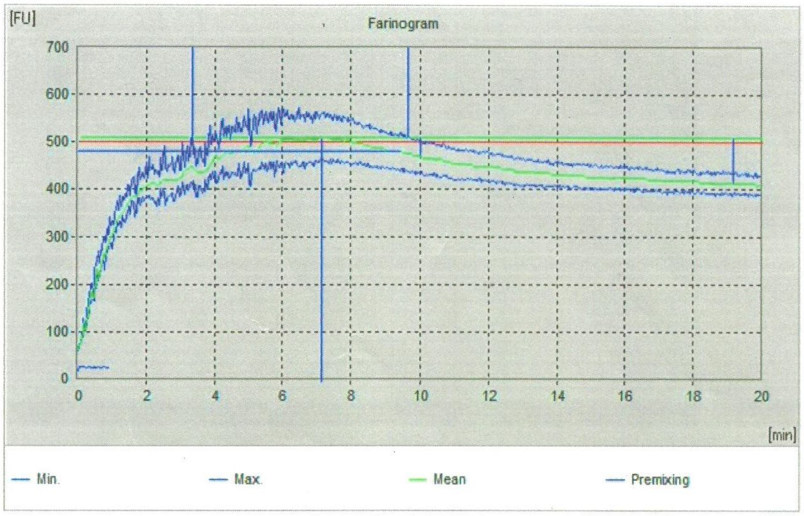

Fig.9: Farinogram of dough prepared from20%Morenga leaves powder

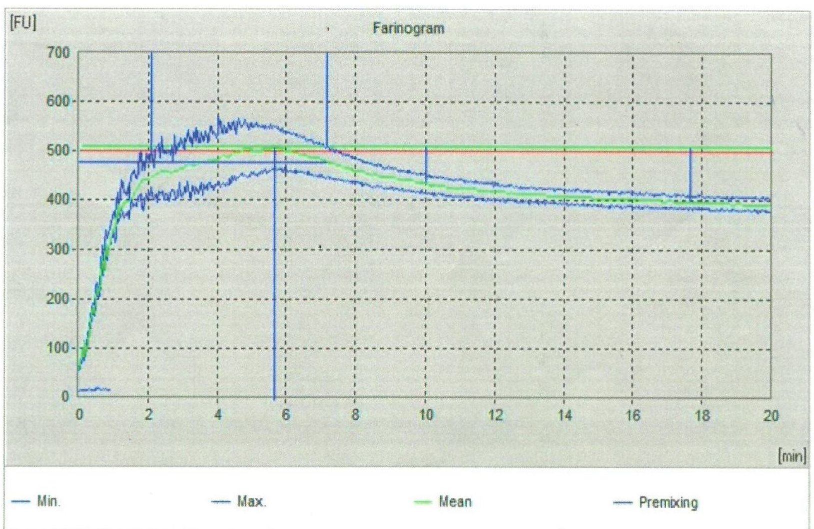

Fig.10: Farinogram of dough prepared from30%Morenga leaves powder

4.5 Extensograph results

The Extensograph results of the wheat flour with and its blends with Moringa leaves powder are shown in table (3) and fig (1,2,3,4).

Wheat flour with 10 , 20 , 30 % moringa leaves powder energy decreased gradually with increasing the level moringa leaves powder .

Resistance of dough prepared from powder of moringa leaves decrease in at all levels (10, 20 and 30%) powder at 45 min .

The addition of moringa leaves powder showed decrease in extensibility at 45 min .Ratio number increase in one levels (10 %) moringa leaves powder.

Table 4.3: Extensograph of bread samples

Bread sample	Energy (cm^2)			Resistance to extension (BU)			Extensibility (mm)			Maximum (BU)			Ratio number			Ratio number (max)		
	Proving time (min)																	
	45	**90**	**135**	**45**	**90**	**135**	**45**	**90**	**135**	**45**	**90**	**135**	**45**	**90**	**135**	**45**	**90**	**135**
A	150^{a} ±2.30	144^{b} ±5.69	106^{c} ±0.85	592^{c} ±2.61	1028^{a} ±2.30	868^{b} ±1.11	161^{a} ±4.95	129^{b} ±6.02	111^{c} ±5.79	810^{c} ±6.52	1069^{a} ±8.15	869^{b} ±7.45	3.80^{e} ±0.17	8.00^{a} ±0.29	7.90^{b} ±0.26	5.20^{h} ±0.04	8.30^{b} ±0.15	7.90^{c} ±0.12
B	53^{d} ±5.14	40^{e} ±4.74	32^{f} ±1.11	441^{d} ±1.45	367^{e} ±1.29	270^{f} ±2.46	86^{d} ±2.34	74^{e} ±1.76	74^{e} ±4.53	472^{d} ±4.13	452^{f} ±4.67	338^{h} ±4.16	5.20^{c} ±0.21	5.00^{d} ±0.12	3.60^{f} ±0.14	5.50^{g} ±0.05	6.10^{f} ±0.08	4.60^{j} ±0.06
C	32^{f} ±2.39	19^{h} ±1.67	15^{i} ±1.05	185^{g} ±2.37	70^{j} ±4.79	134^{i} ±0.95	59^{f} ±1.76	49^{h} ±2.11	52^{g} ±3.16	416^{g} ±3.41	293^{i} ±2.88	251^{j} ±1.72	3.10^{g} ±0.09	1.20^{i} ±0.04	2.70^{h} ±0.11	7.10^{e} ±0.11	6.10^{f} ±0.08	4.90^{i} ±0.07
D	21^{g} ±1.15	10^{j} ±0.98	Nil	28^{k} ±1.46	150^{h} ±0.0	Nil	36^{i} ±2.90	32^{j} ±3.16	Nil	455^{e} ±3.20	240^{k} ±1.94	Nil	0.60^{j} ±0.00	4.90^{d} ±0.08	Nil	12.40^{a} ±0.18	7.60^{d} ±0.13	Nil
$Lsd_{0.05}$	1.8529^{**}			13.5204^{**}			3.8561^{**}			2.9518^{**}			0.7453^{*}			0.2082^{*}		
SE±	0.9631			5782			1.9735			0.7265			0.0699			0.0417		

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Values are mean±SD

Mean(s) sharing same superscript(s) in a column are not significantly ($P>0.05$) different according to DMRT.

Key:

A ≡ wheat flour free addition (control)

B ≡ sample containing 10% Moringa + 90% wheat flour

C ≡ sample containing 20% Moringa + 80% wheat flour

D ≡ sample containing 30% Moringa + 70% wheat flour

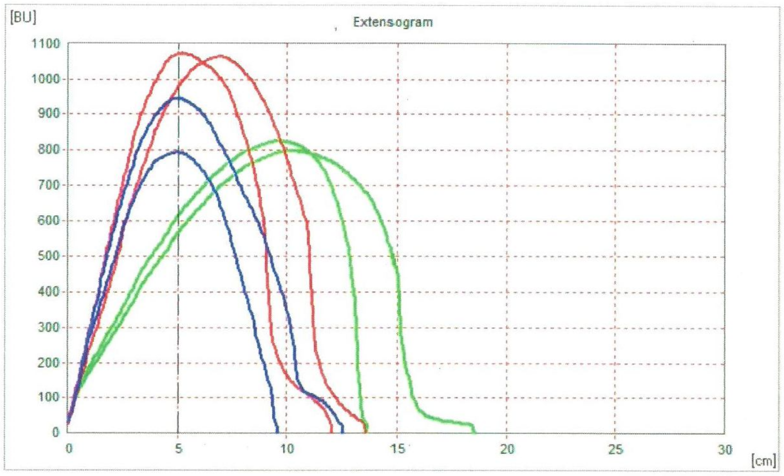

Fig.11: Extensograph of dough prepared from control wheat flour

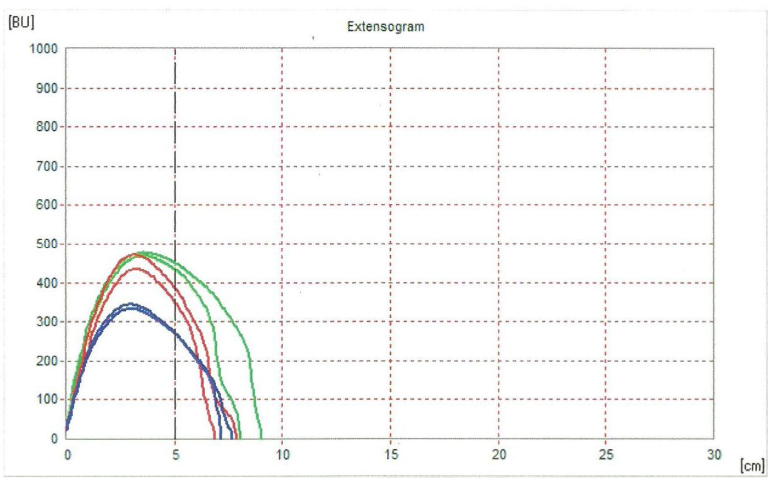

Fig.12: Extensograph of dough prepared from10%Morenga leaves powder

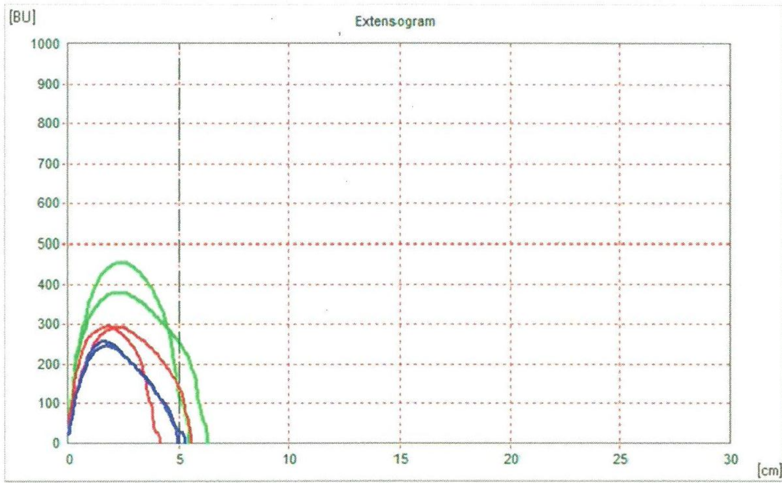

Fig.13: Extensograph of dough prepared from20%Morenga leaves powder

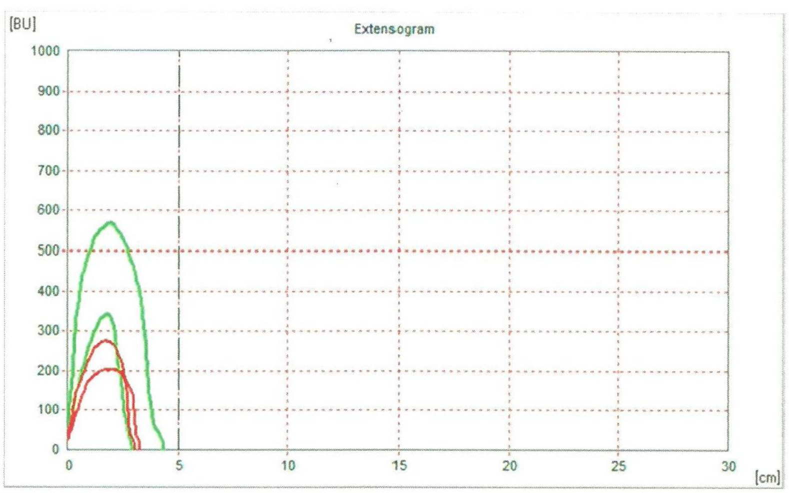

Fig.14: Extensograph of dough prepared from30%Morenga leaves powder

4.6 Bread Specific Volume

Specific volume of control wheat flour and bread loaves containing moringa leaves powder are presented in Table and Plates.

Loaf specific volume of bread made from wheat flour with and without moringa leaves powder ranged between 4.19 to 1.55 cm^3/g . The highest specific volume 4.41 cm^3/g in 10% level.

Table 4.4: Specific volume of bread sample:

Samples	**Specific volume cm3/g**
A	4.19±0.106[a]
B	2.417 ±0.006[a]
C	1.906±0.~~0.~~006[a]
D	1.55±0.006[a]
LSD 0.05	0.1196
SE±	0.~~0~~033

Mean±SD values bearing different superscript(s) within a column are significantly different (P≤0.05).

Key:
A ≡ wheat flour free addition (control)
B ≡ sample containing 10% Moringa + 90% wherat flour
C ≡ sample containing 20% Moringa + 80% wheat flour
D ≡ sample containing 30% Moringa + 70% wheat flour

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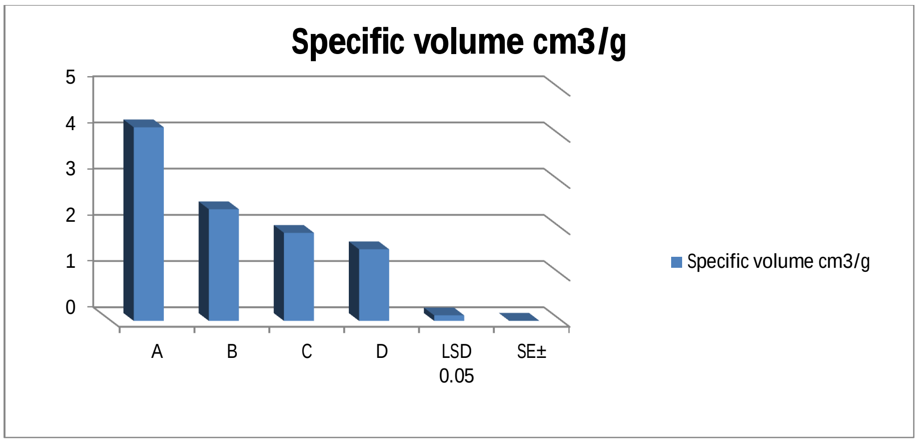

Fig.15: Specific volume cm3/g

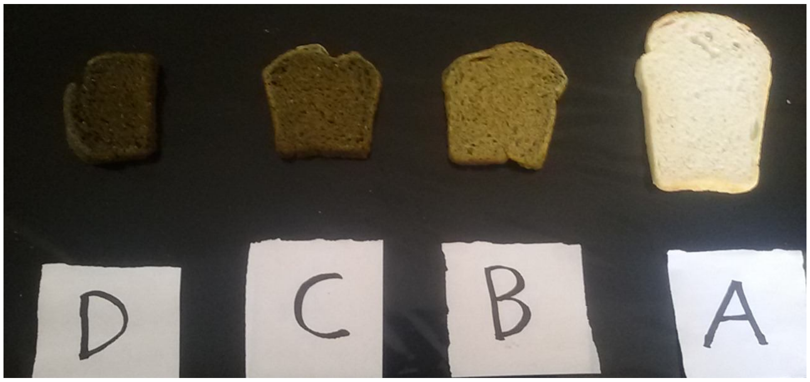

Plate 6: Bread samples containing moringa leaves powder.

A ≡ wheat flour free addition (control)
B ≡ sample containing 10% Moringa + 90% wheat flour
C ≡ sample containing 20% Moringa + 80% wheat flour
D ≡ sample containing 30% Moringa + 70% wheat flour

4.7 Sensory Evaluation:

Sensory evaluation of loaf bread from wheat flour with and without moringa leaves powder were ~~showen~~showen in table (4).

The scores of aroma, taste, crust colour, crumb texture, crumb colour, crumb cells uniformity, general acceptability. The aroma score range between 6 – 4 for three levels of moringa powder significant differences was obtained between these levels added decrease in score when moringa powder. .These treatments was gained low score with compared with control (no significant differences (P≤0.05), particularly 10 % level of moringa.

Table 4.5: Sensory Evaluation

Bread sample	Crust colour	Aroma	Taste	Crust texture	Crumb colour	General acceptability
	Sum of ranks					
A	18.00^{d} ±0.41	27.00^{d} ±0.68	26.00^{c} ±0.96	23.00^{d} ±0.92	26.00^{d} ±0.70	23.00^{c} ±1.06
B	42.00^{c} ±0.77	47.00^{c} ±0.83	50.00^{b} ±1.05	40.00^{c} ±1.23	40.00^{c} ±0.90	45.00^{b} ±0.76
C	59.00^{b} ±0.70	64.00^{b} ±0.70	64.00^{a} ±0.70	56.00^{b} ±0.88	57.00^{b} ±0.68	53.00^{b} ±0.83
D	71.00^{a} ±0.80	73.00^{a} ±0.35	70.00^{a} ±0.62	69.00^{a} ±0.63	69.00^{a} ±0.63	70.00^{a} ±0.49
$Lsd_{0.05}$	0.5047^{*}	0.4869^{*}	0.6224^{*}	0.6885^{*}	0.5375^{*}	0.5929^{*}
SE±	0.1781	0.1719	0.2197	0.243	0.1897	0.2093

Values are sum of ranks±SD

Value(s) sharing same superscript(s) in a column are not significantly (P>0.05) different according to DMRT.

Key:

A ≡ wheat flour free addition (control)

B ≡ sample containing 10% Moringa + 90% wheat flour

C ≡ sample containing 20% Moringa + 80% wheat flour

D ≡ sample containing 30% Moringa + 70% wheat flour

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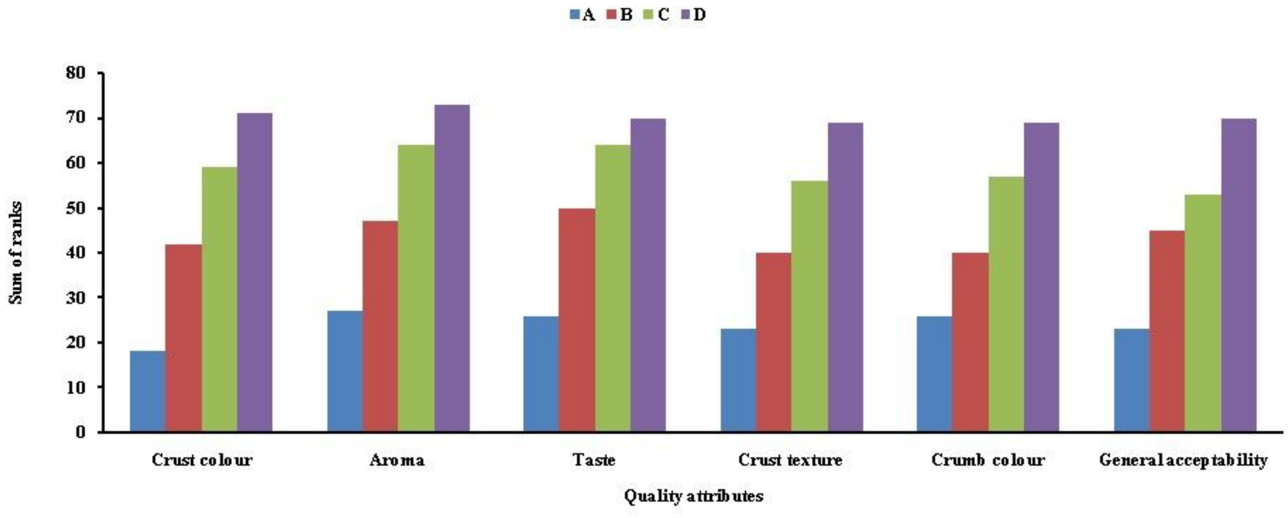

Fig.16: Organoleptic Quality of Bread Samples

CHAPTER FIVE

CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

- Moringa leaves powder contain high levels of Oil, fiber and ash therefore it is more suitable for supplementation to improve cereal based foods.
- A dough supplemented with moringa leaves powder has better rheological properties.
- Bread made of wheat dough supplemented with 10% (w/w) moringa leaves powder has higher protein content comparing to control sample without any variation in acceptability.

5.2 Recommendations

It's recommended that:

1. Using Moringa leaves powder at level of 10% in bread making.
2. Studies required to treat the green color of moringa leaves powder inorder to be used at high level of concentration for supplementation.
3. Further research in Moringa leaves powder to be carried out to develop cereal base product .

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