بِسْمِ اللَّهِ الرَّحْمَٰنِ الرَّحِيمِ

Sudan University of Science and Technology

College of Agricultural Studies

Department of Food Science and Technology

Production of Sweet Potato Sheets (Shurrar)

إنتاج شرار من البامبي

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:

Aisha Alhadi Ahmed

Shahad Mohsin Mustafa

Omnia Moahmmed Aljack

Supervised by:

Ustaz. Eihab Hatem Jad Elrab Altaher

٢٠٢٠

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 (١١٤)

Dedication

To our beloved mothers and fathers

For their support and encouragements

, to our brothers and sisters

and all our friends

to all teachers in different education levels

Acknowledgement

First and foremost, we would like to praise and thanks ALLAH, All praises to Allah who has granted countless blessing, all opportunities , trials , and strength for completion of this research .

Also we would like to show our great thanks to our great supervisor **ustaz:EihabHatimJadalrab** for him guidance, great support and kind of advice thought our graduating project, trials and the research studies. Actually it was a real privilege and honor to us to share him exceptional scientific knowledge , but also of him extraordinary human qualities.

To the our University especially our college, college of Agriculture Studies, and more particularity Department of Food Science and Technology staff.for them support and assistance.

To our colleagues and friends for them fruitful support and encouragement .

Last , but not least we would like to thanks our families for their unconditional support , encouragement , and love , and without which we would not have come this far . Also our gratitude thanks are given to any othere one who had supported us during our educational levels.

Table of Contents

List of Tables

List of Figures

Fig. NO. **Title** **Page No.**

Abstract

The aims of this study was to increase utilization of Sweet potato and production of Sweet potato shurar as a substitute for Celiac disease and to evaluate the of the chemical and sensory evaluation on sweet potato. The results obtained from this research indicate that the dry weight basis Sweet Potato contains carbohydrates, protein, fibers and caloric value 85.78, 10.36, 10.68 and 358.357 K cal respectively, while the product indicates that, the carbohydrates, fibers, protein 60.45, 7.26, 23.86.respectively % and the caloric value 410.0796 kcal.
Finally, the Shurar sweet potato product was highly accepted by the panelist with respect to their the color, flavor, taste, texture and overall quality.

الملخص

الأهداف الرئيسية من هذا البحث زيادة إستخدامات البطاطا الحلوة, و إنتاج الشرار من البطاطا الحلوة كبديل للأشخاص الذين يعانون من حساسية القمح, و تقييم التأثير الكيميائي و مدى قبول المنتج.

النتائج المتحصل عليها من هذا البحث اظهرت ان درنات البطاطا الحلوة تحتوي على كربوهيدرات, بروتين, ألياف و سعرات حرارية على التوالى, بينما المنتج النهائي اظهر انه يحتوي على كربوهيدرات, بروتين, ألياف و سعرات حرارية على التوالى.
اخيرا منتج الشرار المصنع من البطاطا الحلوة كان مقبولا جدا من قبل المتذوقين.

CHAPTER ONE

1.INTRODUCTION

1.1 Sweet potato:

Sweet potato (*Ipomoea batatas(L.) Lam*.) is cultivated throughout the tropics and warm temperate regions of the world for its starchy roots, which can provide nutrition, besides energy. The edible tuberous root is either long and tapered, ovoid or round with a skin colour ranging from white, pale cream, orange or purple.

Besides, the plant is also much valued for its green tops, which are a concentrated source of many essential vitamins and minerals. Although China is the largest producer of sweet potatoes, accounting for more than 80% of the world supply, only 40% of the production is used for human consumption and industrial uses, while, the rest goes as animal feed. Sweet potatoes are considered as one of the most important food crops of man due to the health contributing principles in the tubers and leaves (**Padmaja*et al*., 2012**).

Sweet potato is a large, starchy, tuberous root vegetable. Each and every part of the sweet potato, especially the tuber is beneficial for society. this dicotyledonous plant belonging to ins the family convolvulaceae is scientifically known as Ipomoea batatas L. Sweet potato is now being recognized as a health food due to several of its neutraceutical components and carotenoids. Sweet potato contains magnesium, the key mineral for de-stressing and good mood. It also promotes artery, bone, muscle, and nerve health. Sweet potato varieties may be soft **(Milind and Monika, 2015).**

The Sudanese name for sweet potato is Bambie. The sweet potato is a herbaceous perennial vine with alternate heart-shaped. The food ranking system also showed sweet potato to be strong performer in terms of traditional nutrients. This root vegetable has been used in the traditional system of medicine for Alzheimer's disease because which is rich in beta-carotene. A very good source of vitamin C and manganese, as well as a good source of copper, dietary fiber, vitamin B6, potassium and iron. Moreover, poor in content of protein but which is present contains several of essential amino acids like leucine, lycine, phenylalanine, valine, tryptophan and threonine . Sweet potatoes and its leaves contains antioxidant, phenolic components, have potential values as chemo-preventative materials for human health. Both beta-carotene and vitamin C are very powerful antioxidants that work in the body to eliminate free radicals.

The bio-fortification of staple food crops is a new public health approach to control vitamin A, iron and zinc deficiencies in poor countries. Beta-carotene is the most available important source of pro-vitamin A in the diet of most people living in these countries. Sweet potato could be a good source of protein ingredient for food processing as it possesses good solubility and emulsifying properties (**Abdel-Rahman,2012**).

1.2 Aims of the study:

1.2.1 Main objective:

Using sweet potatoes as a food substitute for wheat, because of the benefits sweet potatoes contains, and as an alternative for people who suffer from wheat allergy.

1.2.2 Specific objectives:

1. To study the nutritional value of sweet potato roots
2. To study the suitability of sweet potato roots for pa product.
3. To evaluate the chemical, physico-chemical and organoleptic characteristic of the end product.

CHAPTER TWO

2. LITERATURE REVIEW

٢.1 Sweet potato:

The **sweet potato** (*Ipomoea batatas*) is a dicotyledonous plant that belongs to the bindweed or morning glory family, Convolvulaceae. Its large, starchy, sweet-tasting, tuberous roots are a root vegetable (**Purseglove andWiliams,1968 and Woolfe and Jennifer, 1992**). The young leaves and shoots are sometimes eaten as greens. The sweet potato is commonly thought to be a type of potato(*Solanumtuberosum*) but does not belong to the nightshade family, Solanaceae, but both families belong to the same taxonomic order, the Solanales. The sweet potato, especially the orange variety, is often called a "yam" in parts of North America, but is botanically very distinct from true yams.

The plant is a herbaceous perennial vine, bearing alternate heart-shaped or palmately lobed leaves and medium-sized sympetalous flowers. The edible tuberous root is long and tapered, with a smooth skin whose color ranges between yellow, orange, red, brown, purple, and beige. Its flesh ranges from beige through white, red, pink, violet, yellow, orange, and purple. Sweet potato cultivars with white or pale yellow flesh are less sweet and moist than those with red, pink or orange flesh (**Gad Loebenstein, 2009 and George Thottappilly, 2009).**

Ipomoea batatas is native to the tropical regions in the Americas(4.5). Of the approximately 50 genera and more than 1,000 species of Convolvulaceae, *I. batatas* is the only crop plant of major importance—some others are used locally (e.g., *I. aquatica* "kangkong").

2.1.1 Origin and history:

The origin and domestication of sweet potato occurred in either Central or South America**(Geneflow,2009).** In Central America, domesticated sweet potatoes were present at least 5,000 years ago, with the origin of *I. batatas* possibly between the Yucatán Peninsula of Mexico and the mouth of the Orinoco River in Venezuela(**Austin1988, Daniel F 1988**) The cultigen was most likely spread by local people to the Caribbean and South America by 2500 BC (**Zhang et al., 1999**).

Sweet potatoes were first introduced to the Philippines during the Spanish colonial period (1521-1598) via the Manila galleons, along with other New World crops (**Loebenastein, 2009 and Gad, 2009**)

It was introduced to the Fujian province of China in about 1594 from Luzon, in response to a major crop failure. The growing of sweet potatoes was encouraged by the Governor Chin Hsüeh-tseng (**Jin Xuezeng)(Spence,1993 and Jonathan ,1993).**

Sweet potatoes were also introduced to the Ryukyu Kingdom, present-day Okinawa, Japan, in the early 1600s by the Portuguese(**Goodman,٢٠١ 3 and Grant, 2013**). Sweet potatoes became a staple in Japan because they were important in preventing famine when rice harvests were poor (**Obrien, 1972 and Patricia, 1972**). Sweet potatoes were later planted in ShōgunTokugawaYoshimune's private garden (**Gunn, 2003 and Geoffrey C.,2003).** It was also introduced to Korea in 1764(**Obrien, 1972 and Patricia J., 1972).**

The sweet potato arrived in Europe with the Columbian exchange. It is recorded, for example, in *ElinorFettiplace's Receipt Book*, compiled in England in 1604 **(Itoh, 2017 and Makiko, 2017)** and (**Takekoshi, 1930 and Yosaburō, 1930).**

2.1.2 Classification of sweet potato:

Edmond, J. B. and G. R. Ammerman. 1971

Domain: Eukarya
Kingdom: Plantae
Phylum: Magnoliophyta
Class: Eudicotyledones
Order: Solanales
Family: Convolvulaceae
Genus: *Ipomoea*
Species: *Ipomoea batatas*

2.1.3 Ecology:

Sweet potato is cultivated as a perennial in tropical and subtropical lowland agroecologies although it is well adapted to other zones and can be grown over widely different environments. The crop will grow with temperatures between 15°C and 35°C; however, the lower and higher temperatures have detrimental effects on yield. Storage roots are sensitive to changes in soil temperature depending on stage of root development. Sweet potato responds well to increasing moisture but is considered a drought-tolerant crop because it is deep rooted and capable of developing storage roots under very dry conditions. Excessive moisture inhibits storage root development in early growth stages and causes decay of storage roots in later growth stages. Sweet potatoes grow best in a sandy loam, well-drained soil. They have been

produced at altitudes in excess of 2000m and as far north as Canada(**Yen,1963 and D. E. ,1963**).

2.1.4 Cultivation:

The plant does not tolerate frost. It grows best at an average temperature of 24 °C (75 °F), abundant sunshine and warm nights. Annual rainfalls of 750–1,000 mm (30–39 in) are considered most suitable, with a minimum of 500 mm (20 in) in the growing season. The crop is sensitive to drought at the tuber initiation stage 50–60 days after planting, and it is not tolerant to water-logging, as it may cause tuber rots and reduce growth of storage roots if aeration is poor (**Ahn, 1993 and Peter, 1993).**

Depending on the cultivar and conditions, tuberous roots mature in two to nine months. With care, early-maturing cultivars can be grown as an annual summer crop in temperate areas, such as the Eastern United States and China. Sweet potatoes rarely flower when the daylight is longer than 11 hours, as is normal outside of the tropics. They are mostly propagated by stem or root cuttings or by adventitious shoots called "slips" that grow out from the tuberous roots during storage. True seeds are used for breeding only.

They grow well in many farming conditions and have few natural enemies; pesticides are rarely needed. Sweet potatoes are grown on a variety of soils, but well-drained, light- and medium-textured soils with a pH range of 4.5–7.0 are more favorable for the plant.[2] They can be grown in poor soils with little fertilizer. However, sweet potatoes are very sensitive to aluminum toxicity and will die about six weeks after planting if lime is not applied at planting in this type of soil.[2] Because they are sown by vine cuttings rather than seeds, sweet potatoes are relatively easy to plant. Because the rapidly growing vines shade out weeds, little weeding is needed. A commonly used herbicide to rid the soil of any unwelcome plants that may interfere with growth is DCPA, also known as Dacthal. In the tropics, the crop can be maintained in the ground and harvested as needed for market or home consumption. In temperate regions, sweet potatoes are most often grown on larger farms and are harvested before first frosts.

Sweet potatoes are cultivated throughout tropical and warm temperate regions wherever there is sufficient water to support their growth (**O`Hair, 1990 and Stephen K, 1990).** Sweet potatoes became common as a food crop in the islands of the Pacific Ocean, South India, Uganda and other African countries. A cultivar of the sweet potato called the *boniato* is grown in the Caribbean; its flesh is cream-colored, unlike the more common orange hue seen in other cultivars. *Boniatos* are not as sweet and moist as other sweet potatoes, but

their consistency and delicate flavour are different than the common orange-colored sweet potato.

Sweet potatoes have been a part of the diet in the United States for most of its history, especially in the Southeast. The average per capita consumption of sweet potatoes in the United States is only about 1.5–2 kg (3.3–4.4 lb) per year, down from 13 kg (29 lb) in 1920. “Orange sweet potatoes (the most common type encountered in the US) received higher appearance liking scores compared with yellow or purple cultivars ***(*Leksrisompomg, *et al2012)***.* Purple and yellow sweet potatoes were not as well liked by consumers compared to orange sweet potatoes “possibly because of the familiarity of orange color that is associated with sweet potatoes ***(*Leksrisompomg*et al., 2012)***.*

In the Southeastern United States, sweet potatoes are traditionally cured to improve storage, flavor, and nutrition, and to allow wounds on the periderm of the harvested root to heal. Proper curing requires drying the freshly dug roots on the ground for two to three hours, then storage at 29–32 °C (85–90 °F) with 90 to 95% relative humidity from five to fourteen days. Cured sweet potatoes can keep for thirteen months when stored at 13–15 °C (55–59 °F) with >90% relative humidity. Colder temperatures injure the roots.

2.1.5 Nutrient content:

Besides simple starches, raw sweet potatoes are rich in complex carbohydrates, dietary fiber and beta-carotene (a pro-vitaminAcarotenoid), with moderate contents of other micronutrients, including vitamin B_5, vitamin B_6 and manganese. When cooked by baking, small variable changes in micronutrient density occur to include a higher content of vitamin C at 24% of the Daily Value per 100 g serving.

The Center for Science in the Public Interest ranked the nutritional value of sweet potatoes as highest among several other foods. In addition, their leaves are edible and can be prepared like spinach or turnip greens.

Sweet potato cultivars with dark orange flesh have more beta-carotene than those with light-colored flesh, and their increased cultivation is being encouraged in Africa where vitamin A deficiency is a serious health problem. A 2012 study of 10,000 households in Uganda found that children eating beta-carotene enriched sweet potatoes suffered less vitamin A deficiency than those not consuming as much beta-carotene.

Table (2. 1) Chemical Composition of Sweet Potatoes

Nutrient	Values

Water (g)	77
Energy (kJ)	360
Protein (g)	1.6
Fat (g)	0.05
Carbohydrates (g)	20
Fiber (g)	3
Sugar (g)	4.18

Table (2. 2) Minerals of sweet potatoes

Minerals	Mg
Calcium	30
Iron	0.61
Magnesium	25
Phosphorus	47
Potassium	337
Sodium	55
Zinc	0.3
Copper	0.15
Manganese	0.26
Selenium	0.6

Table (2. 3) Vitamins of sweet potato

Vitamins	
Vitamin C (mg)	2.4
Thiamin (B1) (mg)	0.08
Riboflavin (B2) (mg)	0.06
Niacin (B3) (mg)	0.56
Pantothenic acid (B5) (mg)	0.80
Vitamin B6 (mg)	0.21
Folate Total (B9) (µg)	11
Vitamin A (IU)	14,187
Vitamin E, alpha-tocopherol (mg)	0.26
Vitamin K1 (µg)	1.8
Beta-carotene (µg)	8,509

2.1.6: Benefits of sweet potatoes:

Sweet potatoes have many benefits that may benefit human health, and they are distinguished from white potatoes as they are rich in calcium and vitamin A, and here are the most important benefits for the body:

2.1.6.1: for promoting cardiovascular health:

The richness of sweet potatoes with potassium makes them a great role in promoting cardiovascular health and controlling blood pressure levels. It is known that potassium is very important to maintain fluid balance in the body and maintain blood pressure levels at normal rates, and every 100 grams of raw sweet potato contains approximately 337 mg of potassium.

2.1.6.2: For providing the body with energy:

Sweet potato is a source of carbohydrates and starches, which are the main source of energy in the body. Each 100 grams of grilled meat provides us with approximately 90 calories, and it may be an ideal meal for those aspiring to increase their weight and get rid of thinness if it is included in a balanced and calculated diet.

2.1.6.3: For diabetics:

Sweet potatoes have a low glycemic index.

According to recent research, it may help reduce episodes of hypoglycemia and insulin resistance in diabetics, as it is a rich source of complex carbohydrates and dietary fiber.

2.1.6.4: for immunity:

Since sweet potato is a rich and high source of both vitamin C and beta-carotene, it will certainly play a great role in strengthening immunity and strengthening it by neutralizing free radicals and fighting many infections and diseases, especially cold and winter diseases. And sweet potato contains choline, it helps relax and treat insomnia, improve learning and memory, and reduce chronic inflammation. While taking it helps treat respiratory infections and asthma. 2.1.7.5: for healthy skin and eyes:

Since sweet potatoes are a great source of vitamin A, which is known as the beauty vitamin, and beta-carotene as a powerful antioxidant that is necessary to neutralize free radicals and combat the signs of aging, aging and wrinkles in particular, potatoes will definitely have a great role in increasing your skin's freshness and radiance.

Also, beta-carotene is known for its importance in maintaining eye health and vision integrity and combating macular degeneration that may be associated with aging! The same is true for Vitamin C and Vitamin E, being two powerful antioxidants.

2.1.6.5: For fighting cancer:

In some of the studies that were conducted, it was found that sweet potato may play a major role in fighting some types of cancer, including prostate cancer and colon cancer. Rich in flavonoids, it helps protect against lung and oral cancers.

2.1.6.6: Benefits of sweet potatoes in preventing anemia:

As sweet potato is a source of iron and folate, it will certainly have a very great role in preventing anemia and anemia. It is especially recommended for pregnant women as an easy-to-digest snack that helps provide them with the important nutrients they need.

2.1.6.7: Benefits of sweet potatoes in promoting digestive health:

It is usually recommended to have a daily intake of dietary fiber of at least 25-30 grams. Unfortunately, most people do not take these quantities most days, which may result in stomach upset and constipation. Sweet potato is one of the foods rich in dietary fiber that actually helps in promoting digestive health, softening stools and preventing constipation.

2.1.7: sweet potato product:

2.1.7.1: Making (shurrar) from sweet potatoes:

(Shurrar) is a traditional Sudanese food that is mostly made from wheat flour, which is a loose dough that is cooked in a hot plate. And here we will use sweet potatoes in its manufacture instead of wheat flour, for the many benefits of potatoes and also for the recent scarcity of wheat, as well as to be a food alternative for people with wheat allergy.

2.1.7.1.1: Ingredients:

Sweet potatoes

Starch:

Makes it sticky, making it easier to cook

Powdered milk:

It is added to improve the taste

Dry vanilla:

It is a white powder and it is called vanilla sugar, and it is a flavoring substance that tastes some bitterness, and therefore it cannot be multiplied when used with sweets dishes.

Salt.

Baking Powder:

It is a mixture of bicarbonate and weak acid, which is a dry fermentation agent and helps to increase the volume and openness of the baked texture by means of carbon dioxide that diffuses into the dough with the reaction of the acid base, which helps to ferment the dough and is used as a lifter.

Yeast:

Originally they are single-celled organisms, and they belong in their classification to the mushroom family, and they enter the process of manufacturing food, pastries and bread, through their interaction that results in the secretion of external enzymes, which contribute to the process of the decomposition of carbohydrates, then they perform the process of absorption until they are able to reproduce and grow And this explains the dough swelling process, as it works to ferment it and increase its size to make it suitable for the baking process, and the dough fermentation process takes time for results to appear.

Water:

Adding water gradually is one of the most important reasons for the success of the dough, so you must add water gradually to obtain the desired consistency

2.1.7.1.2: Tools and equipment used in the experiment:

An electric mixer
Hot plate
Gas stove
Cooking pot (for boiling)
Standard spoons and cups

2.1.7.1.3: How to prepare:

The sweet potatoes were boiled on a stove for 45 min, after the boiling, the sweet potatoes are peeled and by using cups and standard spoons, all ingredients were weighed as follows; 280g of water, 280g of sweet potatoes, 280g of Starch, 105g of powdered milk, 10g of baking powder, 5g of yeast, 3g vanilla and 1.5g of salt were mixed gently together until they are homogeneous and become a loose consistency dough (sparkling texture).

Leave the dough in room temperature for (15- 20) min to rise. The dough after fermented will poured into the hot plate and it is formed in the form of circular disks and leave it until cooked and turn to the other side

CHAPTER THREE

3. MATERIALS AND METHODS

3.1 Materials:

The sweetpotato (*Ipomoea batatas (L.) Lam*.)used in this study was obtained from super market in Omdurman, Khartoum state.

3.2 Methods:

3.2.1 Chemical methods:

3.2.1.1 Moisture content:

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

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

Procedure: A sample of 2±0.001 g was weighed into a pre-dried and tarred dish. Then, the sample was placed into an oven (No.03-822, FN 400, Turkey) at 105°C until a constant weight was obtained. After drying, the covered sample was transferred to desiccators and cooled to room temperature before reweighing. Triplicate results were obtained for each sample and the mean value was reported to two decimal points according to the following formula:

Calculation:

$$\text{Moisture content (\%)} = \frac{(W_s - W_d) \times 100\%}{\text{Sample weight (g)}} \qquad \text{[eq.1]}$$

Where:

W_s = weight of sample before drying

W_d = weight of sample after drying.

3.2.1.2 Crude protein content

The protein content was determined in the different samples by micro-Kjeldahlmethod using a copper sulphate-sodium sulphate catalyst according to the official method of the **AOAC (2003).**

Principle: The method consists of sample oxidation and conversion of its nitrogen to ammonia, which reacts with the excess amount of sulphuricacid forming ammonium sulphate. After that, the solution is

made alkaline and the ammonia is distilled into a standard solution of boric acid (2%) to form the ammonia-boric acid complex which is titrated against a standard solution of HC1 (0.1N). The protein content is calculated by multiplying the total N % by 6.25 as a conversion factor for protein.

Procedure: A sample of two grams(2 ± 0.001 g) was accurately weighed and transferred together with, 4± 0.001g $NaSo_4$ of Kjeldahl catalysts (No. 0665, Scharlauchemie, Spain) and 25m1 of concentrated sulphuric acid (No.0548111, HDWIC, India) was added into a Kjeldahl digestion flask. After that, the flask was placed into a Kjeldahl digestion unit (No.4071477, type KI 26, Gerhardt, Germany) for about 2 hours until a colourless digest was obtained and the flask was left to cool to room temperature. The distillation of ammonia was carried out into 25m1 boric acid (2%) by using 20ml sodium hydroxide solution (45%). Finally, the distillate was titrated with standard solution of HC1 (0.1N) in the presence of 2-3 drops of bromocreasol green and methyl red as an indicator until a brown reddish colour was observed.

Calculation:

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

[eq.2]

Where:

N: normality of HCl (0.1N).

F: protein conversion factor = 6.25

3.2.1.3 Fat content

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

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

Procedure: A sample of 5 ± 0.00l g was weighed into an extraction thimble and covered with cotton that previously extracted with hexane (No.9-16-24/25-29-51, LOBA Cheme, India). Then, the sample and a pre-dried and weighed extraction flask containing about 100 ml hexanes were attached to the extraction unit(Electro-thermal, England) and the extraction process was conducted for 6 hrs. At the end of the extraction period, the flask was

disconnected from the unit and the solvent was redistilled. Later, the flask with the remaining crude ether extract was put in an oven at 105°C for 3 hrs , cooled to room temperature in a desiccators, reweighed and the dried extract was registered as fat content according to the following formula;

Calculation:

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

[eq.3]

Where;

W_1 =Weight of the empty flask

W_2 =Weight of the flask and ether extract

W_3=initial weight of the sample

3.2.1.4 Total carbohydrates

Total carbohydrates were calculated by difference according to the following equation:

Total carbohydrates (%) = 100% - (Moisture% + Protein% + Fat% + Ash %).

[eq.4]

3.2.1.5 Crude fiber content

The crude fiber was determined according to the official method of the **AOAC (2003).**

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

Procedure: About 2 ± 0.001 g of a defatted sample was placed into a conical flask containing 200 m1 of H2SO4 (0.26 N). The flask was then, fitted to a condenser and allowed to boil for 30 minutes. At the end of the digestion period, the flask was removed and the digest was filtered (under vacuum) through a porcelain filter crucible (No.3). After that, the precipitate was repeatedly rinsed with distilled boiled water followed by boiling in 200 ml NaOH (0.23 N) solution for 30 minutes under reflux condenser and the precipitate was filtered, rinsed with hot distilled water, 20m1 ethyl alcohol (96%) and 20 ml diethyl ether. Finally, the crucible was dried at 105°C (overnight) to a constant weight, cooled, weighed, ashed in a Muffle furnace (No.20. 301870, Carbolite, England) at 600°C until a constant weight was obtained and the difference in weight was considered as crude fiber.

Calculation:

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

[eq.5]

Where:

W_1 = weight of sample before ignition (gm).

W_2 = weight of sample after ignition (gm).

3.2.1.6 Available carbohydrates

Available carbohydrates were calculated by difference according to the following equation:

Available carbohydrates (%) = Total carbohydrates% – Crude fiber%.

[eq.6]

3.2.1.7 Ash content

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

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

Procedure:

A sample of 5 ± 0.001 g was weighed into a pre-heated, cooled, weighed and tarred porcelain crucible and placed into a Muffle furnace (No.20. 301870, Carbolite, England) at 600 °C until a white gray ash was obtained. The crucible was transferred to a desiccator, allowed to cool to room temperature and weighed. After that, the ash content was calculated as a percentage based on the initial weight of the sample.

Calculation:

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

3.2.1.8 Food energy value

The energy value of date fruits was calculated based on Atwater factors as indicated by **Leung (1968).**

Protein = 3.87 K. cal/g

Fat = 8.37 K. cal/g

Carbohydrate = 4.12 K. cal/g

K. cal = 4.184 kJ

3.2.2 Experimental processing method

In this method thesweet potatoes are boiled on a stove for 45 min, after the time for boiling has passed, the sweet potatoes are peeled and by using cups and standard spoons, all ingredients are weighed as follows: Two cups of water, (280g) boiled sweet potatoes, (280g) Starch, (105g) powdered milk, (20g) baking powder , (10g) yeast, (5g) vanilla, (2.5g) salt.

Put all the ingredients in an electric mixer and mix them until they are homogeneous and become a loose consistency dough (sparkling texture)

Leave the dough for (15- 20) min to rise

The sheet is put on the fire, and after the dough fermentation period is completed, the dough is poured onto the sheet and it is formed in the form of circular disks.

3.2.3 Organoleptic evaluation method

Inthis method, 25 trained panelists from sudan university of sciences and technology (college of agricultural studies) were asked to evaluate the product with regard to their taste, color, flavor, appearance and overall quality using the following hedonic scale, 1= unacceptable, 2= acceptable, 3= good, 4= very good, 5= excellent.

3.2.4 Statistical analysis method

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

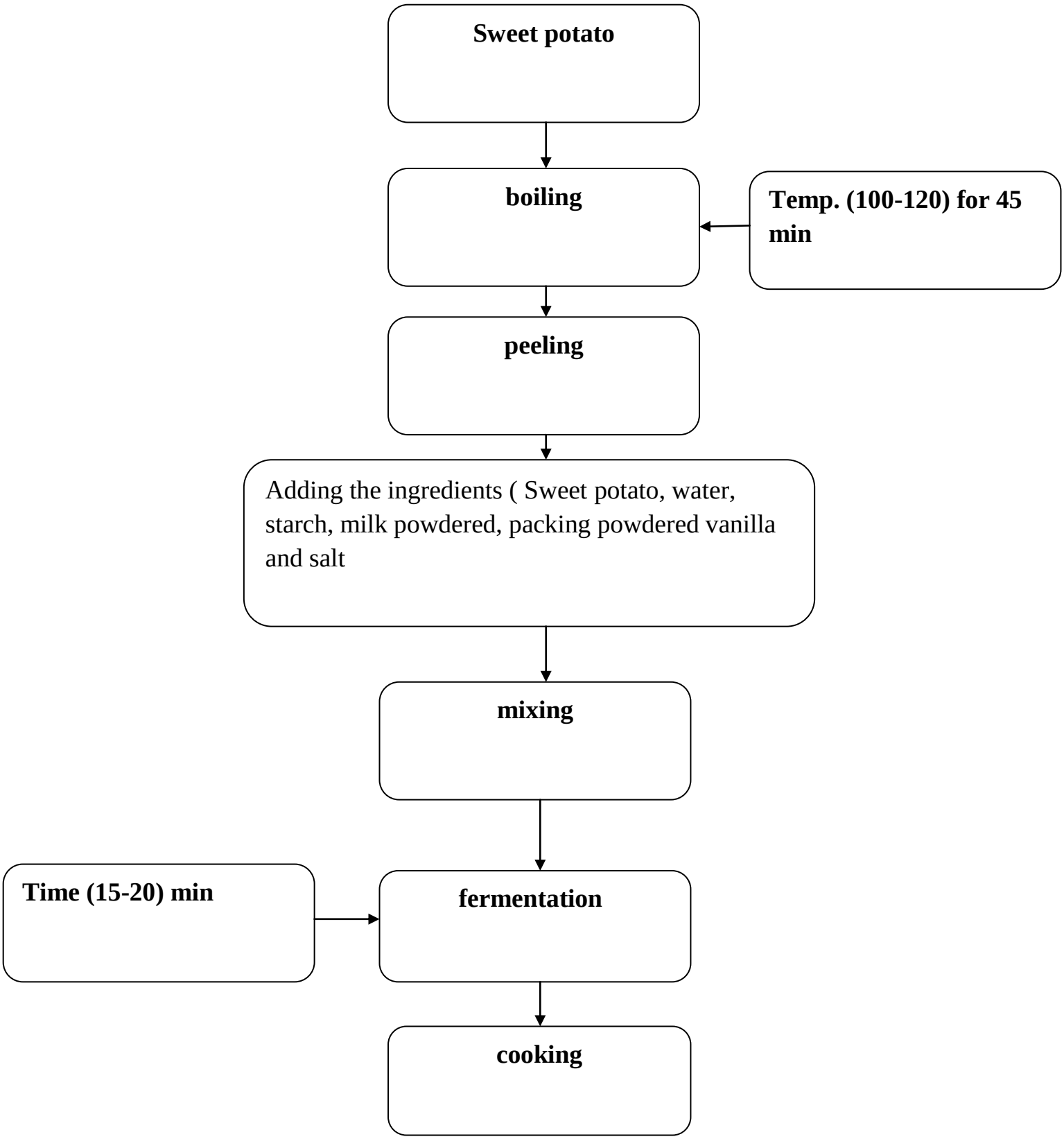

Figure 1: Experimental processing method

CHAPTERFOUR

4. RESULT AND DISCUSSION

Table (4.1) shows the chemical composition of sweet potato on wet and dry basis. The chemical composition on wet basis are moisture , protein , fat , total carbohydrates , available carbohydrates and ash contents were found to be,75,77 , 2.54 , 0.17 , 2.51 , 20.21 , 18.28 , 6.1 , 18.59 , 0.71 . On the dry matter, dry matter , protein , fat , total carbohydrates , available carbohydrates and ash contents were found to be 24.22 , 10.68 , 0.72 , 10.36 , 85.78 , 75.42 , 25.18 , 76.80 , 2.94 . And the energy was acquire from the sweet potato(Caloric value/ 100g) calculating and give 358.357k.cal , (1499.326 K.J) .

Table (4.2) shows the chemical composition of the product (Shurrar) .on wet and dry basis. The chemical composition on wet basis are moisture , protein , fat , total carbohydrates , available carbohydrates and ash contents were found to be 64.17 , 8.54 , 4.32 , 2.6 , 21.45 , 18. 86 , 1.5 . On the dry matter , dry matter , protein , fat , total carbohydrates , available carbohydrates and ash contents were found to be 35.83 , 23.86 , 11.78 , 7.26 , 60.45 , 53.19 , 3.90 . And the energy was acquire from the sweet potato(Caloric value/ 100g) calculating and give 410.0796 k.cal , (1715.773K.J) .

Table (4.3) shows the recipe formulation of processed shurrar , the weight of poached sweet potato tubercles(g) , water (g) , starch (g) ,powdered milk(g) , baking powder (g) , yeast (g) , dry vanilla (g) , salt (g) . 280 , 280 , 280 , 105 , 20 , 10 , 5 , 2.5 , The total 982.5 and the percentage of these ingredients (28.49 % , 28.49% , 28.49% , 10.68% , 2.03 % , 1.017 % , 0.5 % , 0.254 % .The total is 100 %) .

Tale (4.4) shows the organoleptic evaluation of shurrar , the color , flavor , taste , texture and overall quality , the means , of color 4.48 (very good) , flavor 4.04 (very good), taste 4 (very good) , texture 4.08 (very good) , overall quality 4.0 (very good).

Table (4. 1) Chemical composition of sweet potato:

Parameters	Values	
	% , N= 3±SD	
	On wet basis	On dry basis
Moisture and dry matter	75.77 ± 0.898	24.22 ± 0.89
Protein	02.54 ± 0.049	10.68 ± 0.06
Fat	00.17 ± 0.007	0.72 ± 0000
Fiber	02.51 ± 0000	10.36± 0.388
Total Carbohydrates	20.79 ± 0.820	85.78± 0.233
Available Carbohydrates	18.28 ±0.82 0	75.42± 0.155
Total Sugar	06.1 ± 0.113	25.18± 0.466
Starch	18.59 ± 0.919	76.80± 2 .46
Ash	00.71 ± 0.0212	02.94± 0.021
Caloric value/ 100g		358.357k.cal 1499.326 K.J

SD = Standard deviation

N = Number of independent determination.

Table (4. 2): Chemical composition of Shurrar

Parameters	Values	
	% , N= 3±SD	
	On wet basis	On dry basis
Moisture and dry matter	64.17 ±1.41	35.83 ± 1.41
Protein	8.54 ± 0.063	23.86 ± 0.76
Fat	4.32 ± 0.141	11.78± 0.466
Fiber	2.6 ± 0.141	7.26 ± 0.68
Total Carbohydrates	21.45 ± 1.05	60.45 ± 1.37
Available Carbohydrates	18.86± 1.02	53.19± 2.06
Ash	1.5 ± 0.141	3.9± 0.14
Caloric value/ 100g		410.0796 K cal 1715.773 K.J

SD = Standard deviation

N = Number of independent determination.

Table (4. 3)The recipe formulation of processed Shurrar:

Components	**Weight in grams**	**%**
Sweet potato	280	28.49
Starch	280	28.49
Water	280	28.49
Powdered milk	105	10.68
Baking powder	20	2.03
Yeast	10	1.017
Dry vanilla	5	0.5
Salt	2.5	0.254
Total	982.5	100

Table (4. 4) Organoleptic evaluation of the sweet potato shurarr:-

Sense / Range		Unacceptable	Acceptable	Good	Very good	Excellent	Total	Mean ±SD	Evaluation
Color	N	0	0	2	9	14	25	4.48 ± 0.65	Very good
	%	0%	0%	8%	36%	56%	100%		
Flavor	N	0	3	2	11	9	25	4.04 ±0.97	Very good
	%	0%	12%	8%	44%	36%	100%		
Taste	N	0	0	8	9	8	25	4±0.81	Very good
	%	0%	0%	32%	36%	32%	100%		
Texture	N	0	0	4	15	6	25	4.08 ±0.64	Very good
	%	0%	0%	16%	60%	24%	100%		
Overall quality	N	0	1	2	17	5	25	4.04 ±0.67	Very good
	%	0%	4%	8%	68%	20%	100%		

SD = Standard deviation.

1= Unacceptable.

2 = Acceptable.

3 = Good.

4 = Very good.

5 = Excellent

CHAPTER FIVE

5. CONCLUSION AND RECOMMENDATION

5.1 Conclusion

From the results obtained in this study, it can be concluded that the Sweet Potato shurrar were found with high nutritional value especially in protein, fiber and starch, and shurrar has high energy value and the sweet potato is very cheap and available in all seasons of year .

5.2 Recommendation

1. The Sweet Potato containing appreciable amount of carbohydrates so recommended to use this product full meals to people who suffer from gluten allergy.
2. Due to a cheap price of sweet potato we recommend to use the product.
3. The sweets Potato can be keep in any condition and this any person can use it, in prepare his meals and foods.
4. We recommend to use sweet potato in products for diabetic due to high value of fibers.

References:

Purseglove, J. W. (1968). Tropical crops: Dicotyledons. Longman Scientific and Technical. New York: John Wiley and Sons. ISBN 978-0-582-46666-1

Gad Loebenstein and George Thottappilly (2009). The sweetpotato. pp. 391–425. ISBN 978-1-4020-9475-0.

Geneflow 2009. ISBN 9789290438137.

Austin and Daniel F. (1988). "The taxonomy, evolution and genetic diversity of sweet potatoes and related wild species". In P. Gregory (ed.). Exploration, Maintenance, and Utilization of Sweet Potato Genetic Resources. First Sweet Potato Planning Conference, 1987. Lima, Peru: International Potato Center. pp. 27–60. ISBN 9789290601159.

Zhang, D.P., Ghislain, M., Huaman , Z. ,Cervantes, J.C. and Carey, E.E. (1999). AFLP Assessment of Sweetpotato Genetic Diversity in Four Tropical American Regions (PDF). International Potato Center (CIP) Program report 1997-1998. Lima, Peru: International Potato Center (CIP). Archived from the original (PDF) on 23 April 2014.

Spence and Jonathan D. (1993). Chinese Roundabout: Essays in History and Culture *(illustrated, reprint, revised ed.). W. W. Norton & Company. p. 167.* ISBN 978-0393309942.

Goodman and Grant K. (2013). *Japan and the Dutch 1600-1853. London: Routledge. pp. 66–67.* doi:10.4324/9781315028064. ISBN 9781315028064.

Gunn and Geoffrey C. (2003). *"First Globalization: The Eurasian Exchange, 1500-1800". The Sixteenth Century Journal.* ***36*** *(3): 932–933.* doi:10.2307/20477565. JSTOR 20477565.

Obrien and Patricia J. (1972). *"The sweet potato: Its origin and dispersal". American Anthropologist.* ***74*** *(3): 342–365.* doi:10.1525/aa.1972.74.3.02a00070.

Takekoshi and Yosaburō (1930). Economic Aspects of the History of the Civilization of Japan. *p. 352.* ISBN 9780415323802

"Sweet potato". ***Produce Facts****. UC Davis. Archived from* the original *on 5 November 2010.*

Sweet potato production in 2017; World Regions/Production Quantity from pick lists". *Statistics Division (FAOSTAT). Food and Agriculture Organization of the United Nations. 2017*. Retrieved 8 November 2019.

Dincer, C.; Karaoglan, M.; Erden, F.; Tetik, N.; Topuz, A. and Ozdemir, F. (November 2011). *"Effects of baking and boiling on the nutritional and antioxidant properties of sweet potato [Ipomoea batatas (L.) Lam.] cultivars". Plant Foods for Human Nutrition.* ***66*** *(4): 341–347.* doi*:*10.1007/s11130-011-0262-0. PMID 22101780. S2CID 19525345

Yen, D. E. (1963). "The New Zealand Kumara or Sweet Potato". Economic Botany. **17** (1): 31–45. doi:10.1007/bf02985351. JSTOR 4252401. S2CID 32823869

Ahn and Peter (1993). *Tropical soils and fertilizer use. Intermediate Tropical Agriculture Series. UK: Longman Scientific and Technical Ltd.* ISBN 978-0-582-77507-7.[page needed]

O'Hair and Stephen K. (1990). *"Tropical root and tuber crops". In Janick, J.; Simon, J.E. (eds.).* Advances in New Crops. *Portland, OR: Timber Press. pp. 424–428*. Retrieved 26 September 2014.

Leksrisompong, P.P.; Whitson, M.E.; Truong, V.D. and Drake, M.A. (2012). *"Sensory attributes and consumer acceptance of sweet potato cultivars with varying flesh colors". Journal of Sensory Studies.* ***27*** *(1): 59–69.*doi*:*10.1111/j.1745-459x.2011.00367.x.

Edmond, J. B. and G. R. Ammerman. (1971). Sweet potatoes: Production, Processing, Marketing. The AVI Publishing Co., Westport, CT, 334p.

Milind, P. and MONIKA (2015). Sweet Potato as super food. Int. J. Res.AyurvedaPharma, 4: 557-561.

Padmaja, G., Sheriff, J.T. and Sajeev, M.S (2012). Food Uses and Nutritional Benefits of Sweet Potato. Fruit, Vegetable and Cereal Science and Biotechnology. 6(special issuel):115-123.

Abdel-Rahman, N.A(2012). Characterization of Three genotyoes of sweet potato.

AOAC, (2003). Association of Official Analytical Chemists. Official Methods of Analysis, 17th ed., Arlington, Virginia, USA.

Leung, W. T. (1968). Hand Book on Food Composition for Use in Africa. FAO, Rome and Wasington , D.C., USA, P. 23.

Woolfe and Jennifer A. (5 March 1992). Sweet Potato: An untapped food resource. Cambridge, UK: Cambridge University Press and the International Potato Center (CIP). ISBN 9780521402958.

Itoh and Makiko (22 April 2017). "The storied history of the potato in Japanese cooking". *The Japan Times*. Retrieved 5 April 2018.