بسم الله الرحمن الرحيم

Sudan University of Science and Technology

College of Agricultural Studies

Department of Food Science and Technology

Evaluation of Nutritional Value of *Sorghum bicolor (*Red Feterita Sorghum) Fermented Drink (Baganiya)

تقييم القيمة الغذائية لمشروب الفتريتة الحمراء المخمر (البقنية)

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By:

Aisha Salah Alkheir

Osman Mohammed El-Awad

Maab Alam-Aldein Abd-Algalil

Supervisor:

Dr. Salma Elghali Mustafa

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الآية

بسم الله الرحمن الرحيم

قال تعالى:

(فَكُلُوا مِمَّا رَزَقَكُمُ اللَّهُ حَلَالًا طَيِّبًا وَاشْكُرُوا نِعْمَتَ اللَّهِ إِنْ كُنْتُمْ إِيَّاهُ تَعْبُدُونَ)

صدق الله العظيم

سورة النحل (114)

DEDICATION

TO OUR:

DEAR PARENTS

BELOVED FRIENDS

TO EVERYONE WHO TAUGHT US A LETTER

&

TO EVERYONE WHO SUPPORTED US DURING STUDY

ACKNOWLEDGEMENTS

Firstly, unlimited thank to **ALLAH** who helped and gave us health to completed this work.

We wish to express deepest gratitude and thanks to our supervisor **Doctor Salma Elghali Mustafa** for her helpful and continuous advice.

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ABSTRACT

The aim of this study was to prepare and identify the nutritional value of Baganiya drink. Baganiya was prepared using sorghum (Red Feterita). The chemical composition of Red Feterita before and after germination and Baganiya was identified. The physiochemical and organoleptic properties of Baganiya were also determined .The results of chemical composition analysis for Red Feterita flour were 4.80, 15.90, 3.20,70.44, 67.64, 2.80, and 2.06 % for moisture, protein, fat, available carbohydrate, total carbohydrate, fiber and ash respectively. The results of chemical composition analysis for germinated sorghum were 6.80, 12.25, 2.80, 76.65, 74.15, 2.50 and 1.50% for moisture, protein, fat, available carbohydrate, total carbohydrate, fiber and ash respectively. The results of chemical composition analysis for Baganiya were 4.80, 15.90, 3.20, 70.35, 65.70, 2.80, and 2.06 for moisture, protein, fat, available carbohydrate, total carbohydrate, fiber and ash respectively. The results of physiochemical analysis were 1.20, 12.01 and 4.00 for acidity, total soluble solid and pH respectively. the results of organoleptic properties showed acceptability for the product.

الملخص

الهدف من هذه الدراسة هو تحضير وتحديد القيمة الغذائية لمشروب البقنية، تم تحضير مشروب البقنية باستخدام الذرة الرفيعة (الفتريتة الحمراء). تم التعرف على التركيب الكيميائي للفتريتة الحمراء قبل وبعد الانبات وللبقنية، كما تم التعرف علي الخصائص الفيزوكيميائية والخصائص الحسية للبقنية. وكانت نتائج التحليل الكيميائي لدقيق الفتريتة الحمراء 4.80، 15.90، 3.20، 70.44, 67.44, 2.80 و2.06 % لكل من الرطوبة، البروتين، الدهون، الكاربوهيدريت المتاح، الكاربوهيدريت الكلي، الألياف والرماد على التوالي. كانت نتائج التحليل الكيميائي للذرة المنبت 6.80، 12.25، 2.80،76.65، 74.15، 2.50 و1.50% لكل من الرطوبة، البروتين، الدهون، الكاربوهيدريت المتاح، الكاربوهيدريت الكلي، الألياف والرماد على التوالي. كانت نتائج التحليل الكيميائي للبقنية 8.00، 15.30، 3.90، 60.35، 65.70، 4.45 و2.45 % لكل من الرطوبة، البروتين، الدهون، الكاربوهيدريت المتاح، الكاربوهيدريت الكلي، الالياف والرماد على التوالي. كانت نتائج التحليل الفيزوكيميائي 1.20، 12.01 و4.00 لكل من الحموضة والجوامد الصلبة الكلية والأس الهيدروجيني علي التوالي. ونتائج الخصائص الحسية أعطت قبول للمنتج.

CHAPTRE ONE

INTRODUCTION

The production of fermented beverages is one way to utilize cereals for human consumption. Fermentation is known to restrict the proliferation of bacterial pathogens, resulting in an increased shelf-life and microbial safety of these products. The main mechanism for this functionality is that of lowering the pH to values 4 by the production of lactic acid bacteria. Moreover, fermentation leads to a generally perceived improvement in texture, taste and aroma of the final product due to the development of a complex blend of texture and flavor compounds. In addition, advances in scientific knowledge have taught us other benefits of the activities of micro-organisms in food preparation, many traditional cereal-based fermented beverages exist, both alcoholic and non-alcoholic (Zvauya *et al.*, 1997).

These beverages are frequently consumed because they are inexpensive to prepare and do not require refrigeration or pre-heating prior to consumption. As a result of the appetizing taste and flavor, in the case of the non-alcoholic products The fact that the preparation of these beverages is based on spontaneous fermentation entails that the process is not controlled regardless of the vessel used. This leads to a diverse microbial flora from the local environment, besides variations in the production process. The way in which microbial communities develop during spontaneous fermentation, depends on the food ingredients and the surrounding environment in addition to the interaction of the micro-organisms themselves. In non-alcoholic products, lactic acid bacteria dominate (Zvauya *et al*., 1997).

Baganiya is a lactic fermented nonalcoholic cereal beverage produced in Northen state. Baganiya is prepared by fermenting cooked sorghum dough with addition spices. Baganiya is produced by spontaneous fermentation without control of microbiota by addition the starter cultures. Baganiya drink is consumed in the month of Ramadan as is Hulu mur at breakfast of Ramadan.

Although Baganiya is widely spread in north of Sudan and it is not very known in other parts of Sudan, more our there is no data about it, so this study was conducted to evaluate the nutritional value of Baganiya.

1.1 Specific objectives of the study were to:

1. Determine the chemical composition of red Feterita, germinated red Feterita and Baganiya.
2. Identify the organoleptic properties of Baganiya.
3. Identify the physico-chemical properties of Baganiya.

CHAPTER TWO

LITRETURE REVIEW

2.1 Sorghum

Sorghum [*Sorghum bicolor* (L.) Moench], a tropical plant belonging to the family of Poaceae, is one of the most important crops in Africa, Asia and Latin America (Anglani, 1998). More than 35% of sorghum is grown directly for human consumption. The rest is used primarily for animal feed, alcohol production and industrial products (FAO, 1995; Awika and Rooney, 2004).

The acquisition of good quality grain is fundamental to produce acceptable food products from sorghum. Sorghum while playing a crucial role in food security in Africa, it is also source of income of house-hold (Anglani, 1998). In West Africa.

Sorghum is a staple food grain in many semi-arid and tropic areas of the world, notably in Sub-Saharan Africa because of its good adaptation to hard environments and its good yield of production. Among important biochemical components for sorghum processing are levels of starch (amylose and amylopectin) and starch depolymerizing enzymes.

Results show that some sorghums are rich sources of micronutrients (minerals and vitamins) and macronutrients (carbohydrates, proteins and fat). Sorghum has a resistant starch, which makes it interesting for obese and diabetic people. In addition, sorghum may be an alternative food for people who are allergic to gluten.

Sorghum is the staple food for most people living in Sudan, except for the northern areas (Nahr al-Nil and Northern states) where wheat is more common.

The geographical of distribution of sorghum is; Gadarif State (Eastern Sudan) is the most important region for sorghum production, where about 5-6 million Feddan are cultivated on an annual basis.

The sorghum crop is considered one of the most important crops in Sudan and ranks first terms of importance as food for the vast majority of Sudanese in terms of cultivated area and total productivity. Corn is cultivated in Sudan in the irrigated and rain sectors and for workers that he uses his animal and due to the fluctuation of rain under the conditions of the rain agriculture, the irrigated corn has an important role in securing food for the country in general. despite the importance of the corn crop and the existence of the basic ingredient for the production in irrigated projects. Especially irrigation water and the climatic conditions for production, as Sudan is considered one of the habitats of corn

However, its productivity remained low and not commensurate with what was possible in many countries that consider corn an alien crop and the reason for the low productivity is the lack of or incomplete use recommended by the agricultural research authority.

2.1.1 Sorghum Grain Composition and Nutritive Value

Starch is the main component of sorghum grain, followed by proteins, non-starch polysaccharides. The average energetic value of whole sorghum grain flour is 356 kcal/100g (BSTID-NRC, 1996). Sorghum has a macromolecular composition similar to that of maize and wheat (BSTID-NRC, 1996). However, sorghum contains resistant starch, which impairs its digestibility, notably for infants (FAO, 1995). This resistance is desired in other applications to fight human obesity and to feed diabetic people. Foods prepared from high tannin sorghums varieties have a longer passage in the stomach (Awika and Rooney 2004). Edible products incorporating slowly digestible starch are known to exhibit a low glycemic index and increase satiety (Shin *et al*., 2004).

The fatty acid composition of sorghum fat (linoleic acid 49%, oleic 31%, palmitic 14%, linolenic 2.7%, stearic 2.1%, etc.) is similar in content to that of corn fat, but it is more unsaturated (Knudsen *et al*., 1988; Adeyeye and Ajewole, 1992; FAO, 1995). Sorghum is a good source of vitamins, notably the B vitamins (thiamin, riboflavin, pyridoxine, etc.), and the liposoluble vitamins A, D, E and K. Sorghum is reported to be a good source of more than 20 minerals (BSTID-NRC, 1996). Sorghum is also rich in phosphorus, potassium, iron and zinc (Glew *et al*., 1997; Anglani, 1998). Zinc (an important metal for pregnant women) deficiency is more common in corn and wheat than in sorghum (Hopkins *et al*., 1998).

2.1.2 Sorghum Uses

According to U.S. National Sorghum Producers Association (2006), approximately 50% of the world production of sorghum grain is used as human food, while FAO estimates that 95% of its total food use occurs in Africa and Asia (FAO, 1995). Sorghum grain is a staple diet in Africa, the middle east, Asia and Central America where its processed grain may be consumed in many form including porridge, steam-cooked product, tortillas, backed goods or as a be average. Sorghum represents a large portion of the total calories intake in many African counties(FAO,1995). China and India account for almost all of the food use if sorghum in Asia. Sorghum is genetically more closely related to Maize than it is to wheat, rye or barley, and as such is considered a safe food for patients with celiac disease. several million tons of sorghum is used across Africa for traditional beer brewing, and in west, east and central Africa for a large \stout production. Research from Mexico suggests that waxy sorghum (a mutant variety that is nearly 100% amylopectin) may be advantageous for brewing; however, normal sorghum (approximately 75% amylopectin and 25% amylose) is more commonly used for beer production. In other parts of the world, sorghum grain is used mainly as an animals feed. Such use is concentrated in Mexico, many south American countries, the United states and Japan (Del Pozo-Insfran *et al*., 2004; Figueroa *et al*., 1995).

2.1.3 Classification of Sudan Sorghum Foods:

The problem of grouping the various Sudanese food made from sorghum (or millet) in discrete classes is made more difficulty by the complete absence of previous attempts as a foundation on which to build. however, there have been some attempts to classify African and other similar foods

Among the authors who tried to classify African food, Muller (1970-1981) divided the cereal food products of African on a rheological basis into four major groups;

1- Beverage (alcoholic and nonalcoholic) with over 90%water
2- Porridge with about 90%water
3- Dumplings with between 65 and 80%water
4- Baked or fried product

The experts of ICRISAT grouped the traditional sorghum and millet foods into nine groups based on similarities in processing procedures the groups are;

1- Unfermented breads
2- Fermented breads
3- Stiff porridges
4- Thin porridges
5- Boiled sorghum
6- Snack foods
7- Alcoholic beverages
8- Nonalcoholic beverage

In attempting to classify Sudan sorghum and millet fermented foods it become clear from the outset that there is an initial division of these foods into two major groups. the rural Sudanese themselves traditionally divide these foods into major groups. one groups encompass the food and beverage involving the use of germinated grain (malt) and the other group is composed of the food and beverage prepared from only un-germinated grain.

These two group differ from one another in a number of other respect the malt containing food are generally non-major or non –staple foods I-e they are mostly food for special occasions beverage for leisure time or snack foods. although most of them are solid in their processed form, they are often consumed as water suspensions or as extracts. none of these malt foods is consumed as a rule with relishes or sauces from the standard on the order hand, the non -malt sorghum and millet product are major foods. which include the staple dishes of Aseda and Kissra and are mostly made from the standard Ajin. although some are made from a slightly different Ajin. most of the food items in the category are consumed as solid foods with no sweet taste at all. the color of these foods is generally lighter than those in the first group.

2.1.4 Effect of Fermentation on Sorghum Nutrients

The effect of fermentation on sorghum must be profound both physically and chemically but still more research is needed in this neglected area.

In the Sudan it is believed that fermentation makes the sorghum dough brighter in color and smoother in texture. the latter change is so dramatic that one can tell a stiff porridge made from a fermented dough from one made from unfermented dough, not only by taste or odor but even by touch. the porridge from a fermented sorghum dough is very smooth while by that made from an unfermented dough is rather granular. Abdel gadir and Mohamed (1983) reported that a desirable fine texture develops in the later stages of Ajin fermentation

Fermentation has a definite effect on the ease of baking of the very thin Kissra a sheets. in fact, good Kissra, bread, cannot be made from totally unfermented sorghum dough. the fermented dough is more coherent and can easily be spread out into very thin sheets which can also be peeled off the hot plate easily. an explanation of this change in dough texture was given by

Novellie (1982) who stated that the acid produced by fermentation often the protein matrix in which the starch granules are lodged giving a higher initial viscosity during cooking than would be obtained in the presence of water alone. another factor possibly contributing to the coherence and elasticity of the fermented sorghum dough. is the possible production of polysaccharides in the dough by microorganism in fact some lactobacillus isolate from fermented Kissra Ajin were found to produce dextran from sucrose (Mohammed *et al* 1991) Mukherjee *et al* (1965) found that leuconostoc mesenteroides the organism responsible for the fermentation of idle of India, strengthened the bread by producing dextran's.

The flavor component of the fermented sorghum dough need research. The fermented dough has an unmistakable, characteristic flavor which undergoes a noticeable change on baking the dough. Although no doubt. lactic acid gives the desirable sour take. Other minor acid and neutral substance such as ethanol acid, butanoic acid and propionic acid account for much of the organoleptic quality as has been reported for ting sorghum African (Moss *et al*. 1984)

Hamad and fields (1979) report that both germination and natural lactic fermentation improved that nutritional value of cereal. Aliya and Geervani (1981) found that the true digestibility of fermented sorghum increased significantly but not that of of eleusine or pearl millet. these authors also report that the biological value and net protein utilization of bothsorghum and eleusine product increased significantly of fermentation of not those of pearl millet. Mertz *et al* (1984) reported that fermentation of sorghum raised its protein digestibility from 59%to 65% while its raised that of pearl millet protein from 74,8%to the same level as that of wheat, maize and rice i.e. to 85.5%.

Bach Knudsen and Munck (1985) reported that cooking of unfermented sorghum made some protein bind to the dietary fiber and turned some starch resistant to enzyme digestion. fermentation the authors discovered counteracted both those effect and so made more protein and more energy available to the consumer. they added that their finding was consistent with observed beneficial nutritional effect of the traditional method of fermentation of sorghum diets in the Sudan.

Mbugua (1987) found that uji slurry from whole wet maize proved superior to slurry from finely sifted maize flour (unga baridi) in terms of improve protein content during fermentation. crude protein increased slightly but significantly during fermentation, this increase was however attribute to concentration of uji slurry as a result of water loss through evaporation during the fermentation process

In the studying kenkey a major fermented maize dumpling of Ghana amona and muller (1976) reported a slight increase in crude protein duress fermentation. the author microbial synthesis or loss of non-protein material

In India its was found that fermentation reduced the total crude protein by 6-8 %in legume product dhokla and by 4-6 % in the millet produce Ambali but no reduction was observed in the crude protein content of the fermented sorghum Ambali (Aliya and geervani 1981)

2.2 Feterita Sorghum

Sorghum is grown practically throughout the Sudan ‘there is an erroneous belief among the northern Sudan that the crop is not well known is southern Sudan which the better known for the cropping of the cassava, maize and finger millet (Talabun) in fact however in the region sorghum is grown by the maban of the southeastern reaches of the border with Ethiopia (Weddern burn Maxwell 1936) the Toposa on the Sudan.

The bulk of the Sudan sorghum however is produced in the central clay plains particularly in the nuba mountains and east of the Nile. Besyuni (1979) in his study of the history of agriculture in the Sudan in the period 1821_1863 mentioned that the Sudan had in 1821 nearly 20kind of sorghum. Cailliaud (1826), who visited the Sudan in 1821, wrote that all the territory of the sultanate of Sennar, on the Blue Nile depended mainly on sorghum as a staple, of which they had 20 varieties. Tahir (1964) mentioned that in about 1963an effort was made to categorize her barium sample of Sudan cultivated sorghum collected in the preceding years. the effort in the identification of 36 sorghum varieties and 72 distinct form.

The total number of sorghum types to be found to day in the Sudan must be higher that the above estimates would suggest, since new types have been selected and new cultivars in introduced from overseas.

What concerns us in the section in that among the various sorghum varieties of the country, the one locally referred to as Feterita or Feterita is given a special place by the rural Sudanese.

The roots of the word Feterita are not known exactly but Besyuni (1979) mentioned that in 1820, when Ismail pasha of the Egypt and turkey invaded the Sudan, the most widespread sorghum variety of the land was called Feterita. From the description of the variety given by the author, there is no doubt that fit was Feterita which to. day. If the former word is taken as the progenitor of the latter, then the name could possibly have come from the

Sudanese tribe called Feterita which to day inhabit the Bahr Elghazal region however, spelled the word Feterita or el Feterita as el-Feterita tin mentioning that the variety was the most common in the Sudan

The traditional liking of the Sudanese for Feterita tends to disprove the beliefs of may sorghum scientists. For example, Novel lie(1982b) thought that the claims made for the superiority of a particular variety of cereal should not be translated into generalization and should best be treated within the context of chaconne a son gout. also, Doggett (1977) in discuss- in the relationship between the evident quality of sorghum (appearance and cooking properties) and its cryptic quality (based on nutritional worth), stated that nobody buys food just because it does them good, except for a lunatic fringe of health food addicts in the west.

Nevertheless, the rural Sudanese strongly believe in the nutritional superiority of Feterita over other sorghum cultivars, many proverb, tales and poetry verses reflect this belief clearly. for example, there is a cardinal rule that says; no sorghum but Feterita, no woman except one in her home no camels a fast one, and no generosity but one in a year of dearth.

When asked about what kind of sorghum in most nutritious, the rural Sudanese would immediately retort; Feterita. other give such responses as sorghum is basically this by saying that Feterita when it comes nutritional aspect.

Of then the explain this by saying that Feterita gives muruwa (stamina, strength, energy) and that it has Madda (substance) or sass (foundation) both words denoting a nutritionally rich material

There are many indices that point toward a quasi-unanimity that Feterita is the most nutritious sorghum cultivar in the Sudan farm worker of the large agricultural schemes is usually fed Feterita porridge basically because they ask for it. they need a truly sustaining food. fortunately for the scheme are usually fed Feterita porridge, basically the scheme owners Feterita is the cheapest and the most available cultivar in the country. it must be mentioned however, that being cheap is not the major reason why people prefer this type of sorghum as some authors seem to believe (Dundas and futrell.1986). farm workers who get their food for free have no reason ask for a cheap variety. admittedly. Feterita gives better fodder and its grains store better than other sorghum (Culwick 1951) but the major reason behind the liking for Feterita is its higher nutritive.

It was at that time that an illustrative anecdote was spread in the Gezira. the tale went that a certain Gezira farmer, who was known to aspire to the same social status a city people, found the white milo Kissra (bread) quite ego raising and more like civilized life. taking immediate measure, he orders his wife to replace his brown Feterita Kissra, thence forth, with milo Kissra to save all the Feterita grain in the house for his donkey. the order was promptly obeyed and within a few days it became clear that the change in food brought with it a change in habits.

The man did less and less work, and slept most of the day. the donkey on the other hand, gained so much energy that in slept most of its time pulling at its festers and making much clamor. one day the farmer com planned to his wife about the noise tgat the ass was making and how it made it impossible for him to sleep. the wife whose once happy life had been donkey exchange their feed. this reversion back to the original situation put thing right and milo was kicked out of the family life for good it was not even given to the donkey.

The situation described an above concerning the reluctance of the Sudanese farmers to grow the improved milo cultivar, seems to reflect a problem not unique to the Sudan. according to D, Silva and Raza (1980) in Nigeria farmer were also reluctant to grow improved sorghum because according to them .it provided less food value than the traditional Fara –Fara sorghum.

Farmers of the Sudan also believe strongly that Feterita in the best sorghum to be fed to animals. the donkey for instance is an indispensable of farmers that a donkey fed mayo (milo) sorghum would not carry the same load the same distance it would have done had it been fed Feterita.

Feterita is the grain of choice for fattening sheep, goat or cow for slaughter or for milk production. but the most documented (through local poetry) feeding of an animal with Feterita is undoubtedly that of the travel camel. practically all the poetry on the praise of Feterita in the linked to the feeding of the travel or rise camel of the nomad. this kind of camel is a pet animal that is loved and treated buy the owner almost like a human being, naturally .it is fed the best of feeds Feterita.

A preponderance pf poetry emphasizes the positive health effects of Feterita on the camel, par ticularly because it gives it the general strength and endurance needed for long journeys. thus the camel fed Feterita is describe as energetic, fast powerful and has strong well-built bones as well as good reserve of fat.

Feterita is also preferred to other sorghum varieties for reason other than it nutritional superiority there are certain food product that are made wholly or mostly from Feterita and not from other varieties. example of such product are Hulu mur Merissa. Surij Ramdan and Hussuwa Furher practically all sorghum malt is made from Feterita grain.

Feterita is also believed to make the best all round Kissra bread and Aceda. Kissra made from Feterita is said to be the easiest to bake and to keep it is moisture for the longest period, following fermentation, the Feterita dough is claimed to become more glutinous and more elastic than other sorghum doughs.

The results of a preliminary survey in sorghum producing and consume area (Gedarif Halfa Algadida and Shendi reral area)involving 71 families , can be presented as follows about 66 of respondent said Feterita was easiest to digest , compared to other sorghum varieties 73 said Feterita it was best in the ease of baking of Kissra sheets 75 said Feterita was best for nashi (a thin porridge) 86 said it was best for moss (a fattening Acead slurry for women)87 said that Feterita made the best testing Kissra 87 said that it Kissra retained its moisture longest 89 said that it made the best all round Kissra and 100 of the respondent said Feterita gave the best sorghum malt (Babiker *et .al* 1989)

2.2.1 Chemical Composition of Feterita

The strong belief of the rural Sudanese in the relatively high nutritive value of Feterita is of course based on the experience of millions of people over a period of time extending, possibly, for more than a thousand years.

No research has been conducted with the sole aim of verifying whether the beliefs of the Sudanese concerning Feterita are true. However, quite a number of researchers, in the Sudan and elsewhere, have carried out work on the chemical composition of various sorghum grain its, including Feterita.

Chemical analysis of any food however reveal only some of the nutritional attributes of that food. the most important of these are given by the results of feed in trials, a form of research that is only rarely done in the Sudan particularly as regard human feeding. accordingly, the results available from only few feeding experiments will be given here, emphasis being laid on chemical composition, the aim section in then to see if there is any compatibility between popular belief and laboratory finding concerning the nutritive value of Feterita.

As early as 1906 the Sudan government analyst gave tables of chemical composition of Sudanese sorghum varieties. white Feterita contained 12.3 crude protein 2.1 ash and 1.8 crude fiber. red Feterita contained 14.2 crude fiber 2.1 ash and 2.1 crud fiber, whereas brown Feterita had only 8.9 crude protein 1.7 ash and 1.7%crude fiber. moisture content of three kinds of Feterita ranged of Feterita ranged from 4.9 to 6.2

In the government analyst report of 1947(Hennery 1955) no differences were observed in the chemical composition of the various sorghum grain types except in the crude protein content which ranged from 9.3 to 18.9 %. Here Feterita scored a high crude protein value.

Yousif and Magboul (1972) analyses 14 sorghum cultivars from the Sudan. Crude protein values ranged from 6.9 to 12.5% the highest value being recorded for Feterita. The calcium contents of these Sudanese sorghums ranged from 15.8 to 38.0mg. varieties having a high protein content were also found to have a fairly high calcium content. In comparing their results with those reported by the government analyst in 1947, the authors noted that, it is of further interest that the Feterita showed high values both in the 1947 study and in the present one.

Mohammed and Ahmed 1987 (1987) indicate that Safra, Feterita and Himayra varieties contained 13.5, 13.3 and 12.9 %crude protein, respectively. Feterita contained 13.0 %. Feterita also had a slightly lower fiber content and higher ash content than the other two verities.

As mentioned above, feeding trials, comparing sorghum varieties from a nutritional view point, are rare. Mohamed and Ahmed (1987) for example found that Feterita gave a better performance in chick feeding than Safra or Himayra. the authors, however, attributed this superiority to the low tannin content of Feterita rather than to other factor. Negative results were obtained in Uruguay (south America) when Feterita was used to replace increasing percentages of maize, barley and wheat in broiler rations. the results indicate a progressive reduction in body weight with increase in Feterita, while similar percentages using milo did not affect growth (Hulse *et al* 1980).

CHAPTER THREE

MATERIALS AND METHODS

3.1 Materials

Sorghum samples were brought from the northern state, Al-Qureir city, and were well preserved in sealed plastic containers until verification and analysis were conducted on them.

Spices (Ganzabel, Habahan, Gerfa, Kasbra, Helba, Kamoon and Ereg ahmar) were brought from local market in plastic bags. These spices were added in powder form.

3.2 Methods

3.2.1 Baganiya Preparation

3.2.1.1 Sorghum Preparation

Sorghum was cleaned well from impurities and soaked (w/v) in water for 24 hours

3.2.1.2 Germination

The sorghum submerged in the water was placed on a burlap sack with holes to facilitate the exit of the water and covered with another layer of burlap for a period of 5 days. the burlap was sprinkled in the morning and evening until the sorghum sprouts and the filaments are reddish in color. Then it was put under the sun for one day to be dried.

3.2.1.3 Grinding Germinated Sorghum

Grinding was done by a manual grinding machine, and the sprouted sorghum was ground to semi hard flour.

3.2.1.4 Preparation of Dough

The dough was prepared by addition of hot water to the germinated sorghum flour. Then a starter (liquid fermented sorghum flour) was added to the mix, stirred and left for one day for fermentation.

3.2.1.5 Cooking of the Fermented Dough

The fermented dough was poured on a large cooking pot (Saj). The cooking was, done on a low heat and mixed with a wooden mixer until the required degree of maturity was gotten. The spices were added at the end of cooking process.

3.2.2 Proximate Analysis Methods

Sorghum flour, germinated sorghum flour and Baganiya were subjected to chemical composition analysis as follow:

3.2.2.1Moisture Content

The moisture content was determined according to the Association of official's analytical chemists AOAC (1990) as follows: Two grams of each sample were weighed in clean dry and pre-weighed crucible and then placed in an oven at 105C° and left overnight. The crucible was transferred to desiccators and allowed to cool and then weighed. Further placement in the oven was carried out until constant weight was obtained. Moisture content was calculated using the following formula:

$$\mathbf{MC\% = (W2\text{-}W1) - (W3\text{-}W1) \quad \times 100/ W2\text{-}W1}$$

Where:

Mc: moisture content,

W1: weight of empty crucible

W2: weight of crucible with the sample,

W3: weight after drying.

3.2.2.2 Ash Content

The ash content of the sample was determined according to the method of AOAC (1990) as follows: Tow grams of sample were placed in a clean dry pre-weighed crucible, and then the crucible with its content ignited in a muffle furnace at about 550c for 3hours or more until light gray ash was obtained. The crucible was removed from the furnace to a esiccators to cool and then weighed. The crucible was reignited in the furnace and allowed to cooling until a constant weight was obtained. Ash content was calculated using following equation:

$$\mathbf{AC\% = W2\text{-}W1 \times 100/ W3}$$

Where:

Ac: ash content.

W1: weight of empty crucible.

W2: weight of crucible with ash.

W3: weight of sample

3.2.2.3 Crude Protein

Crude protein of the sample was determined by using the micro-Kjeldahl method according to AOAC (1990) as follows:

3.2.2.3.1 Digestion

0.2 gram of sample was weighed and placed in small digestion flask (50 ml). About 0.4-gram catalyst mixture (96% anhydrous sodium sulphate and 3.5% copper sulphate) was added, 3.5 ml of approximately 98% of $H_2SO_4$was added. The contents of the flask were then heated on an electrical heater for 2 hours till the color changed to blue-green. The tubes were then removed from digester and allowed to cool.

3.2.2.3.2 Distillation

The digested sample was transferred to the distillation unit and 20 ml of NaOH (40%) were added. The ammonia was received in 100 ml conical flask containing10 ml of 2% boric acid plus 3-4 drops of methyl red indicator. The distillation was continued until the volume reached 50 ml.

3.2.2.3.3 Titration

The content of the flask was titrated against 0.02 N HCL. The titration reading was recorded. The crude protein was calculated using the following equation;

$$\mathbf{CP\% = (T - B) \times N \times 14 \times 100 \times 6.25 / Ws \times 1000}$$

Where:

CP = crude protein

T = Titration reading

B = Blank titration reading

N = normality of HCL

Ws = sample weight

1000 = to convert to mg

3.2.2.4 Fat Content

Fat was determined according to the method of AOAC (1990) using soxhlet apparatus follows:

An empty clean and dry exhaustion flask was weighed. About 2 gram of sample was weighed and placed in a clean extraction thimble and covered with cotton wool. The thimble was placed in an extractor. Extraction was carried out for 8 hours with petroleum ether. The heat was regulated to obtain at least 15 siphoning per hour. The residual ether was dried by evaporation.

The flask was placed in an oven at 105°C till it dried completely and then cooled in a desiccators and weighed. The fat content was calculated using the following equation:

$$\mathbf{FC\ (\%) = W2 - W1 \quad x\ 100/\ Ws}$$

Where

FC= Fat content

W1= Weight of extraction flask

W2= Weight of extraction flask with fat

Ws= Weight of sample

3.2.2.5 Total Carbohydrates

Total carbohydrates were calculated by subtracting the sum of percentages of moisture, fat, protein and ash contents from 100% as described by (AOAC 2010).

Total carbohydrates % = 100 % - (Moisture % + fat% + protein% + ash %)

3.2.2.6 Available Carbohydrates

The available carbohydrates were calculated by subtracting the fiber percentage from the percentage of total carbohydrates.

Available carbohydrates% = Total carbohydrates (%) – Crude fibre (%)

3.2.2.7 Crude Fiber

Crude fiber was determined according to AOAC (1990). Two grams of defatted sample were treated successively with boiling solution of H_2SO_4 and KOH (0.26 N and 0.23 N, respectively). The residue was then separated by filtration, washed and transferred into a crucible then placed into an oven adjusted to 105°C for 18 – 24 hours. The crucible then with the sample was weighed and ached in a muffle furnace at 500°C and weighed. The crude fiber was calculated using the following equation:

$$\mathbf{CF\ (\%) = W1 - W2 \quad x\ 100/\ Ws}$$

Where:

CF = Crude fiber

W1 = Weight of crucible with sample before ashing

W2 = Weight of crucible with sample after ashing

Ws = weight of sample

3.2.3 Physicochemical Analysis

3.2.3.1 Total soluble solids (TSS)

Total soluble solids (T SS) of Baganiya paste were measured with a Hand-type Refractometer (No.002603, BS Eclipse, UK) (0-50% °Brix) at 25º C and were expressed as percentage or degree Brix **(AOAC, 2010)**.

3.2.3.2 Hydrogen ions concentration

The hydrogen ions concentration **(pH** value) of the sample was measured with a glass electrode pH- meter at (20 º C).

Five grams from the sample were diluted with 50 ml distilled water, and then it was filtered using a Whatman No. (1) Filter paper before determining the pH.

3.2.3.3 Acidity

Procedure: Ten grams (10g±1mg) of sample were added to150 ml of distilled water, stirred for 15 min and filtered using Whatman No. (4) filter paper. Ten milliliters from the prepared sample was titrated against 0.1 N NaOH in the presence of 1-2 drops of 1% phenolphthalein as an indicator, until a pink colour was obtained. The titrable acidity was calculated as percent citric acid according to the following equation.

$$\text{Titrable acidity (\%)} = \frac{\text{Titre (ml)} \times \text{N (NaOH)} \times \text{dilution factor} \times \text{equivalent weight} \times 100\%}{\text{Weight of sample (g)} \times \text{Sample Volume} \times 1000}$$

Where:

N = Normality of NaOH

Equivalent weight of citric / malice acid

3.2.4 Sensory Evaluation:

The sensory evaluation test was conducted by trained people, who were students of Sudan University of Science and Technology, College of Agricultural Studies, Department of food and Technology, and their number was 21 students and evaluation was done according to color, flavor, taste, appearance and overall quality. The ranking scores are given below:

Excellent = 5

Very good = 4

Good = 3

Acceptable = 2

Unacceptable = 1

Samples	**Appearance**	**Color**	**Flavor**	**Taste**	**Overall quality**
A					
B					

3.3 Statistical Analysis

Statistical analysis was accomplished using Statistix8 program (Completely Randomized) and LSD All-Pairwise Comparisons Test.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 Chemical Composition of Sorghum Flour

Table (4.1) shows the chemical composition of sorghum flour on wet and dry basis. The results of dry matter were 8.4%, 2.06%, 15.9%, 3.2%, 2.8% for moisture, ash, protein, fat and fibers; respectively. These results were agreed with those reported by Dirar, (1993) for white Feterita and red Feterita. white Feterita content 12.3% crude protein, 2.1% ash and 1.8% crude fiber and red Feterita content 14.2% crude protein, 2.1% ash and 2.1% crude fiber (Beam, 1906).

4.2 Chemical Composition of Germinated Sorghum

Table (4.2) shows the chemical composition of germinated sorghum on wet and dry basis. The results of dry matter were, 6.8%, 1.5%, 12.25%, 2.8%, 2.5%, for moisture, ash, protein, fat and fibers; respectively. Compare the results obtained from the sorghum flour whit results 8.4%, 2.06%, 15.9%, 3.2%, 2.8% for moisture, ash, protein, fat and fibers.

4.3 Chemical Composition of Fermented Sorghum

Table (4.3) shows the chemical composition of fermented sorghum on wet and dry basis. The results of dry matter were 8.0%, 2.45%, 15.3% 3.9%, 4.65%, for moisture, ash, protein, fat and fibers; respectively. These results were agreed with those reported by Dirar, (1993) for Hulu mur flask 6.10%, 3.45%, 14.26%, 1.78% 2.50% for moisture, ash, protein, fat and fibers.

4.4 Physico-chemical Characteristics of Baganiya Drink

These results were agreed with those reported by Dirar, (1993) for Hulu mur drink and the results was 3.75, 4.50 for acidity and Ph respectively.

Table (4. 1): Chemical Composition of Sorghum Flour

Parameter	% On wet basis	% On dry basis
(n = 2 ± SD)		
Moisture	8.40 ± 0.12	91.60 ± 0.55
Protein	15.90 ± 0.30	17.35 ± 0.35
Fat	3.20 ± 0.14	3.49 ± 0.30
Available carbohydrates	70.44 ± 0.09	79.5 ± 0.54
Total carbohydrates	67.64 ± 0.06	72.3 ± 0.57
Fiber	2.80 ± 0.22	3.05 ± 0.05
Ash	2.06 ± 0.02	2.24 ± 0.44

N = number of independent determination

SD = standard deviation

Table (4. 2):Chemical Composition of Germinated Sorghum

Parameter	**% On wet basis**	**% On dry basis**
	(n = 2 ± SD)	
Moisture	6.80 ± 0.14	93.2 ± 0.35
Protein	12.25 ± 0.61	13.1 ± 0.56
Fat	2.80 ± 0.14	3.00 ± 0.28
Available carbohydrates	76.65 ± 0.07	79.1± 0.12
Total carbohydrates	74.15 ± 0.10	80.3 ± 0.
Fiber	2.50 ± 0.40	2.68 ± 0.14
Ash	1.50 ± 0.28	1.60 ± 0.42

N = number of independent determination

SD = standard deviation

Table (4.3): Chemical Composition of Fermented Sorghum (Final Product)

Parameter	**% On wet basis**	**% On dry basis**
	(n = 2 ± SD)	
Moisture	8.00 ± 0.02	92.0 ± 0.30
Protein	15.30 ± 0.42	16.6 ± 0.35
Fat	3.90 ± 0.21	4.23 ± 0.05
Available carbohydrates	70.35 ± 0.09	77.8 ± 0.18
Total carbohydrates	65.70 ± 0.11	71.0 ± 0.32
Fiber	4.65 ± 0.07	5.05 ± 0.04
Ash	2.45 ± 0.07	2.66 ± 0.09

N = number of independent determination

SD = standard deviation

Table (4. 4):Physico-chemical Characteristics of Baganiya Drink

Parameters	**Values**
Acidity	1.2
T.S.S %	12.01
PH	4

4.5 Organoleptic Evaluation

Baganiya achieved high degree in appearance 4.14 compared to Hulu mur 3.81. while Hulu mur achieved high degrees in color, flavor and taste 4.20, 3.81 and 3.76 respectively compared to the results of Baganiya 3.76, 3.43 and 3.67 for color, flavor and taste respectively.

Table (4. 5): Shows the Organoleptic evaluation of Baganiya and Hulu mur

Sample	APPEARANCE	COLOUR	FLAVOUR	TASTE	OVERALL
A	4.14^{a} ±0.85	3.76^{a} ±0.94	3.43^{a} ±1.12	3.67^{a} ±1.15	3.88^{a} ±0.63
B	3.81^{a} ±1.12	4.20^{a} ±0.77	3.81^{a} ±1.03	3.76^{a} ±1.00	4.10^{a} ± 0.89
CV%	25.09	21.69	29.75	29.02	19.33
SE±	0.31	0.34	0.33	0.33	0.24
$LSD_{0.05}$	0.62^{NS}	2.02^{NS}	0.67^{NS}	0.67^{NS}	0.48^{NS}

(A) = Baganiya drink

(B) = Hulu mur drink

CV = Coefficient of variation

SE = Standard error

LSD = Less significant difference

CHAPTER FIVE

COCLUSION AND RECOMMENDATION

5.1 Conclusion

It was found the germination of sorghum improved its nutritional value of Baganiya.

From the results obtained in this study, it can be concluded that the Baganiya drink has high nutritional value.

Through the results of the sensory evaluation that was conducted, Baganiya found to be acceptable by the panelist.

5.2 Recommendation

1. Further studies of the microorganism that serve to ferment the Baganiya drink.
2. Further studies for Baganiya because it content distinguish flavor and develop it in form of several drinks and beverage in different concentrates.
3. Development and improvement the product and manufacture at a commercial level.

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