CHAPTER ONE

INTRODUCTION

Okra, *Abelmoschus esculentus* is known in various part of the world as ochre, Okra quinmgombo, quimgnbo, lady fingers, kappi, anab, kacang bendi, bhindi, bendi, bamig, manyaer bamich .

Abelmoschus esculentus belongs to family malvaceae. It originated in the old world and is generally grown in hot weather. The origin *Abelmoschus esculentus*, is variably considered to be India, West Africa (Mardock, 1959) and Tropical Asia (Grubben, 1977). There is a record in late 19th century of its occurrence in wild state along th white Nile in Sudan (Singh and Bhatnagar, 1975).

Okra is a summer vegetable crop that is grown in all parts of the Sudan and was consumed by almost all the Sudanese people. It was cooked either as ssleaves are used cooked in Northern Sudan (Kamaluddin, 1996).

Okra pods is the immature edible stage are a rich source of vitamins A and B, and minerals like calcium, phosphorus and iron. It was an excellent source of Iodine so it useful for the control of goiter (Pureswal and Randlhawa, 1947).

Okra is a source of protein, vitamin C and A (Ihekoronye and Ngoddy, 1985) and dietary fiber (Adom *et al*., 1996).

Okra is warm season crop that is grown extensively throughout the Sudan (Ikisan, 2000).

The numerous cultivars vary in time to maturity, color of leaves, stem length, shape of fruit and other characters. The main groups are short and long duration cultivars. Cultivars selected for specific regions (Choudhury, 1977).

Main objective:

To study the effect of cooking temperature on some of nutritive value of two local varieties of Okra

Specific objectives

1- To determine the chemical proximate composition of the two varieties of local Okra before and after cooking.

2- To determine vitamin C and tannin contents before and after cooking.

CHAPTER TWO

LITERATURE REVIEW

2.1 Okra, origin and distribution

Okra is a widely consumed cultivated vegetable in tropical and subtropical countries. The most important Okra producing countries are India, Nigeria, Pakistan, Ghana and Egypt. This vegetable is more famously known by its rows of tiny seeds and slimy or sticky texture when cut open. It is easy to cultivate, suited to regions with moderate rainfall and is normally grown during the summer (Martin and Ruberte, 1978).

2.2 Classification of Okra

King dum: Plants.

Branch: Embryophytes.

Section: Tracheophytes.

Division: Spermatophytes.

Class: Magnoliopsida.

Order: Malvace.

Species: Malvaceae.

Genus: Abelmoschus.

Type: esculentus.

Scientific name: *Abelmoschus esculentus* (Moench, 1794).

2.3 Varieties of Okra

Khartumia: It is the most common varieties in the Sudan and its fruit are spiny and of high dry matter. Farmers called it Aboshara. There are many varieties that devised and has vacationed by Agricultural Research Authority of the most important items Sennar, Reba, Hegirat, Korea and Arbaat and they are a smooth varieties suitable for export. One of

the smooth varieties which imported and grown for export product Celmson Spineless and variety Bozasuane (Mohamed *et al*., 2003).

2.4 Environmental response

Soil type does not appear to influence growth or development to any marked extent, a wide range of soil types has been found suitable. Well-drained, fertile soils with an adequate content of organic material and reserves of the major elements generally prove suitable. Some cultivars are sensitive to excessive soil moisture; others are slightly tolerant to salt. Most cultivars are adapted to high temperatures throughout the grown period, with little diurnal or seasonal fluctuation. Seeds will only germinate in relatively warm soils, no germination occurs below 16ºC. A monthly average temperature range of 20-30ºC is considered appropriate for growth, flowering and pod development.

Okra is tolerant to a wide range of rainfall; supplementary irrigation may be required up to the fruiting period, if the rainfall is marginally adequate to maintain vigorous growth. Most selections are well adapted to cultivation in the lowland humid tropics up to elevations of 500m.

Many cultivars grown in the lowland humid tropics are adapted to short day lengths (Terra, 1966).

2.5 Cultural requirements

Seeds are frequently soaked for 24 hours before being sown in deeply cultivated soil on ridges or beds in rows 60-80cm apart, 20-30cm between plants approximately 8-10kg of seed is required per hectare. Vigorous cultivars require generous spacing. The terminal bud is sometimes removed to encourage lateral branching.

Most cultivars respond to applications of nitrogen before sowing, together with dressings of potash and phosphate if these are relatively lacking. Subsequent dressings of nitrogenous fertilizer at pod set are recommended in some areas but excessive nitrogen applied before pod set delay maturity (Thompson and Kelly, 1957).

2.6 Growth period and harvesting

Young pods may be harvested 60-180 days from sowing, about 5-10 days after flowering, depending on the cultivar grown; succession harvesting of young pods is generally recommended since mature pods become fibrous. The pods are detached by giving them a slight twist with breaks the fruit stalk. Yield up to 2-3 t/ha of green pods may be produced, approximately 4-6 fruits per plant, over a harvesting period of 30-40 days (Tindall, 1968).

2.7 Nutritional composition

As it has been reported by FAO (1968) after cooking of the immature shoots of Okra the nutritional value per 100g of edible portion, has been assessed as: Water 93ml, Calories 18, Protein 2.0g, Fat 0.2g, Carbohydrate 3.0g, Fiber 2.4g,

Calcium 19mg, Phosphorus 47mg, Iron 0.2mg , B-carotene equivalent 540 micrograms, Thiamine 0.18mg, Riboflavin 0.2mg, Niacin 1.5mg . Also it has been reported that proximate chemical compositions of two varieties of Okra were as shown in the following tables:

Table (2-1): Proximate chemical composition of the Baoule variety dried in sun light

	Zatta	Abouakouassikro	Sinzibo	Average	Deviation
Protein%	17.15	17.14	17.16	17.15	0.01
Lipids%	2.14	1.73	2.20	2.02	0.25
Total sugar %	12	12	20	14.66	4.13
Reducing Sugar en%	0.80	0.90	0.90	0.86	0.05
Vitamin E %	0.087	0.087	0.087	0.087	0
Moisture%	7.85	6.90	7.10	7.28	0.50
Ash%	9.80	9.85	9.20	9.61	0.36
Dry matter %	92.14	93.10	92.90	92.71	0.50
Total carbohydrates en%	36.06	64.38	64.34	63.92	0.75
Starch%	45.95	47.14	39.90	44.33	3.88
Sucrose%	10.64	10.54	18.14	13.10	4.35
Crude fiber %	7.58	7.96	7.96	7.83	0.21
Energy value in en kcal	340.10	341.65	345.80	342.51	2.94

Source: Joel Brice Kouassi *et al*. (2013).

Table (2-2): Proximate chemical composition of the Dioula variety dried in sun light

	Zatta	Abouakouassikro	Sinzbo	Average	Deviation
Protein%	15.75	15.77	15.73	15.75	0.02
Lipids%	2.12	2.10	2.30	2.17	0.11
Total Sugar %	20	20	20	20	0
Reducing sugar en%	0.80	0.80	0.90	0.83	0.05
Vitamin E %	0.15	0.15	0.15	0.15	0
Moisture%	7.50	7.10	7.40	7.33	0.20
Ash%	9.60	9.50	9.40	9.50	0.10
Dry matter %	92.3	92.90	92.60	92.60	0.30
Total carbohydrates %	65.3	65.53	65.17	65.24	0.25
Starch%	40.52	40.97	40.65	40.71	0.23
Sucrose%	18.24	18.24	18.14	18.20	0.05
Crude fiber %	11.33	7.76	8.14	9.07	1.96
Energy value in en kcal	342.20	344.10	343.13	343.14	0.97

Source: Joel Brice Kouassi *et al*. (2013).

Osunde and Musa Makama (2007) reported that proportion of vitamin C in the Okra dried by the sun and found a rate of 18.2mg/100g

Ref'at Alkurd *et al*. (2008) reported that proportion of tannins in dried Okra traditionally by the sun and found the rate of 0.1024%.

Also it has been reported that proximate chemical compositions of Okra were as shown in the following tables:

Table (2-3): Proximate composition of fresh and treated Okra samples.

Composition (%)	FS	BOS	BSS
Moisture	89.09 ± 0.01	10.64 ± 0.01	15.36 ± 0.03
Crude fiber	8.34 ± 0.02	6.22 ± 0.02	6.06 ± 0.02
Crude protein	20.7 ± 0.7	25.12 ± 0.01	25.34 ± 0.02
Fat	4.12 ± 0.03	2.44 ± 0.02	1.91 ± 0.03
Ash	7.7 ± 0.04	10.53 ± 0.02	10.05 ± 0.10
Carbohydrate	59.85 ± 0.01	55.68 ± 0.01	56.63 ± 0.03

Values are means of three (3) replications ± standard deviation. Means within a row with the same superscript were not significantly different ($P<0.05$). FS, fresh sample, BOS, Blanched oven-dried sample, BSS, blanched sun dried sample. Means in brackets are in dry weight basis. Source: **Eze and Akubor** (2012).

Table (2-4): Micronutrients of fresh and treated Okra samples.

Parameters	FS	BOS	BSS
Vitamin A (µg)	55.9 ± 0.05	6.08 ± 0.01	5096 ± 0.02
Vitamin C(mg/100g)	71.3 ± 0.01	5.49 ± 0.02	5.67 ± 0.01
Iron (mg/100g)	3.57 ± 0.01	1.29 ± 0.01	0.69 ± 0.01
Zinc (mg/100g)	15.5 ± 0.01	3.76 ± 0.01	3.13 ± 0.01
Calcium (%)	57.1 ± 0.01	19.28 ± 0.01	12.02 ± 0.02
Magnesium (%)	21.6 ± 0.01	5.91 ± 0.01	4.75 ± 0.02

Values are means of three (3) replications ± standard deviation. Means within a row with the same superscript were not significantly different ($P<0.05$). FS, fresh sample BOS, Blanched oven-dried sample BSS, blanched sun dried sample. Source: **Eze and Akubor** (2012).

2.8 Health benefits of Okra

The Okra is a high intake of plant products is associated with a reduced risk of a number of chronic diseases, such as atherosclerosis and cancer (Gosslau and Chen, 2004). These beneficial effects have been partly attributed to the compounds which possess antioxidant activity. The major antioxidants of vegetables are vitamins C and E, carotenoids and phenolic compounds, especially flavonoids. These antioxidants scavenge radicals and inhibit the chain initiation or break the chain propagation (the second defense line). Vitamin E and carotenoids also contribute to the first defense line against oxidative stress, because they quench singlet oxygen (Krinsky, 2001). Flavonoids as well as vitamin C

showed a protective activity to α-atocopherol in human LDL, and they can also regenerate vitamin E, from the α-chromanoxy radical (Davey *et al.*, 2000).

Nutrient antioxidants may act together to reduce reactive oxygen pieces level more effectively than single dietary antioxidants, because they can function as synergists (Rossetto *et al.*, 2002). In addition, a mixture containing both water-soluble and lipid-soluble antioxidants is capable of quenching free radicals in both aqueous and lipid phases (Trombino *et al.*, 2004). Combinations of α tocopherol or vitamin C plus phenolic compounds also provided synergistic effects in human erythrocyte membrane ghosts and phosphatidylcholine liposome systems (Liao and Yin, 2000). Okra seed is rich in protein and unsaturated fatty acids such as linoleic acid (Oyelade *et al.*, 2003). Okra is also a popular health food due to its high fiber, vitamin C, and foliate content. Okra is also a good source of calcium and potassium. Okra pod contains thick slimy polysaccharides, which are used to thicken soups and stews, as an egg white substitute, and as a fat substitute in chocolate bar cookies and in chocolate frozen dairy dessert (Sengkhamparn *et al.*, 2009).

Okra contains high fiber, which “helps to stabilize blood sugar by regulating the rate at which sugar is absorbed from the intestinal tract”. Because of

Fiber along with other nutrition, Okra shows useful for minimizing blood sugar levels within the body, assisting along with diabetes. The fiber likewise helps support blood sugar levels simply by slowing down sugar assimilation through the intestines (Ngoc *et al.*, 2008).

2.9 Utilization of Okra

About 60 percent of Okra grown is for the fresh market and the remainder used for processing. Okra is used in soups, stews, gumbos, and Creole dishes together with many other vegetables. In some countries, Okra is used in folk medicine as anti-ulcerogenic, gastro protective, diuretic agents (Gurbuz, 2003).

The frequent usage of Okra might help avoid kidney disease. Consumed Okra every day decreased clinical indications of kidney damage a lot more than the ones that simply consumed a diabetic diet. This ties along with diabetes, as almost 50% of kidney disease cases are generated by diabetes (Lengsfeld *et al.*, 2004). Okra is used to treat digestive issues. The polysaccharides present in immature Okra pods possessed considerable anti-adhesive properties (i.e. they help remove the adhesive between bacteria and stomach tissue, preventing the cultures from spreading). Okra’s polysaccharides were particularly effective at inhibiting the adhesion of helicobacter pylori, a bacterium that dwells in the stomach and can cause gastritis and gastric ulcers if left unchecked. Therefore, eating more Okra

can keep our stomach clean and create an environment that prevents destructive cultures from flourishing (Messing *et al.*, 2014). Okra is used to supports colon health. It smoothly sails down our colon, absorbing all toxins and excess water in its path. Okra is filled with dietary fiber that is required for colon health and digestive health all together. The fiber Okra offers helps to cleanse the intestinal system, letting the colon to operate at higher amounts of effectiveness. In addition, the vitamin A plays a role in wholesome mucous membranes, assisting the digestive system to function adequately (Georgiadisa *et al.*, 2011).

Okra is used to promote healthy skin and blood. Eating more Okra can rejuvenate our skin and hair, and also shield us from degenerative diseases associated with long-term free radical damage. Vitamin K on the other hand, plays an important role in blood clot formation. If you suffer from regular nosebleeds, bleeding gums, heavy menstrual bleeding, or easy bruising, your blood might be too thin. Consider adding more vitamin K-rich foods like Okra to your diet to improve your blood’s ability to coagulate (Bakre and Jaiyeoba, 2009). Okra is used to promote a healthy of the pregnancy. An incredibly essential vitamin B for creating and maintaining new cells, foliate is a vital substance for optimum pregnancy. The vitamin aids in preventing birth defects just like spine bifida and enables the baby to develop completely. Vitamin C is additionally required for baby

development. Okra is full of both foliate and vitamin C. The high quantity of foliate included in the Okra is helpful for the fetus while pregnant. Foliate is a vital nutrient that increases the growth and development of the fetus brain. The high quantity of folic acid within Okra performs a huge role within the neural tube formation of the fetus through the fourth to the 12th week of pregnancy (Zaharuddin *et al.*, 2014).

Okra is used to improve heart health. The soluble fiber within Okra helps you to reduce serum cholesterol and therefore decreases the chance of cardiovascular disease. Consuming Okra is an efficient method to manage the body's cholesterol level. Okra is additionally loaded with pectin that can help in reducing high blood cholesterol simply by modifying the creation of bile within the intestines (Ngoc *et al.*, 2008). Okra is also used to improve good eye-sight. The Okra pods are fantastic options for vitamin A and also beta carotene that are both important nourishment for sustaining an excellent eye-sight along with healthy skin. Okra is better ingested when joined along with other healthy veggies. Consuming Okra has truly numerous advantages, simply bear in mind to eat natural veggies as opposed to processed veggies (Messing *et al.*, 2014).

Generally, Okra is used to stabilize blood sugar by regulating the rate at which sugar is absorbed from the intestinal tract. It is a good vegetable for those feeling weak, exhausted and suffering, from depression and it is also used in ulcers, lung

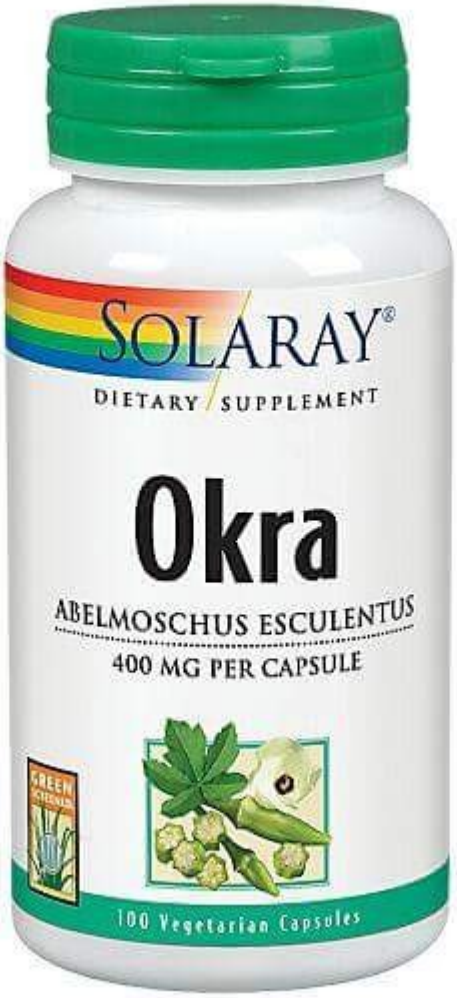
inflammation, sore throat as well as irritable bowel. Okra is good for asthma patients and it also normalizes blood sugar and cholesterol levels (Sengkhamparn *et al*., 2009). Also, Okra polysaccharide lowers cholesterol level in blood and may prevent cancer by its ability to bind bile acids (Lengsfeld *et al*., 2004; Kahlon *et al*., 2007). Additionally, Okra seed possess blood glucose normalization and lipid profiles lowering action in diabetic condition (Sabitha *et al*., 2011).

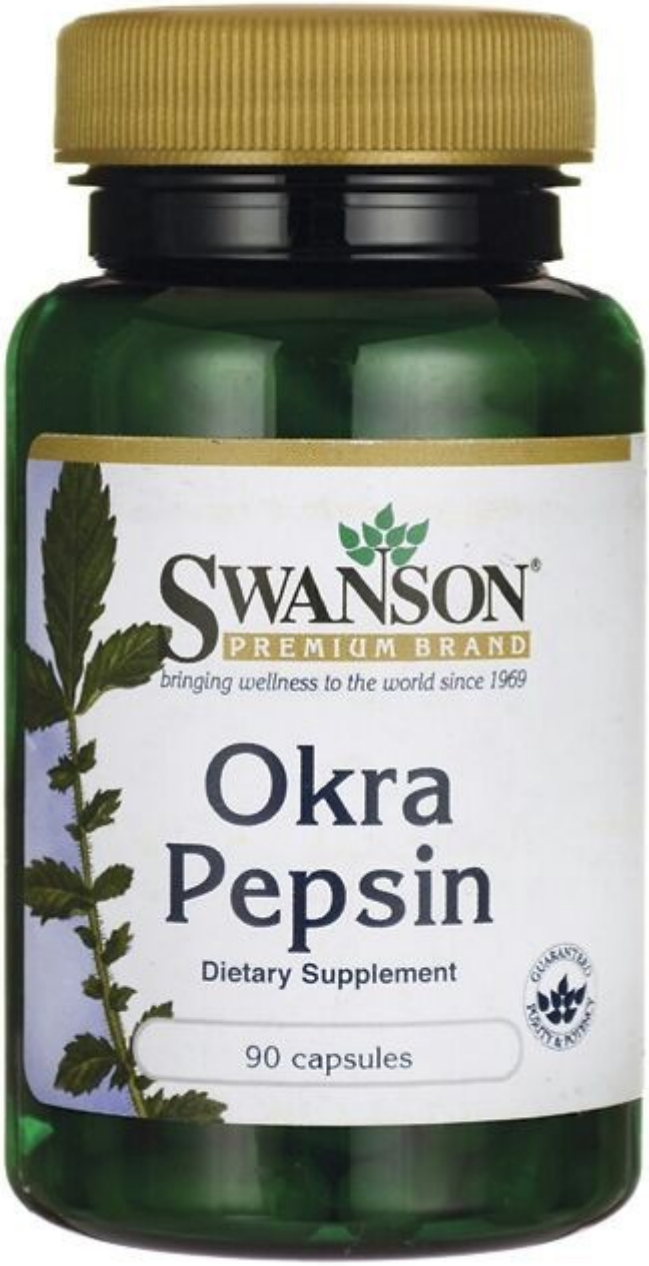
2.10 Drying of Okra

Drying is the traditional and oldest method of processing Okra to reduce the water activity and improve the keeping quality (Fellows, 2000). Drying may be achieved by sun or using hot-air oven. Industrial and home usage of oven is increasing and the primary use in the home is reheating while tempering, cooking, drying and pasteurization are the main applications in the industry (Decareau, 1985).

Dehydrated foods and the dried components of many formulated or manufactured foods are now common articles of commerce and drying is becoming a standard processing operation. Its technology is now rather well defined and it is carried out in well tested types and sizes of equipment to produce billions of pounds of dry product annually (Van Arsdel, 1965).

Okra medicines

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CHAPTER THREE
MATERIALS AND METHODS

3.1 Materials

Samples were taken from Alsoug Ashaabi Omdurman, then kept in dried cloth sacks for further analysis. (moisture, protein, fiber, ash, fat , total carbohydrates, vitamin C and tannins content) .

The samples were heat cooked and then dried and analyzed for the above mentioned parameters.

3.2 Methods

3.2.1 Chemical Analysis

3.2.1.1 Moisture content

The moisture content was determined according to the method described by AOAC (2002).

Five gram of the sample were weighed into pre-dried aluminum dishes, with a lid, and then placed in a temperature controlled oven at 103ºC over night (about 8 hours). The covered samples was transferred to a dedicator and cooled to room temperature, and then weighed.

The moisture content was calculated as percentage of the original weight of the samples:

Moisture content%= $(W_{2-W3)(W2-W1)\times100}$

Where:

W_1= weight of dish + lid.

W_2= weight of dish + lid + sample.

W_3= weigh of dish + lid + sample after drying.

3.2.1.2 Ash content

The ash content of sample was measured according to AOAC (2002).

Two gram of samples were weighed into clean dry porcelain crucibles and placed in muffle (Model Tipoforano ZANo.18203 Get Ran 1002), at 600ºC for 6 hours.

The crucibles was transferred to dedicator, and cooled to room temperature and weighed. The ash content was calculated as follows:

Ash content %= $(W_{1-W2)}$Weight of sample×100

Where:

W_1= weight of crucible with ash.

W_2= weight of empty crucible.

3.2.1.3 Protein content

The protein content of the samples was determined by the micro-kjeldahl method AOAC (2002). Sample of 0.2g of Okra powder was weighed accurately into a micro-kjedahl flask, 0.4gm of catalyst mixture and 3.5ml of concentrated sulphur acid were added, the flask was then placed into the kjeldahl digestion unit for about 2 hours until a colorless digest solution was obtained. The flask was left to cool to room temperature. Twenty ml of 40% sodium hydroxide solution were added to the digested solution and the mixture was heated. The ammonia evolved was trapped into 10 ml of 2% boric acid solution, then titrated against 0.2N hydrochloric acid using universal indicator (methyl red + bromo cresol

green). The total nitrogen and protein were calculated using the following formula:

Nitrogen%= Volume of HCl x N . 14 x 100Weight of sample x 1000

Protein% = nitrogen% . 6.25

Where:

Nitrogen% = crude nitrogen.

Protein% = crude protein.

N = normality of HCL.

14 = equivalent weight of nitrogen.

3.2.1.4 Fat content

Crude fat was determined according to AOAC (2002) method. Two gram weight of sample was extracted with hexane for 8 hours using Soxhelt apparatus. The solvent was evaporated and the remaining crude fat was determined.

Fat % = $W_{2\text{-}W1}$Weigh of sample×100

Where:

W_1 = weight of empty flask.

W_2 =weight of flask with oil.

3.2.1.5 Crude fiber content

Crude fiber was determined according to the method of AOAC (1984). Two gram of sample was weighed. One hundred and fifty ml of the H_2SO_4 (conc.7.3ml/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 105ºC overnight and then weighed (W_1). The residue was ashes in a muffle furnace at 550ºC 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:

Crude fiber % = $W_{1\text{-}W2}$sample weight×100

Where:

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

W_2 = the weight of the treated sample after asking.

3.2.1.6 Total carbohydrates content

A total carbohydrate was calculated by difference according to Pearson (1976) using the following formula:

Total carbohydrates % = 100 – (moisture + fat + crude protein + ash).

3.2.2 Tannins

Quantitative estimation of tannin was carried out using the modified Vanillin – HCL methanol method as described by Price *et al*. (1978). The Vanillin – HCL reagent was prepared

by mixing equal volumes of 8% concentrated HCL methanol and 1% Vanillin in methanol. The two solutions of the reagent were mixed just prior to use. It was discarded if a trace of color appeared. Sample of 0.2g of the ground grain was placed in a small conical flask. Then 10 ml of 1% concentrated HCL in methanol were added. The conical flask was capped and continuously shacked for 20 minutes and the content centrifuged at 2500 rpm for 5 minutes. One ml of the supernatant after centrifugation was pipette into a test tube and 5 ml of the Vanillin-HCL reagent was added. Absorbance at 450 nm was read on spectrophotometer (corning, 259) after 20 minutes incubntion at 30ºC, a blank sample was carried out with each ren of sample. Standard curve was prepared expressing the result as catchin equivalent, i.e. catechin (mg per ml) which gives color intensity equivalent to that given by tannin after correcting for blank. The concentration of the condensed tannins was determined from the standard curve, tannin concentration was expressed as catechin equivalent as follows:

Tannin % = $C \times 10 \times \frac{100}{200}$

Where:

C = concentration corresponding to the optical density.

10 = volume of the extract (ml).

200 = sample weight (mg).

3.2.3 Ascorbic acid (Vitamin C)

Ascorbic acid (vitamin C) was determined according to the indophenols method (AOAC, 1984).

Principle

Aliquots in oxalic solution are titrated with standard 2.6 dichlorophenol indophenols dye till a faint pink color that persists for 5-10 seconds appears. This method is limited to juice of light color because pigments obscure the end point.

Reagents

(1) Indophenols dye (0.04 %): 0.2g 2.6 dichlorophenol indophenols were weighed and dissolved in about 200 ml distilled water. The solution was filtered by Whitman filter paper No.4 into 500ml volumetric flask and make up at 20ºC and stored in refrigerator.

(2) Oxalic acid (0.4%): Four grams of oxalic acid were dissolved in distilled water and diluted to 1000 ml.

(3) Oxalic acid (10%): Fifty grams of oxalic acid were dissolved in 500 ml water.

(4) Ascorbic acid: 0.05 grams of ascorbic acid were weighed out accurately and made up to 250 ml in volumetric flask with 10% oxalic acid.

Strength of the dye

Five ml ascorbic acid solution was pipetted, and then 5 ml of 10% oxalic acid were added. The aliquot was titrated against dye solution to a pink color. Number of mg of ascorbic acid equivalent to 1 ml of dye was calculated by dividing 1 by the number of ml dye used.

Titration procedure

Thirty grams of sample were blended with reasonable amount of 0.4 % oxalic acid for one minute, aliquot was transferred to 500ml volumetric flask, made up to volume with 0.4% oxalic acid and then filtrated through Whitman filter paper No.4, twenty ml aliquot were pipetted and titrated against the dye solution to faint pink color end point.

Calculation:

Ascorbic acid (mg/100g) = Titration (ml x dye strength x 100)Factor

Factor = Sample weight x sample volume for titrationTotal volume of sample

Dried Okra

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 Proximate chemical composition of two local varieties of dried Okra before cooking

4.1.1 Moisture content

As shown in table (1) it was found that, the moisture content in the varieties Sara and Khartoumia were 8.48% and 10.15%, respectively. In comparison with the results obtained by Joel Brice Kouassi *et al*. (2013) varieties Baoule and Dioula were found to be 7.28% and 7.33%, respectively. The higher values of the present study may be due to time of drying, and storage condition.

4.1.2 Crude protein content

As shown in table (1) it was found that, the protein content in the varieties Sara and Khartoumia were 10.11% and 9.22%, respectively. In comparison with the results obtained by Joel Brice Kouassi *et al*. (2013) varieties Baoule and Dioula 17.15% and 15.75%, respectively. It was found that our results were less than their results. This may be due to difference of variety and low quality of reagents.

4.1.3 Crude fiber content

As shown in table (1) it was found that, the fiber content in the varieties Sara and Khartoumia 20.93% and 15.94%, respectively. In comparison with the results obtained by Joel Brice Kouassi *et a l*. (2013) varieties Baoule and Dioula 7.83% and 9.07%, respectively. The higher values of the

present study may be due to difference of variety, climate condition and agricultural practices.

4.1.4 Fat content

Table (1) shows that fat content in the varieties Sara and Khartoumia 0.60% and 1.1%, respectively. In comparison with the results obtained by Joel Brice Kouassi *et al*. (2013) varieties Baoule and Dioula 2.02% and 2.17%, respectively. It was found that our results were less than their results. This may be due to difference of variety and low quality of reagents.

4.1.5 Ash content

Table (1) shows that ash content in the varieties Sara and Khartoumia 9.57% and 7.78%, respectively. In comparison with the results obtained by Joel Brice Kouassi *et al*. (2013) varieties Baoule and Dioula 9.61% and 9.50%, respectively. It was found that our results were less than their results. This may be due to time of burning and low quality of reagents.

4.1.6 Total carbohydrates

Table (1) shown that it total carbohydrates content in the varieties Sara and Khartoumia 71.24% and 71.75%, respectively. In comparison with the results obtained by Joel Brice Kouassi *et al*. (2013) varieties Baoule and Dioula 63.92% and 65.24%, respectively. The higher values of the present study may be due to difference of variety, climate condition and agricultural practices.

4.2 Vitamin C content

Table (1) shows that vitamin C content in the varieties Sara and Khartoumia 23.83mg/100g and 23.77mg/100g, respectively. In comparison with the results obtained by Osunde and Musa Makama, (2007) 18.2mg/100g. The higher values of the present study may be due to difference of variety, climate condition and Agricultural practices.

4.3 Tannins content

Table (1) shows that tannin in the varieties Sara and Khartoumia 0.26% and 0.21%, respectively. In comparison with the results obtained by Ref'at Alkurd *et al*. (2008) 0.1024%. The higher values of the present study may be due to difference of variety, climate condition and Agricultural practices.

Table (4-1): Proximate chemical composition of two local varieties of dried Okra before cooking

Composition	Variety (A)	Variety (B)
Moisture	8.48 ± 0.11	10.15 ± 0.15
Crude protein	10.11 ± 0.10	9.22 ± 0.11
Crude fiber	20.93 ± 0.061	15.94 ± 0.08
Fat	0.60 ± 0.31	1.1 ± 0.09
Ash	9.57 ± 0.13	7.78 ± 0.05
Total carbohydrates	71.24 ± 0.33	71.75 ± 0.08
Vitamin C	23.83 ± 0.76	23.77 ± 0.25
Tannin	0.26 ± 0.003	0.21 ± 0.01

Values are means of three (3) replications ± standard deviation. **A:** variety Sara , **B**: variety Khartoumia**.**

4.4 Proximate chemical composition of two local varieties of dried Okra after cooking

4.4.1 Moisture content

As shown in table (2) it was found that, the moisture content in the varieties Sara and Khartoumia 11.64% and 12.02%, respectively. In comparison with the result obtained by **Eze and Akubor,** (2012) 15.36%. It was found that our results were less than their result. This may be due to time of drying after cooking.

4.4.2 Crude protein content

As shown in table (2) it was found that, the protein content in the varieties Sara and Khartuomia 19.87% and 14.73%, respectively. In comparison with the result obtained by **Eze and Akubor,** (2012) 25.34%. It was found that our results were less than their result. This may be due to difference of variety.

4.4.3 Crude fiber content

Table (2) shows that fiber content in the varieties Sara and Khartoumia 20.16% and 15.63%, respectively. In comparison with the result obtained by **Eze and Akubor,** (2012) 6.06%. The higher values of the present study may be due to difference of variety.

4.4.4 Fat content

Table (2) shows that fat content in the varieties Sara and Khartuomia 3.17% and 3.5%, respectively. In comparison with the result obtained by **Eze and Akubor, (**2012) 1.91%. The higher values of the present study may be due to difference of variety.

4.4.5 Ash content

Table (2) that ash content in the varieties Sara and Khartoumia 9.97% and 11.1%, respectively. In comparison with the results obtained by **Eze and Akubor,** (2012) 10.05%. It was found that their result between our results. This may be due to time of burning.

4.4.6 Total carbohydrates

Table (2) shows that total carbohydrate content in the varieties Sara and Khartoumia 55.35% and 58.65%, respectively. In comparison with the results obtained by **Eze and Akubor, (**2012) 56.63%. It was found that their result between our results. This may be due to difference of variety.

4.5 Vitamin C content

Table (2) shows that vitamin C content in the varieties Sara and Khartoumia 15.3mg/100g and 13.30mg/100g, respectively. In comparison with the results obtained by **Eze and Akubor (**2012) 5.67mg/100g. The higher values of the present study may be due to difference of variety.

4.6 Tannins

Table (2) shows that tannin content in the varieties Sara and Khartoumia 0.22% and 0.20%, respectively.

Table (4-2): Proximate chemical composition of two local varieties of dried Okra after cooking

Composition	Variety (A)	Variety (B)
Moisture	11.64 ± 0.30	12.02 ± 0.16

Crude protein	19.87 ± 0.47	14.73 ± 0.20
Crude fiber	20.16 ± 0.15	15.63 ± 0.15
Fat	3.17 ± 0.15	3.5 ± 0.1
Ash	9.97 ± 0.15	11.1 ± 0.36
Total carbohydrates	55.35 ± 0.05	58.65 ± 0.09
Vitamin C	15.3 ± 0.44	13.30 ± 0.03
Tannins	0.22 ± 0.01	0.20 ± 0.00

Values are means of three (3) replications ± standard deviation. **A:** variety Sara, **B**: variety Khartoumia

CHAPTER FIVE

CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

1- Through this study, it has been found that the proportion of each of the moisture, protein, ash, fiber, total carbohydrates, vitamin C and tannins and in a variety Sara were higher than the variety Khartoumia, but the fat content is higher in the variety Khartoumia than Sara.

2- The cooking temperatures affected the proximate composition for each of the two varieties (Sara and Khartoumia) where the moisture content, ash content, fat content and protein content increased, while the proportion of total carbohydrates, fiber, vitamin C and tannins decreased.

5.2 Recommendations

1- It is recommended that the two varieties Sara and Khartoumia can be consumed since they are of high nutritive value.

2- To increase the awareness of people about the great benefits of Okra as they are containing high fiber percent (anti-cancer) and high in vitamin C and tannins (anti-oxidants).

3-Further studies are needed in these two local varieties.

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