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Sudan University of Science and Technology

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Production of Biscuits from Pearl Millet and Rice Flour

إنتاج بسكويت من دقيق الدخن اللؤلؤي ودقيق الأرز

A dissertation submitted in partial fulfillment of the requirements for the B. Sc. degree (Honors) in Food Science and Technology

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الآية

بسم الله الرحمن الرحيم

قال تعالى:

(فَتَعَالَى اللَّهُ الْمَلِكُ الْحَقُّ وَلَا تَعْجَلْ بِالْقُرْآنِ مِنْ قَبْلِ أَنْ يُقْضَى إِلَيْكَ وَحْيُهُ وَقُلْ رَبِّ زِدْنِي عِلْمًا)

صدق الله العظيم

سورة طه الآية (114)

Dedication

To our mothers, fathers and brothers

To our extended families

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.

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Abstract

This study was conducted for the purpose of making biscuits from pearl millet and rice flour (free gluten biscuits) . Proximate analysis was performed on samples of whole millet flour and rice flour . The results of the analysis showed that the whole millet flour contains higher percentage of protein (12.4%) , fat (5.4%) , fiber (1.6%) and ash (1.8%) , while it contains less carbohydrate compared with the rice flour . It was found that the rice flour contains 0.68% of ash, 8.9% of protein ,0.64% of fat and 0.41% of fiber while containing a higher percentage of carbohydrates 74.7%. Three samples of biscuits were made in different proportions as follows :

Millet flour 87.5% and rice flour 12.5% (B), millet flour 75% and rice flour 25% (C), millet flour 50% and rice flour 50% (D) .

The chemical components of each type of biscuit were also studied. The study found that biscuits containing a higher percentage of millet have higher nutritional value than other types. The results of sensory evaluation also showed high acceptance of biscuits containing a higher percentage of millet than those containing less millet.

الملخص

اجريت هذه الدراسه بغرض صناعة بسكويت من الدخن اللؤلؤي ودقيق الأرز بسكويت (خالي من الجلوتين) وتم اجراء التحليل التقريبي علي عينات دقيق الدخن الكامل ودقيق الارز. أوضحت نتائج التحليل التقريبي أن دقيق الدخن الكامل يحتوي علي نسبه أعلي من البروتين 12.4% والدهون5.4% والالياف 1.6% والرماد 1.8%بينما يحتوي علي نسب أقل من الكربوهيدرات 74.7%مقارنه مع دقيق الأرز .حيث وجد أن دقيق الارز يحتوي على 0.68% من الرماد و 8.9% من البروتين و0.64 من الدهون و0.41 من الالياف بينما يحتوي علي نسبة اعلي من الكربوهيدرات 79.1% . تمت صناعة ثلاثه عينات من البسكويت بنسب مختلفه وكانت نسب الاضافه كالاتي :

دقيق دخن لؤلؤي87.5 % و دقيق أرز 12.5 (B) , دقيق دخن لؤلؤي 75% و دقيق أرز 25% (C) , دقيق دخن لؤلؤي 50% ودقيق أرز 50% (D).

وأيضا تمت دراسة المكونات الكيميائية لكل نوع من البسكويت .اثبتت الدراسه أن البسكويت المحتوي علي نسبة أعلي من الدخن ذو قيمة غذائية عالية مقارنة بالانواع الاخري. كما أظهرت نتائج التقييم الحسي درجة القبول العالية للبسكويت المحتوي علي نسبة أعلي من الدخن مقارنة بتلك المحتوية علي نسبة أقل من الدخن.

CHAPTER ONE

1. INTRODUCTION

Baked products have popularities in the populace because of their availability, ready to eat convenience and having good shelf life **(Kumar *et al*., 2013).** Because of their low moisture content this ensures less chance of microbial spoilage, therefore large scale production and distribution spossible **(Dhankar, 2013).** Common bakery products include biscuits, cookies, pastries, muffins, cake, bread etc. Biscuits, among all the bakery products, are more significant since they are vastly used as snacks by children and adult **(Dhankar, 20013).** Attempts are being made in recent days to improve nutritional qualities and functionalities of biscuits, due to competition in the market for healthier, natural functional products, in cost effective manner **(Masoodi and Bashir, 20012).** It is produced by mixing various ingredients like flour, fat, sweeteners and water to form dough. The dough formed unlike bread is not allowed to ferment, and then it is baked in the oven**(Lake ,1980).**

Gluten intolerance person (Celica) allergic to gliadin , millets are the gluten free there for , attempts are made for the formulation of biscuits , in which wheat flour partially replaced with pearl millet flour and fortified with rice milled .

Pearl millet is one of important millet grown in tropical and semi arid region of the world. Millet are indigenous African cereals that, un like wheat or rice , are well adapted to African semi -arid and sub tropical agronomic condition. Millet grow under difficult ecological conditions and tolerate poor soil and a certain degree of drought batter than any other cereal crop **(Obilana, 2003) .**

Pearl millet is a good source of Protein , minerals and energy Except of lysine deficiency, pearl millet has well -balanced protein, with higher threonine and lower leucine content than sorghum protein. Tryptophan levels are generally higher in pearl millet than in other cereal **(Chung and Pomeranz, 1985).** less starch, flavonoids and phenolic acid are both highly active antioxidant which is present in pearl millet.

Rice, oryza sativa is the world, s second most important cereal crops .Rice is the major caloric source.Nearly2.5 billion people depend on rice as their main food.Rice is cultivated mostly in developing countries and its primary source of income for employment for more 100 million households in Asia and Africa**(FAO, 2004).**

Rice is whole some nutritious cereal grain and it has qualities, which make it ideally suited for specific need. It is used almost exclusively as direct human food. Rice grain containing 100% amylopectin is called glutinous or waxy rice. A complex carbohydrate with no cholesterol or sodium, rice is nearly fat, rich in vitamin andminerals, and very easy to digest.

Rice containavery high percentage of carbohydrate, which reach 76% in decorticated rice. The protein in rice is well balanced because all essential amino acid are present and proper proportion 10%. Rice contain only traces of fat and ash 1 %**(Awok *et al.*, 1996).**

Rice is consumed as milled rice after dehulling process and whitening. After whitening parts of rice were removed which has low starch content but has high percentage of oil,protein, vitamin and minerals (**EL.Hissewy *et al.*, 2002)**

Main objective :

-To utilize rice and millet flour in making biscuits free gluten , for gluten intolerant people .

Specific objectives :

1- To determine the proximate composition of millet and rice .
2- To determine the proximate composition of biscuits .
3- To evaluate the organoleptic characteristics of biscuits .

CHAPTER TWO

2. LITERATURE REVIEW

2.1 Pearl millet:

2.1.1 Classification of Pearl Millet

Kingdom: plants

Sub kingdom: Tracheobionta (vascular plants)

Super division: Spermato photo (seed plants)

Division: Mangnoliophyta

Class: Liliopsida . Monocotyledons

Sub class: Commelinidae

Order: Cyperales

Family: Poaceae . Grass Family

Genus: Pennisetum . Fountain grass

Species: Pennisetum glacum **(Baker,2003)**

2.1.2 Regions of cultivation

It is commonly grow as a grain crop in the semi-arid region of west Africa, the driest parts of east Africa and the Indian sub-continent. In Australia,south Africa and united states, It is grow as a feed crop.

The bulk of this crop is grow in India and several Africa countries**(Nour, 1986).**

Production statistics on millet often combine data on all millet species. Estimates based on total millet production and relative importance of pearl millet indicate annual production of 13 million ton from a planted area of 25 million hectare the largest acreages occur in India and the dry region of Africa **(FAO Statistics cpc, 2005).**

Pearl millet is grow in the Sudan on the sandy soils of Darfur and Kordofan and in upper Nile, Bahr ELgazal and Equatoria.It is cultivated in small patches in Damazin , Gedarif and Gezira states in some parts of the eastern state is produced by flood irrigation . Whereas in central, eastern and South East state it is produced on clay plains under rains. However, Pearl millet is major cereal crops in western Sudan. Over 90% of Sudanese Pearl millet is grows in Kordofn and Darfur states **(Hassan and Hussein, 2015).**

2.1.3 Uses

2.1.3.1 Health benefits of millets

2.1.3.1.1 Millets and Diabetes

Lower incidences of diabetes have been reported in millet-consuming population. Millet phenolic inhibits like alpha-glycosidase, pancreatic amylase reduce postprandial hyperglycemia by partially inhibiting the enzymatic hydrolysis of complex carbohydrates **(Shobana *et al.*, 2009).** Inhibitors likealdose reeducates prevents the accumulation of sorbitol and reduce the risk of diabetes induced cataract diseases **(*Chethan et al*., 2008)**.

Finger millet feeding controls blood glucose level improves antioxidant status **(Chethan *et al*., 2008)** and hastens the dermal wound healing process in diabetic rats**(Rajasekaran *et al*., 2004) .**

2.1.3.1.2 Millets and cardiovascular disease

Millets are good sources of magnesium that is known to be capable of reducing the effects of migraine and heart attack. Millets are rich in phyto-chemicals containing phatic acid which is known for lowering cholesterol. (**Coultably *et al.*, 2011)** Finger millet may prevent cardiovascular disease by reducing plasma triglycerides in hyperlipidemic rats **(Lee *et al.*, 2010).**

2.1.3.1.3 Millets and celiac disease:

Celiac disease is an immune-mediated enteropathy triggered by the ingestion of gluten in genetically susceptible individuals. Millets are gluten-free, therefore an excellent option for people suffering from celiac diseases and gluten-sensitive patients often irritated by the gluten content of wheat and other more common cereal grains **(Saleh *et al.*, 2013).**

2.1.3.1.4 Millets and cancer:

Millets are known to be rich in phenolic acids, tannins, and phytate that act as “ant nutrients” However; these ant nutrients reduce the risk for colon and breast cancer in animals. It is demonstrated that millet phenolics may be effective in the prevention of cancer initiation and progression in vitro **(Chandrasekhar and Shahidi, 2011).**

2.1.3.1.5 Millets and anti-Inflammatory activity:

Ferulic acid is very strong antioxidant, free radical scavenging and anti- inflammatory activity. Antioxidants significantly prevent tissue damage and stimulate the wound healing process. It is reported good antioxidant effects of finger millet on the dermal wound healing process

in diabetes induced rats with oxidative stress-mediated modulation of inflammation. **(Rajasekaran *et al.*, 2004).**

2.1.3.1.6 Millets and aging:

The chemical reaction between the amino group of proteins and the aldehyde group of reducing sugars, termed as nonenzymatic glycosylation, is a major factor responsible for the complications of diabetes and aging. Millets are rich in antioxidants and phenolics; like phytates, phenols and tannins which can contribute to antioxidant activity important in health, aging, and metabolic syndrome. **(Hedge *et al.*, 2002)**.

2.1.3.1.7 Millets and antimicrobial activity:

Millets fraction and extract have been found to have antimicrobial activity. Seed protein extracts of pearl millet, sorghum, Japanese barnyard millet, foxtail millet, samai millet and pearl millet were evaluated in vitro for its ability to inhibit the growth of Rhizoctonia solani, Macrophomina phaseolina, and Fusarium oxysporum. Protein extracts of pearl millet are highly effective in inhibiting the growth of all 3 examined phytopathogenic fungi **(Raelhajeyalakahmi *et al.*, 2003).**

2.1.3.3 Pearl Millet used as food

His grow mainly for the grain which serves as the staple food for the inhabitants of those parts of the country. The grain is grounded into flour and eaten as bread, porridge and native beers (**Dep. Agricultural Economics, Annual report, 2004).**

2.1.3.2 Medical uses of Pearl Millet

Table 1: Shows medicinal uses of pearl millet

Disease	Benefits	Positive Factors in Pearl Millet
Anemia	May help in increasing Hb	High iron content (8mg/100g) High Zinc content(3.1mg/100g)
Constipation	May help in dealing with constipation	High fiber (1.2g/100g)
Cancer	Anti-cancer property Inhibit tumor Development	
Diabetes	Help in dealing with diabetes	Has Low glycemic index
Celiac	Anti-Allergic	Gluten free
Diarrhea	Probiotic treatment	Lactic acid bacteria
NCDs	Inhibits DNA scission, LDL cholesterol, liposome oxidation and proliferation ofHT-29 adenocarcinoma Cells.	Flavonoids, phenolics Omega 3 fatty acids
Helps in	Pearl millet has a large amount of	Due to large amount of phosphorus.
bone growth development and repair	Phosphorus. Phosphorus is very essential for bone growth and development as well as for development of ATP which is the energy currency of our body.	Phosphorus.
Stomach Ulcers	Pearl millets recommended for curing Stomach ulcers. The most common cause for stomach ulcers is excess acidity in the	Prevents formation of excess acidity.

	stomach after food intake. Pearl millet is one of the very few foods that turns the stomach alkaline and prevents formation of stomach ulcers or reduces the effect of ulcers.	
Heart health	The lignin and phytonutrients in millet Acts as strong antioxidants thus preventing heart related diseases. This is why,pearl millet is considered good For heart health. High amounts of magnesium present in pearl millet have been shown to on troll blood pressure and relieve hearts tress.	The lignin and python utrients in millet acts Strong antioxidants thus p revent in heart.
Respiratory problems for asthma patients	Pearl millet contains high concentration Of magnesium which helps reduce severity of respiratory problems for asthma patients and is also effective in reducing migraine attacks	Due to high amount of magnesium
Weight loss (Obesity)	Pearl millet can aid the process of Weight loss as it is high in fiber content. Owing to its fiber content it takes longer for the grain to move from the stomach to the intestines. This way, pearl millets at iates hunger for a long period of time and thus helps in lowering the overall consumption of food.	Due to high fiber content
Preventing **Gallstones:**	The high fiber content in pearl millet is Also known to reduce the risk of gall stone occurrence. Then soluble fiber content in pearl millet reduces the production of	Due to high in fiber content

	excessive bile in our system. Excessive amount of bile secretion in our intestine often leads to aggravate the condition of gallstones.	
Anti-allergic properties:	Pearl millet is a treasure trove of Beneficial properties. The grain is very digestible as such and has a very low Probability of causing allergic reactions. Due to its hypo allergic property, it can be safely included in the diets of infants, lactating mothers, elderly and convalescents.	Due to its hypo allergic property

Source: Malik (2015)

It is used in Sudan as flour making "Kisra" which is a thin bread from fermented dough or stiff porridge known locally as "Asida" a thin porridge "Nash" and "Madeedah" Damergah and "Umjener" **(Dep. Agricultural Economics , Annual report , 2004)**

2.1.2.4 Other uses

The straw is used as animal feeding, fuel and for making fences and the stalks are used for thatching and building **(Dep. Agricultural Economics, Annual report, 2004).**

2.1.4 Nutritional Value

The nutritional properties of pearl millet have received more attention that those of the other common millets, because it is the largest-seeded, most widely grown type **(Hoseney *et al.*, 1989).** Pearl millet is low in lysine, tryptophan, threonine and the sulfur-containing amino acids. In an evaluation of several cereals, methionine content was found to be highest in prosody, followed by sorghum, pearl millet, and maize.

The level of lysine content of pearl millet grain on a dray matter basis was 0.357%, 21% greater than corn and 36% greater than low-tannin sorghum **(Sullivan *et al*., 1990).** With icrearising protein, lysine as a percent of protein decreases, but as yields go up, the total lysine per hectare will increase. Generally the amino acid profile of pearl millet compares favorably with that of wheat, barley and rice **(Hulse *et al*., 1980)**. Seed proteins of pearl millet showed the essential amino acid leucine is the highest, but threonine, lysine and the sulfur containing amino acids were lower. The results indicate that this grain has a good nutritive value **(Basahy, 1996).**

Biological value of millet protein alone was 63.8 and was 84.2 when supplemented with lysine and threonine**(Nishizawa *et al*., 1989).**

Sorghum and millet cultivars were evaluated for nutritive values as affected by maturity, results indicated positively with lignin and other cell well constituents, but negatively with crude protein, degradability of dry matter and inorganic nutrients. There was no significant difference in the nutritive values of sorghum and millet cultivars **(Aganga *et al*., 1996).**

In comparison between sorghum and pearl millet, the phosphorus content was high in both grains while calcium was low; also they were low in sulphur amino acid and lysine. Sorghum and millet were similar in their proximate constituents **(Nwokolo, 1987).**

Milling of pearl millet grains affected its gross composition, while milling and heat treatment during chapatti (an unleavened bread) making significantly lowered polyphenols and phytic acid and significantly improved the protein and starch digestibilites, but baking did not significantly affect the nutrient content of raw pearl flour **(Chowdhury and Punia, 1997).**

Table 2: Pearl millet nutrition facts amount: 1cup Weight: 200g

Nutrients	Amount(gram)
Basic Components	
Proteins	22 g
Water	17.3 g
Ash	6.5
Calories	
Total Calories	756
Calories from Carbohydrates	600
Calories from Fats	71
Calories from Proteins	85.3
Carbohydrates	
Total Carbohydrates	146
Dietary Fiber	17 g
Fat and Fatty Acid	
Total Fat	8.4 g
Saturated Fat	1.4 g
Monounsaturated Fat	1.5 g
Polyunsaturated Fat	4.3 g
Omega-3 Fatty Acids	236 mg
Omega-6 Fatty Acids	4 g
Vitamins	
Vitamin E	100 mcg
Vitamin K	1.8 mcg
Thiamine	842 mcg
Riboflavin	580 mcg
Niacin	9.4 mg
Vitamin B6	768 mcg
Foliate	170 mcg
Pantothenic Acid	1.7 mg
Minerals	
Calcium	16 mg
Iron	6 mg
Magnesium	228 mg
Phosphorus	570 mg
Potassium	390 mg
Sodium	10 mg
Zinc	3.4 mg
Copper	1.5 mg
Manganese	3.3 mg
Selenium	5.4 mcg

Source: Malik (2015).

2.1.5 Chemical composition of pearl millet

2.1.5.1 Moisture content

The moisture content of pearl millet ranged from 7.8 to 14.2% as reported by (**Hoseney, 1986).** The moisture content of local Sudanese millet varieties ranged from 10.6 to 11.7% as reported **by Khatir (1990). Eltayeb (2006),** reported values of 5.4% and 6.48% for moisture content of two Sudanese pearl millet cultivars.

2.1.5.2 Crude Protein Content

Among millet contains a higher protein content and better amino acid balance than sorghum. Large variations in Protein content from 6% to 12% have been observed **(Serna-Saldivar *et al.*, 1991)**.The higher ratio of germ to endosperm was found to be responsible for the higher Protein content of Pearl millet (**Dendy ,1995; Abdullah *et al.*, 1998 and Subramanian *et al.*, 1986**) reported that the Protein content of Pearl milled genotype ranged from 8.5 to 15.% and from 8.6 to 15.6% , respectively. **Abdallah (2003)** reported 12.5 and 13.6% Protein content for two Pearl millet cultivars . **Khatir (1990)**,found the protein content of local Sudanese varieties ranging between 14.2 to 15.5% which is higher than sorghum maize and rise.

2.1.5.3 Ash content

Pearl millet varies in ash content from 1.2 to 3.4% .**Barton *et al.* (1972)** gave range from 1.46% to 3.88%. For Sudanese cultivars **Abdullah *et al.* (1996) ,** reported a range from 1.6 to 2.4%.for two pearl millet cultivars. **Eltinay *et al.* (2005)** reported 1.8% and 1.6% ash content for two pearl millet cultivars.

2.1.5.4 Crude fiber content

The fiber of Sudanese local varieties ranged from 3.18% to 3.67% **(Khatir, 1990). Eltinay *et al.* (2005)** reported 2.4 and 8.6% fiber for two pearl millet cultivars**. Abdalla (1996)** reported values between 2.6% to 4.0% fiber content.

2.1.5.4 Crude fat content

In contrast of other cereal pearl millet has highest content due to the large proportion of the germ to the endosperm. Ether_extractable lipids ranged from 3.0 to 7.4%, they are mostly in the germ **(Hulse *et al.*, 1980). Eltinay *et al.* (2005)** investigated two pearl millet cultivars and reported 6.1% and 5.4% oil content.

Hadimani *et al*. (1995) found oil content in the range of 3.4 to 7.4%.

2.1.5.7 Carbohydrate content

In general carbohydrate component is about 75% of the content of cereal .The cereal major groups of carbohydrate are sugar, starches and cellulose and related materials **(Hulse *et al.*, 1980). Abdullah *et al*. (1998)** stated that the carbohydrate content of pearl millet ranged form 58.5% to 70.67% for ten pearl millet cultivars**. Eltayeb (2006)** investigated two pearl millet cultivars and reported 73.67% and 68.55% carbohydrate content.

2.2 Rice

Rice, oryza sativa is the world, s second most important cereal crops .Rice is the major caloric source.Nearly2.5 billion people depend on rice as their main food. Rice is cultivated mostly in developing

countries and its primary source of income for employment for more 100 million households in Asia and Africa **(FAO, 2004).**

Rice is whole some nutritious cereal grain and it has qualities, which make it ideally suited for specific need. It is used almost exclusively as direct human food. Rice grain containing 100% amylopectin is called glutinous or waxy rice. A complex carbohydrate with no cholesterol or sodium, rice is nearly fat, rich in vitamin and minerals, and very easy to digest. Rice contains a very high percentage of carbohydrates, which reach 76% in decorticated rice .

The protein in rice is well balanced because all essential amino acid are present and in proper proporation (10%). Rice contains only traces of fat and ash(1%).

2.2.1 Cultivates of rice in Sudan

In the Sudan ,there is a plenty of land suitable for rice production, which was estimated by 300000 hectares in White Nile ,Bahr Elgazal ,South Darfur,Gadarif and Blue Nile State. Rice in Sudan has been grown since 1905,but on a very limited acreage and information about methods of production are lacking **(Farah,1981).**Swamp and Upland varieties were first tried at the Gezira Research Farm in 1951.Later, extensive rice trials were carried out at Malakal and several varieties were selected the Gezira Research Station .Although rice cultivation in the Sudan was known for some times, especially in Southern Sudan and White Nile areas, large –scale production started only for security reasons production was abandoned. Rice production was started once again along the White Nile at Abu Gassaba **(Awok *et al* ., 1996*).***

2.2.2 Nutritional value of rice

A detailed analysis of nutrient content of rice suggests that the nutrition value of rice varies based on a number of factors. It depends on the strain of rice that is between white, brown, black, red and purple verities of rice-each prevalent in different parts of the world. It also depends on nutrient quality the soil rice is grown in, whether and how the rice is polished or processed, the manner it is enriched, and how it is prepared before consumption **(Juliano,1993).**

Rice is consumed as milled rice after dehulling process and whitening (removal of pericarp, bran layer and embryo from brown rice). After whitening parts of rice were removed which has very low starch content but has high percentages of oil, protein, vitamins and minerals, **(El-Hissewy *et al.*, 2002)**. Rice is a great source of complex carbohydrate which gives as the energy we need. According to FAO, rice provides 20% of the world's dietary energy supply.

2.2.3 Uses of rice

Consumed largely in the boiled state in United States of milled rice. Sold rice is used in manufacture of breakfast food, the flour is common ingredient of cake mixtures .In Japan used in cakes, salted bean paste,soy sauce and making rice wine.

Rice bran and polish are used as feed for livestock, germ faction of the bran my eventually provide rice oil its manufacture in soap**(Warren and John, 1983).**

2.2.4 Chemical composition

Table 3: Chemical composition of rice

Components (%)	Raw rise
Moister	12.09±0.38
Fat	1.10±0.14
Proteins	7.350±0.212
Fiber	1.25±0.07
Ash	0.33±0.02
Carbohydrates	77.89±0.78

Source : Mohammed (2015).

2.3 Biscuits:

Biscuits are a popular food stuff consumed by a wide range of population due to their varied taste, long shelf life and relatively low cost. Because of composition in the market and increased demand for healthy natural sand functional products, attempts are being made to improve the nutritive value of biscuits and functionality by modifying their nutritive composition **(Massodi and bashir, 2012).**

Cookies are products made from soft wheat that are characterized by formula high in sugar and shortening (substituted by fat) and relatively lowing the water. Similar products made in Europe and the United Kingdom are called "biscuits". The American actually chemically leavened bread or a bun is unique to the United State. It has become quite popular, particularly in fat-food establishment (**Hoseney, 1986).**

2.3.1 Biscuits ingredients:

The basic ingredients of biscuits are:

2.3.1.1 Flour

For biscuits soft wheat with high extensibility and low elasticity and (9-9.5%) protein content is used generally**(NCFM, 2003).**

The water is added as tougher**(Matz, 1968).**

Biscuits not only vary in looks and taste but also in the type of flour needed to produce a desirable product.

2.3.1.2 Sugar and syrup

Sweetener is an important component for cookies formula ; it affects the flour , texture and appearance. It is either added as granulated or powder to cookie mixture **(Matz, 1968)**

2.3.1.3 Shortening

Fat such as butter, shortening and oil is essential ingredient in baking**(Philips, 2003).**

2.3.1.4 Milk powder

The dried milk is more preferred because of convenience of use and their stability. We added milk for color improvement, water absorbing and spread control properties and flavor.

2.3.1.5 Sodium bicarbonate or ammonium bicarbonate

The most common used sources of carbon dioxide are sodium and ammonium bicarbonates. When heated, ammonium, bicarbonate breaks up to give three gases, as known below.

$$NH_3\ HCO_3 \longrightarrow NH3+CO2+H2O$$

[eq.1]

The most popular leaving agent by far is sodium, bicarbonate (baking soda). It is popularity I based upon a number of advantages it offers:

1. The commercial product is of high purity

2. Low cost

3. It is nontoxic

4. Easy to handle

2.3.1.6 Salt

It used in little amount about 1% and it affects the texture and taste .

2.3.1.7 L-cysteine

It is a reducing agent , the three most important reasons to include a reducing agent in the recipe is reducing of mixing time , decrease in dough resilience , and the use of activated dough development . Around 1970, the use of L-cysteine , in combination with an oxidant was very popular in activated (or chemical) dough development **(Sluimer,2005)** .

2.3.2 Method of biscuits making

2.3.2.1 The single stage method

In this method all the ingredients are added in one stage but the mixing speed and time may differ. The single stage method has the advantage of giving greater mixing tolerance for most cookie doughs

2.3.2.2 The continues method

There is no variation in speed or distinct separation to phases. Continues equipment is used for true batter. **(Matz, 1968)**.

2.3.2.3 Mixing

The mixing method is classified into, multi stage or creaming method, the simplified single stages method and the continuous method.

The multi stage method is done in many stages using different ingredient during the mixing process. It requires initiating with the shortening and some and sometimes the syrup, then adding sugar followed by addition of other ingredient.

The mixing process continues at low or medium speed until all the component became a homogeneous mixture and the mixer takes up air in form of bubbles.

The creaming mixing process has benefit effect in fat-coating that delays solubilization or, hydration of sugars and flour, and the incorporation of small air bubbles which assists in leavening and establishing the structure of the finished cookie.

2.3.2.4 Shaping and baking

After the mixing, the biscuit dough is ready to be shaped. There are two ways to shape the dough, roll and cut, or drop for rolling and cutting, the dough rolled with a rolling pin into a rectangle in floured work surface. The rolling and kneading with flakiness biscuits cutter, about 2-3 inches in diameter. The cutting must be done to many biscuits as possible as in one time to make the least amount of scrapes then the pieces are placed in a greased baking sheet.

The dropping method is an easy way to make biscuit by the dropping the dough in an irregularly shape into greased baking sheet by the lightly floured fingertips. The dough is more sticky but it does not need more flour to work with. The shaped dough, then put in a well preheated oven from 205-250c **(Phillis, 2003).**

CHAPTER THREE

MATERIALS AND METHODS

3.1 Materials

3.1.1 Food materials

Pearl millet seed cultivar (yellow) was purchased from Bahry market Sudan. Also rice seed were purchased from Bahry market Sudan.Paking material were obtained from Bahry market as well.

3.2 Methods

3.2.1 Sample preparation

Pearl millet grains and rice seeds were cleaned and freed from any foreign materials, and then ground to flour using commercial mill (sieve 0.4mesh sieve.)..The flours were packed in polyethylene bags and stored until needed for further investigation.

3.2.2 Analytical methods

The determination of moisture, ash, fat, and crude fiber were carried out according to the standard official methods of analysis **(AOAC, 2003)** and determination of crude protein to **AOAC (1984).**

3.2.2.1 Moisture content determination

Two grams of well – mixed samples were weighed accurately in clean preheated moisture dish of known weight by using sensitive balance. The uncovered sample and dish were kept in an oven provided with a fan at $105^{o}C$ and left to stay overnight. The dish was covered and transferred to a desiccators, and weighed after reaching room temperature. The dish was heated in the oven for another two hours and was re- weighed. This was

repeated until constant weight was obtained. The loss of weight was calculated as percent of weight and expressed as moisture content.

$$\text{Moisture content (\%)} = \frac{W_1 - W_2}{\text{Sample weight}} \times 100$$

[eq.2]

Where:

W_1 = Weight of sample + dish before oven drying. W_2 = Weight of sample + dish after oven drying.

3.2.2.2 Ash content determination

A crucible was weighed empty, and then accurately two grams of sample**s** were put in it. The sample and the crucible were placed in a muffle furnace at 550 ^{O}c for 3 hr or more until white grey or reddish ash was obtained. The crucible was removed from furnace and placed in a dedicator to cool, then was reweighed. The process was repeated until constant weight was obtained.

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

[eq.3]

Where:

W_1 = weight of empty crucible

W_2 = weight of crucible + sample after ashing

W_s = weight of dry sample.

3.2.2.3 Crude protein determination

Crude protein was determined according to the method of **AOAC (1984)** using micro- Kjeldahl nitrogen digestion and distillation method as follows:

Twenty mille gram of oven dried sample was weighed into 100 ml Kjldahl flask, and 0.4 g of catalyst mixture (96% anhydrous sodium sulphate + 4% cupric sulphate) was added with 3.5 ml of concentrated sulphuric acid. The sample and contents were heated on an electric heater for two hour (hr). The sample was cooled. diluted and placed in the distillation apparatus. Amount of 20 ml NaOH 40% were added, and distilled for 7 min. The ammonia evolved was received in 10 ml of 2% boric acid solution, contained in a conical flask attached to the receiving end. The trapped ammonia was titrated against 0.02 HCL using a universal indicator (methyl red + bromocresol green). The protein (%) was calculated using the following equation:

$$\text{Crude protein (\%)} = \frac{(\text{ml HCI} - \text{ml HCI Blank}) \times 0.02 \times 14 \times F \times 100}{\text{Dry sample weight} \times 1000}$$

[eq.4]

Where:
0.02 = normality of HCI.

14 = nitrogen molecular weight.
1000 = to convert from g equivalent to mg.

F = Factor (5.7 for wheat flour, 6.25 for other grains)

3.2.2.4 Crude fat determination

Two gram of oven dried ground sample were weighed. Extraction of the fat from each sample was carried out by Soxhlet using n. hexan as a solvent for 8 hr. After recovery of the solvent, the fat was dried in the oven at 105 ^{o}C for two h, then allowed to cool in a desicator, and finally weighed to a constant weight. The percentage of the crude fat was calculated using the following equation:

Where:

$$\text{Dry Crude fat (\%)} = \frac{W_2 - w_1}{\text{Dry sample weight}} \times 100$$

[eq.5]

W2= The weight of the empty extraction flask

W_2= The weight of the extraction flask with the extracted oil.

3.2.2.5 Crude fiber determination

Two g of dry defatted sample were weighed. One hundred and fifty ml of the H_2SO_4 (conc.7.3 ml/L) were added and then heated to boiling. The mixture was boiled for 30 min and then filtered. The residue was washed three times with hot water. The 150 ml of pre-heated KOH (12.89 g/L) were added and heated to boiling for 30 min and then filtered. The residue was washed three times with hot water, dried under suction and then in an oven at 105 ^{o}C overnight and then weighed (W_1). The residue was ashed in a muffle furnace at 550 ^{o}C for three hours till a light grey ash was formed, and then weighed (W_2). The percentage of the crude fiber was calculated using the following equation:

$$\text{Crude fiber (\%)} = \frac{W_1 - W_2}{\text{Dry sample weight}} \times 100$$

[eq.6]

Where:

W_1 = The weight of oven dry sample after treatment by H_2SO_4 and KOH

W_2 = The weight of e treated sample after ashing.

3.2.2.6 Total carbohydrates content

Total carbohydrates were calculated by difference. The summation of moisture, ash, crude protein, crude fiber and crude fat contents was subtracted from 100 to obtain the carbohydrates by difference .

3.2.2.7 Food metabolized energy value:

The energy value of biscuits was calculated based on Atwater factors for protein , fat and available carbohydrates as indicated by **Leng (1968).**

Fat factor = 8.37(Kcal/g)

Protein factor = 3.87(Kcal/g)

Carbohydrate factor = 4.12(Kcal/g)

1cal =4.184(Kj)

3.2.3 Preparation of millet and rice biscuits

Biscuits were generally prepared according to **Vatsala and HaridsRao (1991)** method. The formula used in biscuit processing was as follows:

Ingredient	Quantity (g)
Biscuit flour	100
Sugar powder	30
Shortening	30
Skim milk powder	2
Sodium chloride	1
Sodium bicarbonate	0.4
Ammonium bicarbonate	1.5
Glucose	2
Water	15 ml

Procedure:

Sugar powder, skim milk, sodium bicarbonate, sodium chloride and ammonium sulphate were added to 500 gram of millet flour and rice flour. Then added butter and glucose were added and mixed. Then water was added to get dough, recycle the dough and shaped, then baked biscuits in oven. The baked biscuits were cooled at room temperature.

3.2.4 Sensory evaluation of biscuits

Seventeen panelists from the Faculty of Agriculture University of Sudan. were carried the test as prescribed in Appendix(V).

3.2.5 Statistical analysis

One –way ANOVA were performed to examine significant differences between normally distributed data of replicated measurement . probability level of less than 0.05 was considered significant ($p \leq 0.05$). All data were analyzed using vision 17MINITAB statistical soft ware for windows (2007).

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 Proximate composition of flour pearl millet

The chemical composition of pearl millet is shown in Table (4).The results are expressed on dry basis.

4.1.1 Moisture content

The data showed that the moisture content of flour pearl millet was 11.71% .The result is within the range reported by **Johnson and Sinha (1964) and Agarwal and Sinha (1964**) who reported that the moisture content for pearl millet in the range 11.9%_ 12% respectively , also in line range reported by **Ahmed (1999)** who reported that the moisture content pearl millet was 11.7% . But is reported by **Abdulla (1996)** who reported that the moisture content of pearl millet were 9.13%.

4.1.2 Ash content:

The ash content was found to be 2.09% . The results is within the range reported by **Burton *et al*. (1972)** who reported values 1.2% to 3.4% higher than the values, but reported by **Eltinay *et al*. (2005)** who reported values 1.8% and 1.6% . Ash content for two pearl millet cultivars.

4.1.3 Protein content:

The protein content of pearl millet flour was found to be 13.89% the result within the range reported by **Abduall (2003)** who reported that the protein content for two pearl millet cultivars in the range 12.5%_ 13.6% . Also lower than those reported by **Khatir (1990)** who reported that the protein content for pearl millet were 14.2% to 15.5%.

4.1.4 Fat content

The fat content of pearl millet flour was found to be 6.09% . The value within the range reported by **Hadimani *et al.* (1995)** who reported values 3.4% to 7.4%

4.1.5Crude Fiber

The fiber content of pearl millet flour was found to be 1.15%. The values are lower than the value reported by **Eltinay *et al.* (2005)** who reported values 2.4% and 8.6% , also is lower than reported by Abdulla (1996) who reported values 2.6% to 4.0% , but within the range 1.3% to 1.7% reported by **Singh *et al.* (1987).**

4.1.6 Carbohydrate content:

Carbohydrate was 76.8% for pearl millet flour. The value is higher than reported by **Hulse *et al.* (1980)** who reported value 75% in pearl millet cultivars, also higher than the value reported by **Eltayeb (2006)** who reported that of 73% , 67% and 68% , 55% for two pearl millet cultivars.

Table 4: Proximate composition (%)of millet flour and rice flour (on wet and dry basis).

Parameter	Pearl millet		Rice	
	%on wet basis	%on dry basis	%on wet basis	%on dry basis
	N= 3±SD			
Moisture or dry matter	10.41±0.15[a]	89.59±0.11[a]	9.91±0.51[a]	90.09±0.73[a]
Ash	1.87±0.20[a]	2.09±0.22[a]	0.68±0.11[b]	0.75±0.13[b]
Protein	12.43±0.22[a]	13.87±028[a]	8.91±0.32[b]	9.89±0.21[b]
Fat	5.45±0.16[a]	6.08±0.19[a]	0.64±0.44[b]	0.71±0.32[b]
Crud Fiber	1.64±0.05[a]	1.83 ±0.07[a]	0.41±0.15[b]	0.45 ±0.16[b]
Total Carbohydrate	74.72±9.9[a]	83.40±0.46[a]	79.18±45[a]	87.89±0.79[a]

Values are mean ±SD

N=Number of independent determination

SD= Standard deviation

4.2 Chemical characteristics of biscuit wheat flour and biscuit containing different levels of pearl millet flour and rice flour.

4.2.1 Proximate composition:

4.2.1.1 Moisture content

Table (5) shows the proximate composition of biscuit wheat flour (control) and different level of millet flour and rice flour.

The moisture content of biscuits wheat flour (control) biscuit sample (A) was found to be 4.20% the value is lower than biscuits (B) 6.03% , (C) 6.44%and (D) 5.40% .

Generally the statistical analysis showed no significant different ($P \geq 0.05$) between (B) and (C) , also significant different ($P \leq 0.05$) among of control biscuits (A) and composite flour in term moisture content. It is observed that the moisture content decreasing with increase rice flour, present could be attributed to low moisture content of pearl millet flour and rice flour.

These results are contrary with data which reported by **Aljack (2009)** found that , the moisture content decreases when substituting wheat with decorticated pearl millet flour and lupin seed flour , while **Mohamed (2007)** found that the moisture content decreases when substituting wheat with teff flour.

4.2.1.2 Ash content

The ash content of (A) is 0.98% but the other samples 1.83% , 1.59%, and 1.51% for (B) , (C) and (D)respectively. The statistical analysis showed no significant differences ($P \geq 0,05$) between (A) , (B) ,

(C) and (D) in their ash content. It is observed that there ash content with decreases, increase milled rice in sample (B) , (C) and (D) .

These result are contrary to those reported by **Dhingra and Jood (2001)** who observed that the breads containing barley with full fat soy flour manifested intermediate protein connect . Also these results are no similar to reported by **Aljack (2009)** when substituting wheat with decorticated millet flour and lupin seed flour .

4.2.1.3 Fat content

The fat content of wheat flour biscuit (A) was 14.66% , the value is lower than biscuits from pearl millet flour and rice flour and found to be 19.2% , 18.9% , and 17.7% for (B), (C) and (D) respectively. The increasing fat content of biscuits (B), (C)and (D) compared with (A) due to the high content of fat in pearl millet flour , it is observed decreasing fat content with increasing rice milled in biscuits (B), (C) and (D) , due to low content of fat in rice milled. The results are contrary mentioned by **Dhingra and Jood (2001)** who observed increasing fat content with increasing supplementation of full fat soya bean with barely flour for bread production , also contrary to studied by **Aljack (2009)** who observed that fat content increase when substituting pearl millet flour and lupin seed flour , also is determined the fat content to of biscuit mad from different level of pearl millet and lupin flour and found to be 20.6%, 21.2% and 22.5% respectively.

4.2.1.4 Fiber content

The fiber content of wheat flour biscuit (A) was found to be 0.69% but in biscuit (B), (C)and (D) was found to be 1.62% , 1.23% and 1.11% respectively , this value decreased with increased rice flour. No significant difference ($P \geq 0.05$) was observed between (C) and (D). The

results are contrary to that finding for **Aljak (2009)** who reported that the level of crude fiber increases with increasing supplementation of pearl millet flour and lupine flour, in wheat flour for biscuit production from 0.29% in (A) and increased to 0.38% , 0.42 and 1.35% for (B), (C) and (D) respectively.

4.2.1.5 Protein content:

The protein content of biscuits samples is given in table (5) Wheat biscuit (A) had 14.1% , which changed significantly ($P \geq 0.05$) in biscuits (B), (C) and (D) were founded to be 16.7% , 15.8% and 15.04% respectively. These value of which were significantly higher than what was obtained by **Abdulla (2003)** who reported that the protein content of biscuit from wheat and sorghum flour were 8.49% and 8.48%. This higher different protein value due to the higher content of protein in pearl millet flour compared with sorghum and wheat.

As the percentage of milled rice increased , percentage of protein decreased , with significant different ($P \geq 0.05$) , this is due to the low level of protein in rice flour shown in table (4).

4.2.1.6 Carbohydrate content

The carbohydrate content of biscuit samples is given in table (5) wheat biscuit (A) had 67.3% , which changed significantly ($P \leq 0.05$) in biscuits (B) , (C)and (D)were founded to be 60.52% , 62.95% and 63.55% respectively. As the increase of the rice flour the percentage of carbohydrate increased , this due to the higher percentage of rice carbohydrates as shown in table (5).

4.2.1.7 Energy content

The energy content of biscuits A (control) was found to be 466.05 % the value is lower than biscuits (B) 482.04% , (C) 457.8%and (D) 456.7% Generally the statistical analysis showed no higher significant different (P≥ 0.05) between (c) and (d) , also found high significant different (P≤ 0.05) between among of control biscuits (A) and composite flour in term energy content.

4.3 Sensory evaluation of biscuits

The sensory characteristics of biscuits are shown in Table (7). Significant difference ($p \leq 0.05$) was observed between biscuit wheat flour (A) control to millet and rice flour biscuit, with respect to flavor, texture, taste, and over all acceptance except color was found to be similar.

4.3.1 Color

The color preference score varied from 1.88_ 2.8. The highest value was given by (C) 2.8 , (A), (B) and (D) give 1.88 , 2.2 and 2.5 respectively. The statistical analysis showed no significant difference (P≥ 0.05) between all biscuits.

Table 5: Proximate composition (%) of biscuit wheat flour and biscuits prepared from pearl millet flour containing different levels of rice flour(on dry basis).

Parameter	A	B	C	D
	On dry basis			
	N=3±SD			
Moisture	95.97±1.06^{b}	94.31±0.34^{a}	93.94±0.03^{a}	94.82±0.13^{ab}
Ash	0.98±0.24^{a}	1.82±0.67^{a}	1.58±0.02^{a}	1.52±0.13^{a}
Protein	14.17±0.16^{d}	16.72±0.03^{a}	15.79±0.03^{b}	15.04±0.15^{c}
Fat	14.59 ±0.15^{c}	19.26±0.005^{a}	18.98±0.13^{a}	17.71±0.13^{b}
Crud fiber	0.68±0.045^{c}	1.62±0.06^{a}	1.23±01^{b}	0,79±0.04^{c}
Total carbohydrate	69.45±1.06^{a}	60.57±0.63^{b}	62.37±0.15^{c}	64.95±0.49^{b}
Available carbohydrate	68.76±0.81^{a}	58.95±0.76^{c}	61.14±0.13^{d}	64.16±0.43^{b}
Energy (Kcal/g)	460.25±3.33^{b}	468.79±3.33^{a}	471.87±0.40^{c}	470.78±0.60^{c}
Energy(Kj)	1925.69	1961.45	1974.30	1969.74

* Values are means (± standard deviation)

* Mean values having different superscript letters in the same column are significantly different ($p \leq 0.05$).

Where:

A : Control biscuit sample . B: 87.5% biscuit millet flour + 12.5% rice flour.

C: 75% biscuit millet flour + 25% rice flour. D : 50% millet flour + 50% rice flour

Table 6: Proximate composition (%) of biscuit wheat flour and biscuits prepared from pearl millet flou different levels of rice flour(on wet basis).biscuits prepared from pearl millet flour containing differen flour (on wet basis).

Parameter	A	B	C	D
	On wet basis			
	N=3±SD			
Moisture	4.03±0.97[b]	5.69±0.31[a]	6.06±0.0265[a]	5
Ash	0.94±0.24[a]	1.72±0.63[a]	1.49±0.025[a]	1
Protein	13.60±0.03[d]	15.77±0.265[a]	14.83±0.041[b]	1
Fat	14.01±0.005[d]	18.17±0.06[a]	17.83±0.11[b]	1
Crud fiber	0.66±0.05[c]	1.53±0.05[a]	1.16±0.01[b]	0
Total carbohydrate	66.66±0.81[a]	57.13±0.76[c]	58.59±0.13[c]	6

* Values are means (± standard deviation)

* Mean values having different superscript letters in the same column are significantly different ($p \leq 0.05$).

Where:

A : Control biscuit sample

B : 87.5% biscuit millet flour + 12.5% rice flour.

C : 75% biscuit millet flour + 25% rice flour.

D : 50% millet flour + 50% rice flour.

4.3.2 Texture

The texture preference score varied from (1.94 _ 4.15). The highest value was given by (C) 4.15 due to the increasing rice. (A) , (B) and (D) give 1.94 , 2.58 and 3.0 respectively. The statistical analysis showed no significant difference ($P \geq 0.05$) between biscuits (B) and (C).

4.3.3 Taste

The taste of all biscuits except (A) is similar because the addition of rice flour to millet flour does not affect the taste of biscuits.

The statistical analysis showed no significant difference ($P \geq 0.05$) between biscuits (B) ,(C) and (D).

4.3.4 Overall acceptance

The control (A) gained the highest score of overall acceptance 2.47 while (B) , (C) and (D) gained score of 2.82 ,2.99 and 3.64 respectively.

Table 7: Sensory evaluation of biscuit prepared from biscuit pearl millet flour containing different levels of rice flour.

Biscuit	Color	Taste	Flavor	Texture	Over all acceptance
A	1.88 ±1.2[a]	2.2±1.1[a]	1.7±1.16 [a]	1.94±1.4[a]	2.471.23 [a]
B	2.2±0.9 [a]	2.5±0.79[b]	2.6±0.8 [b]	.58±1.22 [b]	2.82±0.88 [b]
C	2.5±1.03[a]	2.6±0.78 [b]	2.9±1.16[b]	3.0±1.06[b]	2.99±1.02 [c]
D	2.8±1.2[a]	2.9±1.17[b]	3.6±0.93[c]	4.15±1.007 [d]	3.64±1.05 [d]

*Values are means (± standard deviation)

* Mean values having different superscript letters in the same column are significantly different ($p \leq 0.05$).

Where:

A : Control biscuit sample

B : 87.5% biscuit millet flour + 12.5% rice flour.

C : 75% biscuit millet flour + 25% rice flour.

D : 50% millet flour + 50% rice flour

CHAPTER FIVE

CONCULSIONS AND RECOMMENDATIONS

5.1 Conclusions

- The result of the sensory evaluation showed that biscuits containing more millet flour were the most acceptable and of best nutritional value.

- Add a larger quantity of rice flour make the texture of biscuit similar to the texture to that of wheat biscuit and do not affect the taste.

5.2 Recommendations

1. Millet and rice flour can be a good choice for development of quality and nutritious convenience biscuit products.
2. Pearl millet could be recommended for addition to other cereal flour due to its relatively high protein content for attaining higher content for many food product.
3. Composite flour made of millet flour and rice flour could be used as replacement to wheat flour biscuits for people who suffer from celiac disease.
4. Millet and rice based convenience biscuit food products can perhaps be popularized through proper marketing strategies .
5. Further studies on incorporation of millet in other flours for making biscuits famine food and infant food should be conducted.

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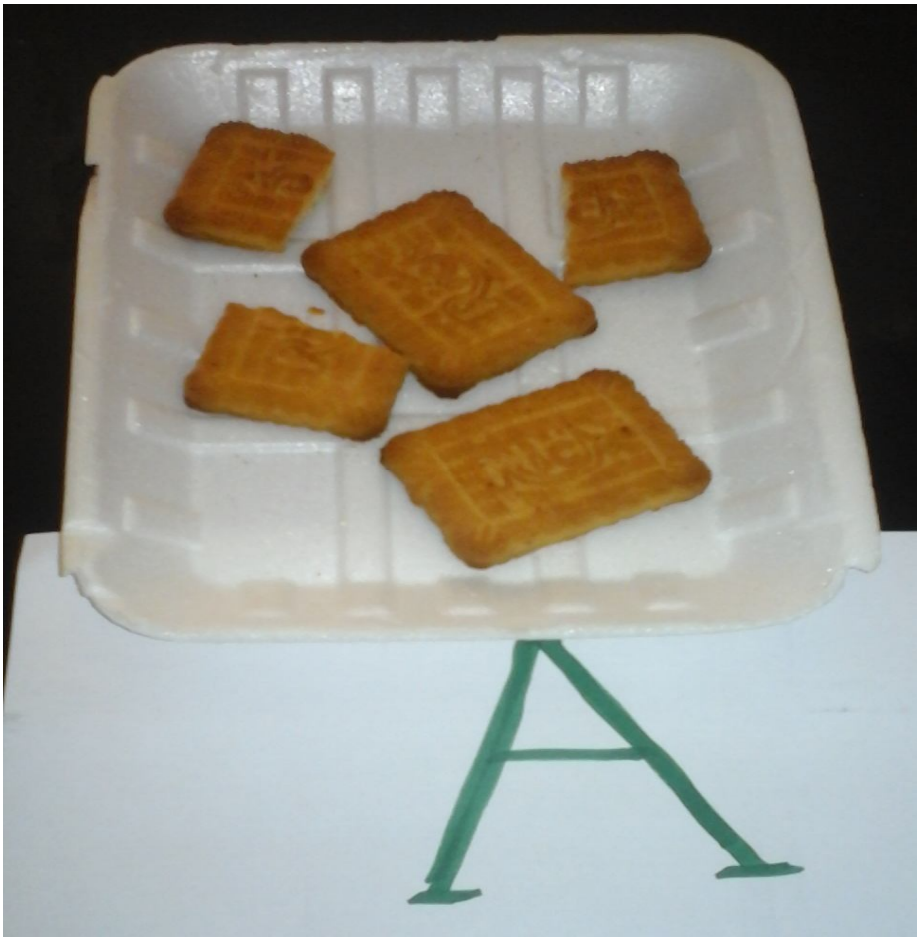
APPENDICES



Appendix (I) Control Biscuit

Appendix (II) Biscuit (B)

Appendix (III) Biscuit (C)

Appendix (IV) Biscuit (D)

Appendix (V) **Sensory evaluation**

PANEL TEST FOR BISCUIT SAMPLES (Ranking)

Please examine the following samples of biscuits presented in from of you, and give rank to attributes shown bellow, taking (1) Excellent (2) Very good (3) Good (4) Acceptable (5) Poor

No. of sample	**Color**	**Taste**	**Flavor**	**Texture**	**Over all acceptance**
A					
B					
C					
D					