EFFECTS OF BOILING ON THE ANTIOXIDANT PROPERTIES OF THREE SPECIES OF GARDEN EGG

(*Solanum aithiopicum Solanum aubergine and Solanum anguivi*)

SUBMITTED BY

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BEING A DISSERTATION SUBMITTED TO THE DEPARTMENT OF INDUSTRIAL CHEMISTRY, FACULTY OF SCIENCE, FEDERAL UNIVERSITY,OYE-EKITI

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CERTIFICATION

This is to certify that this project was carried out under my supervision by ADELEYE TEMITOPE ADEWUMI of the Department of Industrial Chemistry for the award of Bachelor of Science.

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HEAD OF DEPARTMENT

DEDICATION

This research work is dedicated to the Almighty God, the creator of the world, for his protection and love over my life.

ACKNOWLEDGEMENTS

Glory be to Almighty God who kept me till now and made me who I am.

My appreciation goes to my loving and diligent supervisor, Dr. (Mrs) Ogundele, J.O who was always monitoring my work and made sure that I did the correct work. She was like a mother to me, advices, corrects strictly and correct strictly with explanation which has led to the success of the project. May God be with you ma.

I also wish to extend my sincere appreciation to the Head of Department of Industrial Chemistry Dr (Mrs) Akintayo, C.O for her love and support she gave to make this work a success. My appreciation will be incomplete if I fail to appreciate my lecturers like Dr. Olumayede, E.G, Dr.(Mrs) Adunbiaro H.O, Mr Olusanya S.O, Mrs Babalola, M.O, and Mr Shodeinde, K.O for their support ,encouragement and their constructive critism all through my year of study in FUOYE. God bless you all.

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My grea t appreciation goes to my loving and caring parents Mr and Mrs Adeleye who were always there for me and have been my source of joy. They labored in harsh conditions to make me who I am today. You will surely eat the fruit of your labour in Jesus name.

ABSTRACT

Garden egg (*Solanum* spp) has been reported to exhibit several pharmacological properties and widely used in folk medicine for the traditional treatment of ailments. Hence, this study sought to investigate the antioxidant properties of the aqueous extract of boiled and unboiled garden egg varieties (*solanum aubergine Solanum aithiopicum Solanum anguivi*) using several antioxidant parameters. The extracts were tested for free radical scavenging ability, ferric reducing properties and Fe^{2+} chelating ability. Furthermore the phytochemicals constituent (Total phenolic, flavonoids and vitamin C) of the extract were determine.

Result showed that the extracts demonstrated potent free radical scavenging and ferric reducing ability and iron chelating activity in vitro. The total phenolic content, and the antioxidant capacity (free radical scavenging ability, ferric reducing properties and Fe^{2+} chelating ability), of the boiled extracts were substantially higher than those of the unboiled, while the flavonoid, vitamin C and Fe^{2+} chelating ability of aqueous extract of *Solanum* spp of the boiled extract reduced for all the three varieties studied. Among the three varieties, *solanum aubergine* has a significantly much higher content of total phenolic which varied between (11.87-18.75mg gallic acid equivalents [GAE] mg/ml). Additionally, a high correlation between total phenolic content and antioxidant capacity (except Fe^{2+} chelating ability of aqueous extract which reduced) was found in all the three garden egg varieties. In conclusion, our results demonstrated that the effectiveness of bioactive compounds in food can be affected by thermal treatment. Boiling can increase the antioxidant activity.

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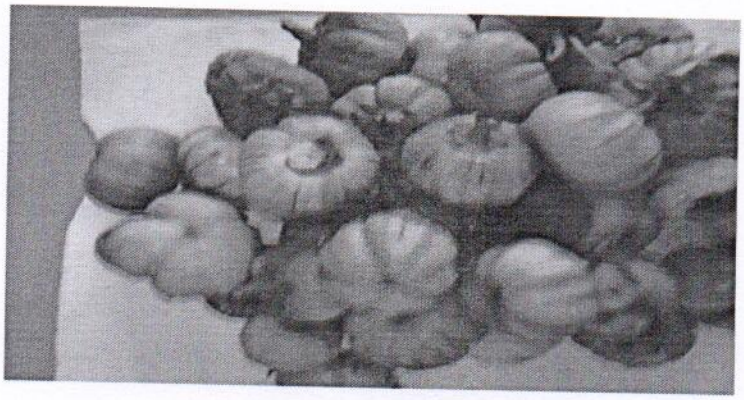
CHAPTER ONE

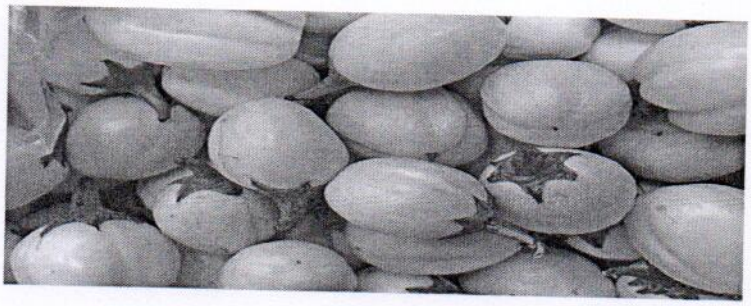
1. INTRODUCTION

Eggplant (*Solanum* spp) is a plant native in India, and many cultivars exhibiting different size, shape, and color are cultivated in tropical, subtropical, and temperate zones. Its fruit, commonly known as aubergine, melanzana, garden egg, brinjal, or patlican, also has same name and widely used as a vegetable in cooking. The most widely cultivated varieties are elongated ovoid or slender type in a dark purple skin. Eggplant is ranked as one of the top ten vegetables in terms of oxygen radical scavenging capacity due to the fruit's phenolic constituents (Cao *et al.*, 1996). Many factors will influence the antioxidant content of vegetables and the type and level of losses due to boiling. These include the genetic make-up of the plant or animal, the soil in which it is grown, use of fertilizer, prevailing weather, maturity at harvest, packaging, storage conditions and method of preparation for processing (Sahlin *et al* 2004).



Solanum aithiopicum

Solanum aubergine



Solanum anguivi

Boiling is a techniques used to transform raw ingredient into consumable food or to transform food into other forms for consumption by humans or animals either in home or by the food processing industry. Boiling has various effects on foods it softens the fiber and dissolves the connective tissues in meat, softens cellulose in cereals, vegetables, fruits and dissolves other substances in many foods. The effect of boiling on anti-nutrient and antioxidant content will depend on the sensitivity of the nutrient to the various conditions prevailing during the process, such as heat, oxygen, pH and light. The antioxidant retention may vary with a combination of conditions, such as the characteristics of the food being boiled, and the concentration of the nutrient in the food. (Rehman *et al* (2003).

The popular thinking is that fresh fruits and vegetables are better for us than cooked ones nutrition wise. However, Carotenoids, the colorful pigments in a variety of red, yellow and orange vegetables are more available for absorption from cooked than raw foods. Cooked sweet yellow corn had 44% higher total antioxidant activity than the same corn before cooking.(Dewanto *et al* 2002b)

Most vegetables are usually cooked by boiling in water or microwaving (unlike fruits that are usually consumed in their raw forms) before consumption. These cooking processes could bring about a number of changes in physical characteristics and chemical composition of vegetables (Rehman *et al.* 2003)

Raw foods such as meat, eggs, fruits and vegetables may harbor food poising bacterial, which if consumed are likely to cause illness. The optimum temperature for the multiplication of most food poisoning bacterial is between 5-63°C, whilst, at temperature over 70°C most bacterial are killed and below 5°C most food bacterial can only multiply slowly or not at all. Boiling will heat foods to over 70°C so applying such a temperature for a carefully calculated time period will prevent many food borne illnesses that would otherwise manifest if the raw food was eaten.

1.1 AIM OF RESEARCH WORK

The aim of this research work is to determine the effects of boiling on antioxidant properties of garden eggs verities (*Solanum spp.*)

1. Determine the antioxidant content (total phenol, total flavonoid, Reducing property (FRAP), Fenton (Hydroxyl Radical), Iron chelation) and Vitamin C

2. Determine the Effect of boiling on the antioxidant content (total phenol, total flavonoid, Reducing property (FRAP), Fenton(Hydroxyl Radical), Iron chelation) and Vitamin C

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1. BOILING

Boiling is usually carried out in order to increase the palatability and to improve the edibility of some food. The popular thinking is that fresh fruits and vegetables are better to us than cooked ones nutrition wise. Most vegetables are usually cooked by boiling in water or microwaving (unlike fruits that are usually consumed in their raw forms) before consumption. These boiling processes could bring about a number of changes in physical characteristic and chemical composition of vegetables (Rehman *et al*, 2003). Sahlin *et al* (2004) reported that boiling and baking had a small effect on the ascorbic acid, total phenolic, lycopene and antioxidant activity of the vegetables. Zhang and Hamauzu (2004) pointed out that cooking affected the antioxidant components and antioxidant activity of broccoli. While Jeongetal, (2003) found that thermal treatment decreased the total phenolic content in some vegetables such as kale, spinach, cabbage, swamp cabbage and shallots and antioxidant activity in some of them.

2.2 Vegetables (leafy and fruits) are widely grown in most parts of sub-Saharan Africa, especially, in the urban areas, and they constitute the most affordable and sustainable source of micronutrients in diets.

The name "Garden eggplant" was derived from the shape of the fruits of some varieties which are white and shaped like chicken eggs (Chang *et al.*, 2001). The plant (*Solanum* spp) is a vegetable with increasing popularity in the world (Pessarakli and Dris 2003), and it originated from Tropical Africa (Normal 1992). It is an economic flowering plant belonging to the family Solanaceae, of which members of about 1,400 species found throughout the temperate and tropical regions of the world are mostly herbaceous plants. The fruit of the plant comes in a wide array of shapes and colours, some are yellow and small with green stripes; there are the big yellow ones with white colour and flat ribbed green types among others (Chang *et al*,2002). The importance of the garden-egg cannot be overemphasized. It is consumed on daily basis by urban families and also represents the main source of income for producing households in West Africa (Danquah-Jones, 2000). Eggplant also contains phyto-nutrients such as nasunin and chlorogenic acid (zhang et al ali 2003). The Garden Eggplant with its bitter taste and spongy texture could really make an amazing pot of stew with a nice Aroma. When eaten with boiled yam or rice, it becomes a delicacy you do not want to miss at the slightest opportunity. (Sabo and Dia, 2009).

Medicinally, they are processed and used in the preparation of condiments and products used in treating different diseases and health problems (Medal etal 2005). A Meal of garden egg is proven to be of benefits to patients suffering from raised

intraocular pressure (glaucoma) and convergence insufficiency, as well as in heart diseases and *Arteriosclerosis* (Harish et al., 2008).

Garden Eggplant can be regarded as a brain food because it houses the anthocyanin phytonutrient found in its skin, Nasunin, a potent antioxidant and free radical scavenger that has been shown to protect cell membranes from damage.

Studies have shown that nasunin protects the fats in brain cell membranes. Nasunin is not only a potent free radical scavenger, but is also an iron chelator. Iron is an essential nutrient, necessary for oxygen transport, normal immune function and collagen synthesis, but when it becomes too much in the blood stream; it becomes a major concern. Excess iron increases free radical production and is associated with an increased risk of heart disease and cancer. Menstruating women, who lose iron every month in their menstrual flow, are unlikely to be at risk, but in post-menopausal women and men, iron, which is not easily excreted, can accumulate.

By chelating iron, nasunin lessens free radical formation with numerous beneficial results including protecting the blood cholesterol from peroxidation, preventing cellular damage that can promote cancer, and lessening free radical damage in joints, which is a primary factor in rheumatoid arthritis. The predominant phenolic compound found in garden eggs is chlorogenic acid, which is one of the most potent free radical scavengers found in plant tissues. (Harish *et al.*, 2008).

The chlorogenic acid performs antimutagenic (anticancer) activities in the body. It also performs anti- LDL (Low density lipid) activities by increasing the levels of HDL (High density lipid) in the body and at the same time has antiviral and antimicrobial properties. Consuming high amounts of garden eggs have been found to be beneficial for people with glaucoma because it lowers the eye pressure. (Burkill, 1985).

Chewing thoroughly while eating, can enable you get significant benefits, including absorption of calcium from calcium-rich foods plant foods that also contain oxalic acid. As such, eating garden eggs does not stop you from meeting your calcium requirements. Eggplant is low in calories and high in fibre. The eggplant is good for carbohydrate counters and dieters can actually snack on Garden eggs in-between meals. (Chen *et al.,* 2001).

Nigeria, specifically, in Abia State, garden-egg popularly called "Mikimiki " (big sized green fruit with very deep and sweet "endocarp") is grown commercially while in the savannah zone of Nigeria; the yellow, white and thick green skinned varieties are grown on large scale. (Chen *et al.*, 2001).

2.3 EFFECTS OF BOILING

Boiling has various effects on foods. It toughens the albumin in eggs, softens the fiber and dissolves the connective tissues in meat, softens the cellulose in cereals, vegetables, and fruits, and dissolves other substances in many foods. A good point

to bear in mind in preparing foods by boiling is that slowly boiling water has the same temperature as rapidly boiling water and is therefore able to do exactly the same work. However, certain recipes may specify rapid boiling or slow boiling due to other conditions (such as not wanting to disintegrate soft food, or wanting to make use of the bubbles that appear in rapid boiling). (Chen *et al.*, 2001).

Besides serving to cook foods, boiling also renders water safe, as it destroys any germs that may be present. Boiled water, as is known, loses its good taste. However, as this change is brought about by the loss of air during boiling, the flavor can be restored and air again introduced if the water is shaken in a partly filled jar or bottle, or beaten vigorously for a short time with an egg beater or whisk. (Gulcin et al., 2002)

2.4 ANTIOXIDANTS IN VEGETABLES.

Various reactive oxygen species (ROS) are generated in living organisms through different ways. Reactive oxygen species (ROS), which include free radicals such as Superoxide anion radicals, hydroxyl radicals and non-free radical species such as H_2O_2 and singled oxygen, are various forms of activated oxygen (Gulcin et al., 2002). These molecules are exacerbating factors in cellular injury and aging process (Lai et al., 2001). Iron, an essential metal for normal cellular physiology, can result in cell injury when in excess. This is because it plays a catalytic role in

the initiation of free radical reactions. Fe(II) can react with hydrogen peroxide (H_2O_2) to produce the hydroxyl radical (OH•) via the Fenton reaction, whereas Superoxide can react with iron (III) to regenerates iron (II) that can participate in the Fenton reaction (Harris,1996).

The human body is equipped with an antioxidant defense system that deactivates these highly reactive free radicals; this includes antioxidant enzymes (made in the body) and antioxidant nutrients (found in foods) that soak up all the excess reactivity that these free radicals have, turning them to harmless particles that can be get rid of (Oboh, 2006; Oboh and Akindahunsi, 2004; Oboh, 2005). However, recent studies have revealed that one of the practical ways through which the activity of free radicals could be managed in the body is through dietaryMeans (Oboh and Akindahunsi, 2004). Dietary antioxidants may play an important role in protecting the cell against damage caused by free radicals by acting as radical scavengers, reducing agents, forming complexes with pro-oxidant metals, and quenchers of singlet oxygen formation (Oboh, 2005a;)

CHAPTER THREE

3.0 MATERIALS AND METHOD

3.1 SOURCE OF MATERIAL

Fresh of samples 3 Garden egg varieties (*Solanum aithiopicum Solanum aubergine and Solanum anguivi*) were purchased from Oba's market in Akure, Ondo State, Nigeria.

3.2 PROCESSING OF THE SEEDS

Samples of the garden eggs varieties collected were processed into:

- Raw dried flour
- Boiled flour

3.2.1 PROCESSING OF THE SAMPLE INTO DRIED FLOUR

Garden egg (*Solanum* spp) varieties were sliced, oven dried at 50-60^{0}C for four hours, pulverized by blending and packaged in an polyethylene nylon and kept in an air tight plastic container and kept in cool dry place out of reach of pest.

3.2.2 PROCESSING OF THE SAMPLE INTO THE BOILED FLOURS

The raw garden eggs were boiled for 30 minutes as described by (Giami and Bakebain, 1992). The boiled sample were drained and allowed to cool. The sample were evenly spread and dried in the oven at 50-60^{0}C. They were blended and they

were packaged in polyethylene bags and kept in air tight plastic containers and kept in cool dry place.

3.2.3 AQUEOUS EXTRACT PREPARATION

Matured boiled and unboiled garden eggs were washed in distilled water, the fruits were diced, dried and pulverized.

The aqueous extract of the garden egg was subsequently prepared by homogenizing the garden egg in water. (0.05:1 w/v); the homogenates were centrifuged at 2,000 rpm for 10 min. The supernatant was used for the assay. (oboh et al., 2007). The sample concentration is 5mg/ml.

3.2.4 The differently processed garden eggs flour were coded as stated below

CODE	Description
R1	Raw oven dried white colored solanum spp flour
R2	Raw oven dried oval shape green colored solanum spp flour
R3	Raw oven dried round shape green colored solanum spp flour
B1	Boiled oven dried white colored solanum spp flour
B2	Boiled oven dried oval shape green colored solanum spp flour
B3	Boiled oven dried round shape green colored solanum spp flour

hydrogen peroxide, and 40 µl 500 µM $FeSO_4$, and the volume were made to 800 µl with distilled water. The reaction mixture was incubated at 37°C for 30 min and the reaction was stopped by the addition of 0.5 ml of 2.8% trichloroacetic acid; this was followed by the addition of 0.4 ml of 0.6% thiobarbituric acid (TBA) solution. The tubes were subsequently incubated in boiling water for 20 min. The absorbance was measured at 532 nm in a spectrophotometer (colorimeter).

$$\%=\frac{Abs_{ref}-Abs_{sam}}{Abs_{ref}} \times 100$$

3.3.5 Fe2+ chelation assay

The Fe2+ chelating ability of Boiled and Unboiled garden egg water extracts were determined using a modified method of Minotti and Aust (1987) with a slight modification by Puntel et al. (2005). Freshly prepared 500 µmol l^{-1} $FeSO_4$ (150 µl) was added to a reaction mixture containing 168 µl of0.1mol l^{-1}Tris-HCl (pH 7.4), 218 µl saline and the extracts (0 - 25µl). The reaction mixture was incubated for 5 min, before the addition of 13µl of 0.25% 1, 10-phenanthroline (w/v).The absorbance was subsequently measured at 510 nm in a spectrophotometer. The Fe2+ chelating ability was subsequently calculated.

$$\%=\frac{Abs_{ref}-Abs_{sam}}{Abs_{ref}} \times 100$$

3.4 Vitamin C determination

The vitamin C was determined using the method of Benderitteretal. (1998). Briefly 75 µl of DNPH (2 g of dinitrophenyl hydrazine, 230 mg thiourea and 270 mg CuSO4. 5H2O in 100 ml 5 M H_2SO_4) was added to 500 µl reaction mixture (300 µl of the garden egg extracts with 100µl 13.3% TCA and water, respectively). The reaction mixture was subsequently incubated for 3 h at 37°C, then 0.5 ml H_2SO_4 65% (v/v) was added to the medium, and the absorbance was measured at 520 nm, and the Vitamin C content of the sample was subsequently calculated, using a vitamin C standard curve.

CHARPTER FOUR

4.0 RESULT AND DISCUSSION

4.1 RESULTS

Table 1. Total phenol, Total flavonoid and Vitamin C content of the aqueous extracts of *Solanum spp* Species

Sample	Total phenol(mg/ml)	Total flavonoid(mg/ml)	Ascorbic acid (mg/ml)
RA	6.56± 0.44	4.73± 0.74	59.65±4.96
RB	11.87 ± 0.88	5.26± 1.48	84.21±0.00
RC	9.06 ± 1.32	5.78± 0.74	73.68±4.96
BA	13.12 ± 0.00	4.21±0.00	52.63±4.96
BB	18.75 ± 0.88	4.73± 0.74	56.14±9.92
BC	18.43 ± 2.20	5.26± 1.48	56.14±4.96

RA= Raw *Solanum anguivi* RB= Raw *Solanum aithiopicum* RC= Raw *Solanum aubergine* BA=Boiled *Solanum anguivi* BB= Boiled *Solanum aithiopicum*

BC=Boiled *Solanum aubergine*

The antioxidant activities of plant phytochemicals occurs by preventing the production of free radicals or by neutralizing / scavenging free radicals produced in the body or reducing/chelating the transition metal composition of foods (Amic, 2003; oboh *et al.*, 2007) prevention of the chain initiation step by scavenging various reactive species such as free radicals is considered an important antioxidant made of action (Dastmalchi *et al.,* 2007), total phenolic content is reported as Gallic acid equiva-lent of the unboiled varies between 6.56mg/ml GAE/gram-9.06mg/ml GAE/gram while the boiled garden egg varies between 13.12mg/ml GAE/gram-18.75mg/ml GAE/gram, the total flavonoid contents of the unboiled ranged from 4.21-5.78 mg QE/ gram while the value of boiled varies from 4.21-5.26 mg QE/ gram (Table 1). Vitamin C content of the unboiled ranged from 59.65-84.21mg/ml while that of the boiled varies from 52.63-56.14 mg/ml as shown from the studies (Table 1). The ferric reducing antioxidant capacity (FRAP) of the extract reported as ascorbic acid equivalents is a measure of the ability of the phenolic extracts to reduce Fe(III) to Fe(II) a measure of their antioxidant properties. However, all the extracts showed good ferric reducing antioxidant property 2.50-19.70mg/ml at various concentrations (Table 4). The results from Table 2, shows the ability of the extract to scavenge hydroxyl radical which ranges from 21.27-70.21mg/ml for the boiled and unboiled extract at different concentrations respectively.

Table2.OH* scavenging ability (%) of aqueous extract of *Solanum* spp.

Sample	Volume			
	50µl	100µl	150µl	200µl
RA	21.27±3.00	51.06±0.30	57.44±0.00	63.829±3.01
RB	46.80±3.01	55.31±3.01	57.44±6.00	59.57±3.01
RC	44.68±0.00	59.57±3.01	59.57±3.00	59.57±9.02
BA	44.68±0.00	53.1±6.017	53.19±0.00	61.70±0.00
BB	70.21±6.01	68.08±3.00	70.00±6.02	76.59±3.01
BC	51.06±3.01	63.83±3.00	72.34±3.00	70.21±6.02

RA= Raw *Solanum anguivi* RB= Raw *Solanum aithiopicum* RC= Raw *Solanum aubergine* BA=Boiled *Solanum anguivi* BB= Boiled *Solanum aithiopicum*

BC=Boiled *Solanum aubergine*

Table3. %Fe^{2+} chelating ability of aqueous extract of *Solanum* spp (mg/ml)

Sample	Volume				
	20µl	40µl	60µl	80µl	100µl
RA	36.36±0.00	40.90±1.29	46.36±1.28	49.09±2.57	56.36±5.14
RB	31.81±1.28	33.63±1.28	40.90±1.28	48.18±1.28	50.00±1.28
RC	33.63±1.28	34.54±0.00	36.36±0.00	38.18±2.57	±42.72±1.29
BA	36.36±2.57	40.59±1.28	41.81±2.57	48.18±1.28	52.72±2.57
BB	28.18±1.28	30.00±1.28	31.81±1.28	33.63±1.28	39.09±3.85
BC	22.72±1.29	26.36±1.29	30.00±1.29	32.00±0.00	35.45±1.29

RA= Raw *Solanum anguivi* RB= Raw *Solanum aithiopicum* RC= Raw *Solanum aubergine* BA=Boiled *Solanum anguivi* BB= Boiled *Solanum aithiopicum*

BC=Boiled *Solanum aubergine*

Table.4 Ferric reducing antioxidant properties of aqueous extract of *Solanum* spp (mg/ml)

Samples	Volume			
	50µl	100µl	200µl	250µl
RA	2.5±0.02	3.52±0.42	6.76±0.00	9.4±0.41
RB	4.71±1.24	7.64±0.41	11.03±0.21	13.24±0.42
RC	2.64±0.00	4.26±0.20	9.11±0.00	10.88±0.00
BA	7.06±0.42	8.67±0.62	16.02±0.62	19.26±0.20
BB	8.67±0.20	13.38±0.20	15.73±0.20	19.11±0.41
BC	9.11±0.41	14.11±0.83	16.32±0.20	19.70±0.00

RA= Raw *Solanum anguivi* RB= Raw *Solanum aithiopicum* RC= Raw *Solanum aubergine* BA=Boiled *Solanum anguivi* BB= Boiled *Solanum aithiopicum*

BC=Boiled *Solanum aubergine*

Table 2, 3 and 4 are graphically depicted bellow

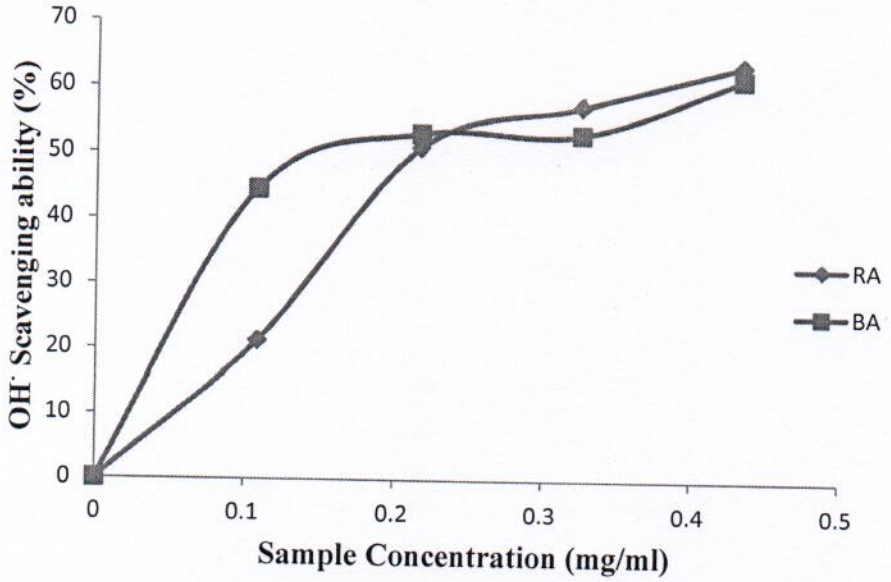


Figure 1 OH· Scavenging ability (%) of boiled and unboiled *Solanum anguivi*

RA= Raw *Solanum anguivi* BA=Boiled *Solanum anguivi*

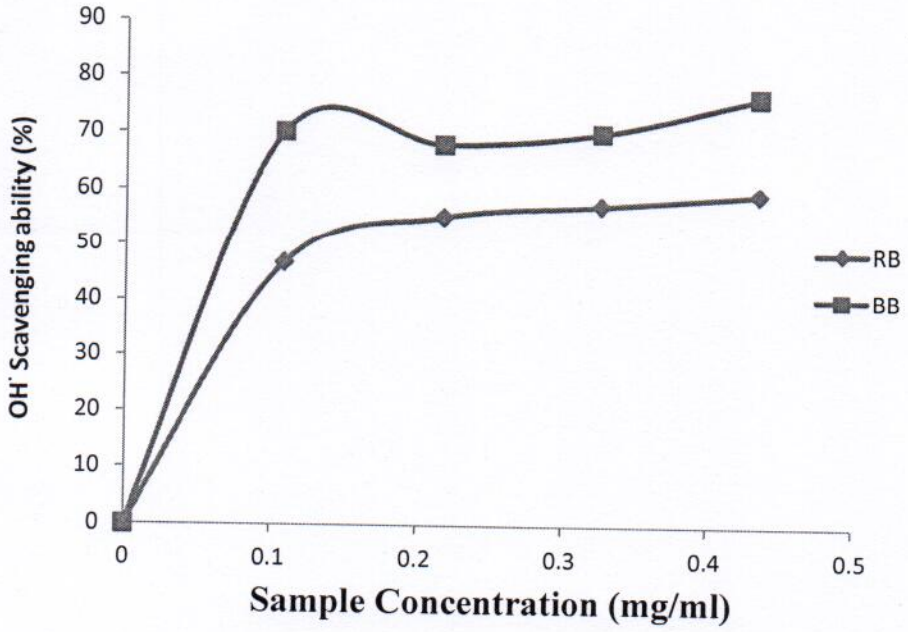


Figure 2 OH· Scavenging ability (%) of boiled and unboiled *Solanum aithiopicum*

RB= Raw *Solanum aithiopicum* BB= Boiled *Solanum aithiopicum*

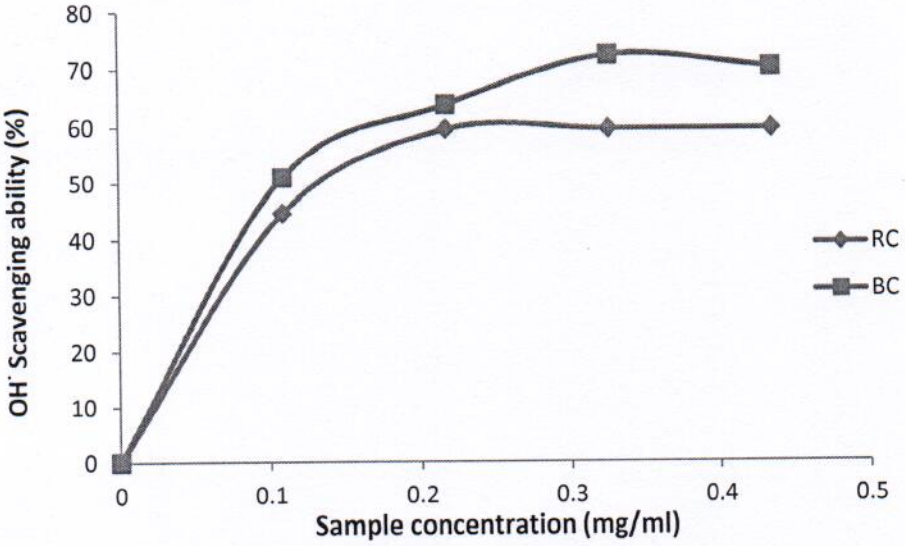


Figure 3 OH· Scavenging ability (%) of boiled and unboiled *Solanum aubergine*

RC= Raw *Solanum aubergine* BC=Boiled *Solanum aubergine*

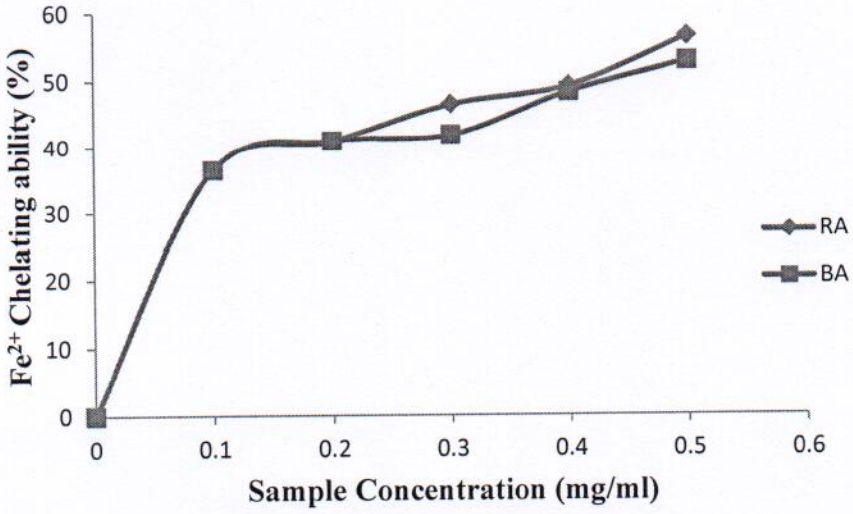


Figure 4 Fe^{2+} Chelating ability (%) of boiled and unboiled Solanum anguivi

RA= Raw Solanum anguivi BA=Boiled Solanum anguivi

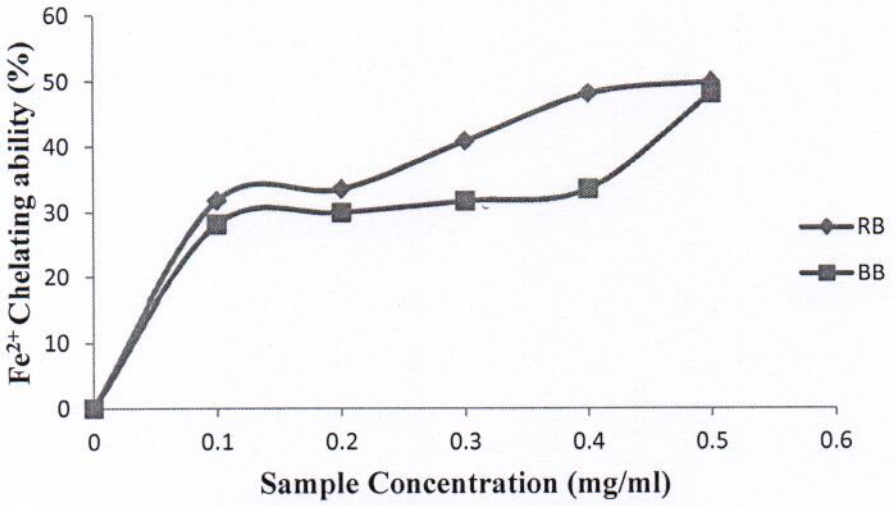


Figure 5 Fe^{2+} Chelating ability (%) of boiled and unboiled solanum aithiopicum

RB= Raw *Solanum aithiopicum* BB= *Boiled Solanum aithiopicum*

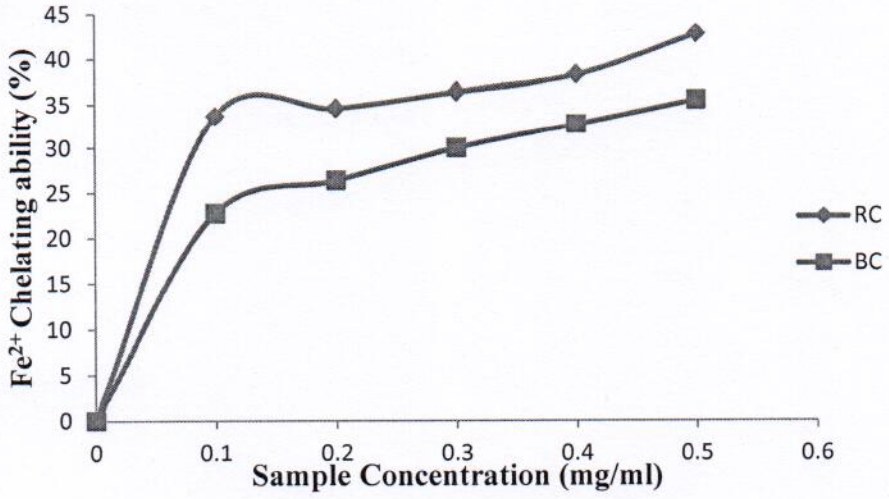


Figure 6 Fe^{2+} Chelating ability (%) of *Solanum aubergine*

RC= Raw *Solanum aubergine* BC=Boiled *Solanum aubergine*

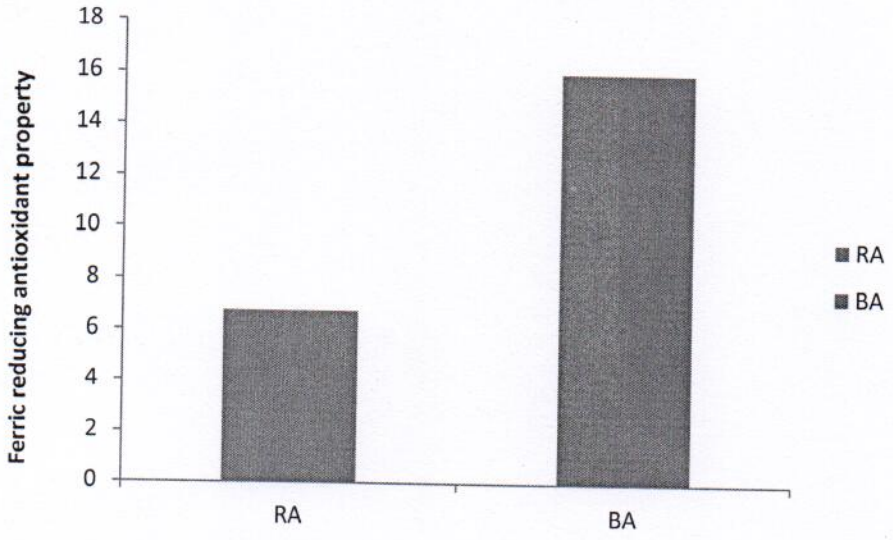


Figure 7 Ferric reducing antioxidant property of boiled and unboiled *Solanum anguivi*. RA= Raw *Solanum anguivi* BA=Boiled *Solanum anguivi*

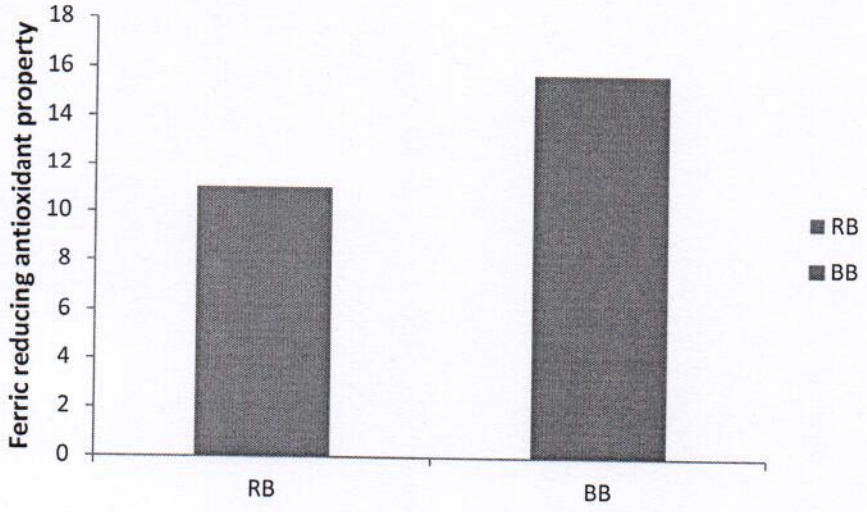


Figure 8 Ferric reducing antioxidant property of boiled and unboiled *Solanum aithiopicum*. RB= Raw *Solanum aithiopicum* BB= Boiled *Solanum aithiopicum*

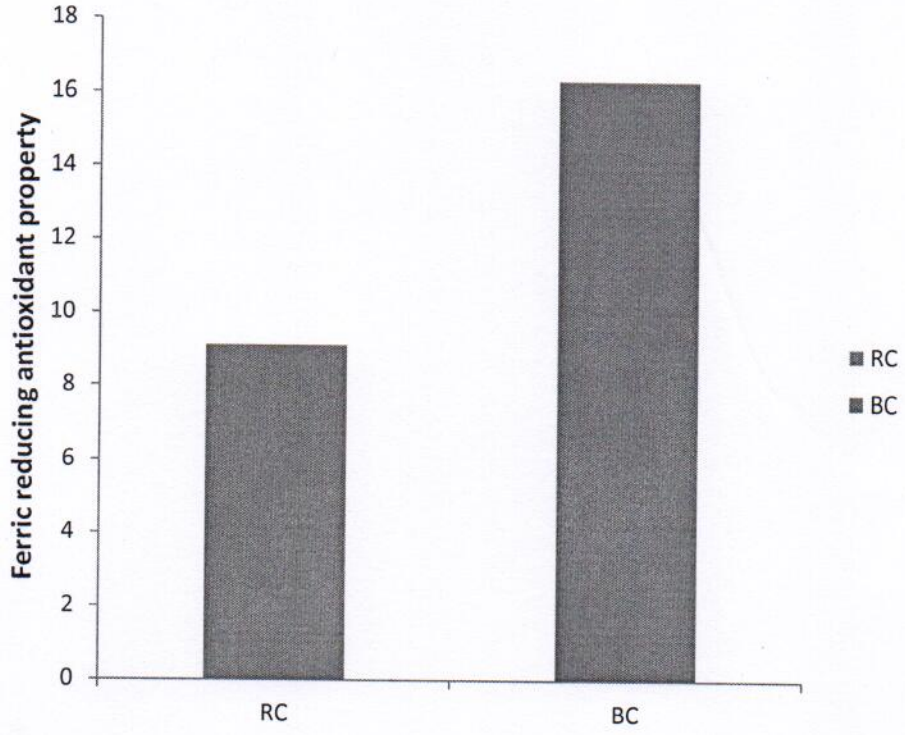


Figure 9 Ferric reducing antioxidant property of boiled and unboiled *Solanum aubergine*

RC=Raw *Solanum aubergine* BC=Boiled *Solanum aubergine*

Table 3, indicate the %Fe^{2+} chelating ability of aqueous extract of *Solanum* spp it ranges from 22.72-49.09mg/ml for the boiled and unboiled extract at different concentrations respectively.

4.2 DISCUSSION

The result from phytochemical screening indicates that there is difference in raw and heat processed samples after boiling for 30minutes. Heating *S.aithiopicum* for 30 minutes in water bath was found to reduce flavonoid from 4.73-4.21 mg/ml, vitamin C from 59.65-52.63mg/ml and Fe^{2+} chelating ability of the aqueous extract from 56.36-52.72mg/ml

Flavonoid and vitamin C are potent water soluble antioxidant and free radicals scavenger which reduce readily when heated. (Salah *et al*, 1995).

The phenolic content of *S.aithiopicum* increased from 6.56-13.06mg/ml, *solanum aubergine* increased from 11.87-18.75mg/ml, *Solanum anguivi* increased from13.12-18.43mg/ml, OH* scavenging ability of *Solanum aubergine* increased from 59.57-76.59mg/ml *S.aithiopicum* increased from 21.27-44.68mg/ml *S.anguivi* increased from 59.57-72.34, Ferric reducing antioxidant content of *S.aithiopicum* increased from 3.52-8.67mg/ml, *Solanum aubergine* increased from 11.03-15.73mg/ml, *S.anguiv* increased from 10.88-19.70mg/ml this is similar to the result given for boiled *asparagus,* Cooking asparagus was found to increase total phenolic by 23%.(Fanascaetal.2009).

Podsedeketal (2008) in his study on antioxidant properties of raw and cooked spears of green asparagus cultivals, the cooking process increased the antioxidant activity by 16%.

The ascorbic acid content of unboiled *Solanum aubergine* is 84.21mg/ml is higher than the value of Vitamin C content of *Solanumincacum*59.65mg/ml and *S.anguivi* 73.68mg/ml. The high level of ascorbic acid in this species shows that the fruit could be used to promote healthy living such as protection against scurvy and other ascorbic acid deficiency related ailment. Boiled *Solanum aubergine* has the highest phenolic content of 18.75mg/ml compared to *Solanum incacum* and *S.anguivi* that has 13.12mg/ml and 18.43mg/ml respectively, Numerous phenolic compounds are located in the (skin) of fruits and vegetables. (talcott *et al* 2000)

When boiled the skin is tendered and the phenolic content become more accessible and available for consumption thus the value increases compared to when most of it is shielded by the skin. This study also shows that phenolic-rich extracts from these *Solanum* spp could be exploited for potential use in pharmaceutical formulations for preventive medicine in the management of degenerated diseases.(Oboh, et al 2005)

CHAPTER FIVE

5.0 CONCLUSION AND RECOMMENDATION

5.1 CONCLUSION

This study has clearly shown that the effectiveness of bioactive compounds in food can be affected by thermal treatment. Boiling reduces vitamin C and flavonoid content of food, while phenolic content increases. Furthermore, it will be wrong to think that since most food processing techniques will bring about a marked decrease in the composition and biological activity of many food nutrients, that food antioxidant will suffer same.

5.2 RECOMMENDATION

People with or wants to prevent free radical mediate diseases such as diabetes, obesity coronary heart diseases and cancer are advised to consume more of boiled *solanum aubergine* it has high phenolic compounds that have the ability to prevent degenerated diseased such as diabetes, obesity coronary heart diseases.

Finally, although antioxidant research is very active all over the world, however, there are still very limited data on the antioxidant properties of food from tropical African and the effect of traditional processing techniques conventionally used in this part of the world on the antioxidant property vis-à-vis their bioavailability.

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