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Effect of Fermentation on the Anti-Nutritional Factors and Mineral Composition of Melon Seed Varieties for Ogiri Production

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Abstract

The effect of fermentation on the anti-nutritional factors and mineral composition of melon seed varieties for Ogiri production was studied. Melon seed varieties such as *Citrullus vulgaris, Citrulluslanatus, Colocynthiscitrullus, Cucurbita pepo, Cucurmeropisedulis* were respectively sorted, washed, boiled wrapped seed were then boiled again for 2 hours, drained, cooled and allowed to ferment naturally for 86 hours (primary fermentation). The primary fermented sees were then pounded and wrapped in little portions with "ofoala" leaf (*Icacinatrichantha* olive) and kept in wire mesh near a heat source for another 144 hours (secondary fermentation). Samples were drawn from the raw, boiled and fermented melon seed varieties for the quantitative analysis of mineral content and anti-nutritional prepared with the raw and primary fermented samples. Raw seed of C*itrulluslanatus* had the highest mineral analysis showed a decline in the boiled samples and secondary fermented sample, compared with the raw and mineral composition ranging from potassium, magnesium, cacium, iron and zinc of 1.21, 1.06, 0.89, 0.45 and 0.41mg/100g respectively followed by raw Citrullus Vulgaris with potassium, magenesium, calcium, iron and zinc of 1.18, 1.02, 0.55, 0.44 and 0.38 mg/100g respectively and 1.11, 0.94, 0.81, 0.38 and 0.31 mg/100gof potassium, magenesium, calcium, iron and zinc respectively in the primary fermented product. Statistical analysis of anti-nutrients revealed a significant reduction ($p<0.05$) in all the processed melon. There was a significant difference in all the processed melon with lowest anti-nutrient content ranging from alkaloid, saponin, HCN, phytate, tannin and flavonoid (0.00, 0.00, 0.00, 0.00, 0.03and 0.09 respectively) and C*olocynthiscitrullus* had the highest anti-nutrient content in the secondary fermentation.

Keywords:Fermentation, anti-nutritional factors, Ogiri, mineral content,melon seed varieties.

1.0 Introduction

Fermentation processes play important roles in food technology in developing countries (Campbell, 2004). In traditional fermentation processes, natural microorganisms are employed in the preparation and preservation of different types of food. These processes add to the nutritive value of foods as well as enhancing flavor and other desirable qualities associated with digestibility and edibility. The fermentation techniques are often characterized by the use of simple, non sterile equipment, chance or natural inoculum, unregulated conditions, sensory fluctuations, poor digestibility, and unattractive packaging of the processed product (Nout, 1990). Many of the fermented products result in new and desired products. Fermentation can produce important nutrients or eliminate anti-nutrients. The increased nutritive values of digested sugars, free fatty acids, amino acids, as well as synthesis of certain vitamins (Motarjemi, 2002). Ogiri is a fermented food condiment of flavoring agent, whose character and organoleptic properties depends on microbial activities (Nwosu, and Ojimelukwe, 1993). The production process is still a traditional family art and the fermentation is by chance inoculation (Steinkraus, 2002). It is consumed mainly in Southern Nigeria especially by the Igbos (Steinkraus, 1995). Ogiri is produced by traditional fermentation of melon seeds (*Citrullusvulgaris),* castor oils seeds (*RicinusCommunis*), fluted pumpkin (*Telfariaoccidentalis*), and are called Ogiri-egusi, Ogiri-igbo and Ogiri-ugu respectively (Achi, 2013).

Many traditional methods of food preparation such as fermentation, cooking and malting increase the nutritive quality of plant foods through reducing certain anti-nutrients such as phytic acid, polyphenols and oxalic acids (Sarkar, and Nout, 2014). Anti-nutrients are natural or synthetic components that interfere with the absorption of nutrients. The choice of substrate for ogiri which is popular among the Igbos of Southern Nigeria depends on the locality (Sanusi, *et al*, 2012). During the last three decades, the consumption of ogiri as well as the price of its various substrates has increased in Nigeria. Apart from *Citrullus vulgaris* which is the regular substrate used for the production of ogiri-egusi, there are other varieties of melon seeds which are not utilized for any other product apart from roasting and boiling and also eaten as snacks. This development has given impetus for the trial of these relatively cheaper and unpopular seeds which are *Cococynthiscitrillus*(egusi Hausa),*Cucumeropsisedulis* (Ahuru), *Cucurbita pepo* (Ugboguru), *Citrulluslanatus* (Watermelon seeds) and C*itrullus vulgaris* (Egusi).

1.1 Aims and Objectives

The objectives of this paper are:

- To determine the mineral composition andanti-nutritional factors of the raw, boiled, fermented underutilized melon seeds.
- To determine the effect offermentation on these mineral content and the anti-nutrient.
- To compare the mineral composition and anti-nutrient with the regular substrate *Citrullus vulgaris.*

1.2 Justification

Although several works have been carried out on the fermentation of melon seeds, the recent work focuses on the effect of fermentation and mineral content of five underutilized species of melon seeds as well as comparing the result with the regular melon and analysis of the anti-nutritional factors of these seeds. The information can be used to improve on already existing ogiri and also create varieties in the product.

2.0 Material and Methods

2.1.0 Material Collection and Preparation

2.1.1 Plant Material:

Melon seeds used for this study were obtained from a local seller in Eke ututu market, Imo State, Nigeria and were identified as; Egusi (*Citrullus vulgaris),*EgusiHausa (*Colocynthiscitrullus),* watermelon (*Citrulluslanatus),*Ahuru (*Cucumeropsisedulis),* and Ugboguru (*Cucurbita pepo).* The seeds were sorted for bad ones.

2.1.2 Chemicals

Chemicals such as ethanol, hydrochloric acid, tanuric acid, sodium chloride, butanol, sodium carbonate, ammonium solution, ethyl acetate layer, di-ethyl ether were obtained from Reliable Research laboratory, Umuahia. All chemicals and reagents were of analytical grade.

2.1.3 Equipment

Muffle furnace (Carbolite Bamford, England, 530 2AU),Dessicators Hot air oven (Genlab, model, MINO 50, Serial No-10c076) and Analytical sensitive balance (Hcm No AR3130, OHAUS Corp, China), Spectrophotometer.

2.2.0 Methods

2.2.1 Traditional Production of Fermented Melon Seed (Ogiri)

Undehulled melon seeds were properly washed and boiled for 3hours, cooked and dehulled. The cotyledon were wrapped tightly in layer of blanched short banana leaves (*Musa sapietum)* and then perforated with fork. The wrapped cotyledon was then boiled for 2hours, place on a wire mesh to drain for 1hour. The wrapped cotyledon was then left to ferment at the prevailing ambient temperature (28^{oc}) for four days. At the end of the fermentation period, the seeds were pounded in a laboratory morta and pestle into a paste. The paste was then wrapped in little portions with ofoala(Nwosu and Ojimelukwe 1993,)

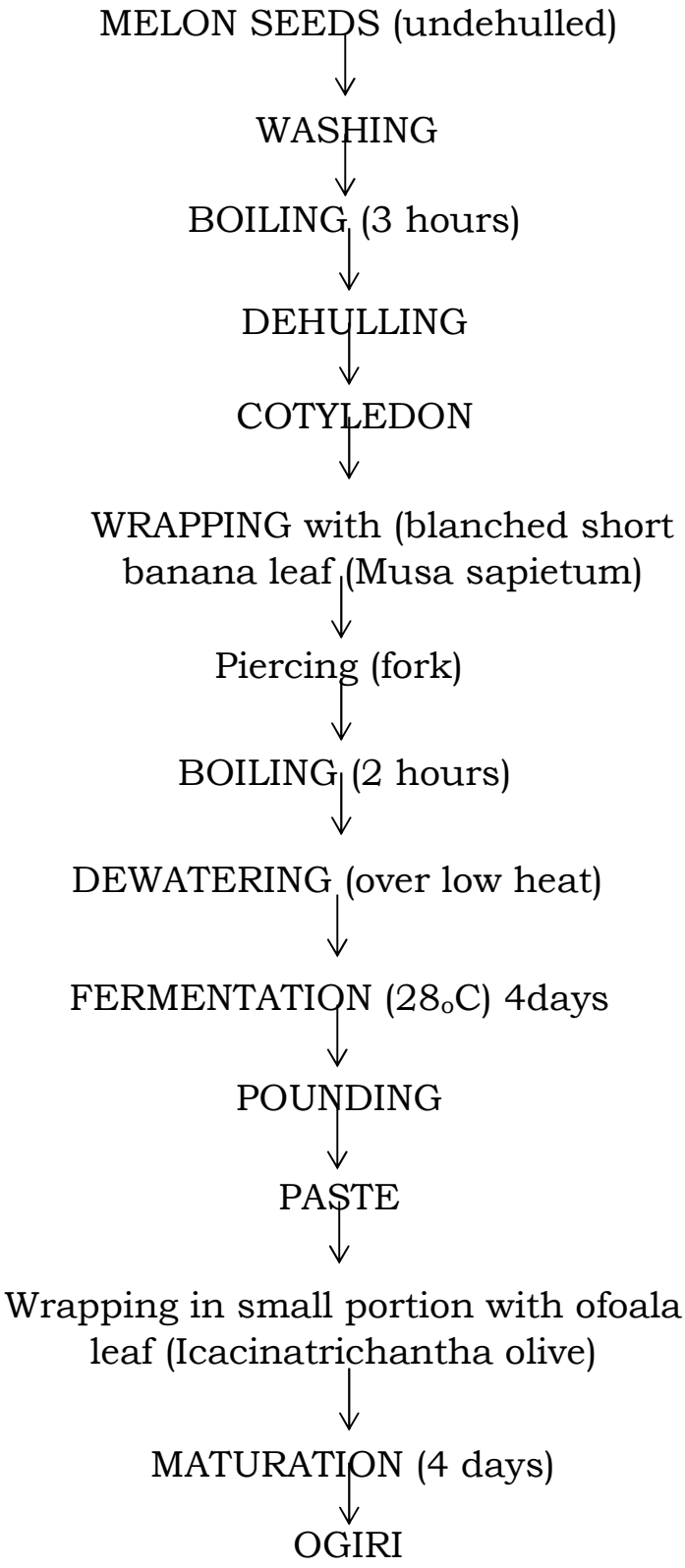

Fig 1: The flow diagram of production of Ogiri-Egusi.

2.3 Determination of Some Anti - Nutritional Properties Present in the given Melon Seed Varieties.

2.3.1 Determination of Saponin:

The saponin content of the sample was determined by double extraction gravimetric method(Harborne, 1973 andUematsu,2000). Five (5)grams of the powdered sample was mixed with 50ml of 20% aqueous ethanol solution in a flask. The mixture was heated with periodic agitation in water bath for 90 minutes at 55^{o}C; it was then filtered through what man filter paper(No42). The residue was extracted with 50ml of 20% ethanol and both extract were poured together and the combined extract was reduced to about 40ml at 90^{o}C and transferred to a separating funnel where 40ml of diethyl ether was added and shaken vigorously. Separation was by partition during which the ether layer wad discarded and the aqueous layer reserved. Re-extraction by partitioning was done repeatedly until the aqueous layer become clear in color. The saponins were extracted, with 60ml of normal butanol. The combined extracts were washed with 5% aqueous sodium chloride(NaCl) solution and evaporated to dryness in a pre-weighed evaporation dish. It was dried at 60^{o}C in the oven and reweighed after cooling in a desiccator. The process was repeated two more times to get an average saponin content was determined by difference and calculated as a percentage of the original sample thus.

$$\%\text{Saponin} = \frac{W_2 - W_1}{\text{Weight of sample}} \times \frac{100}{1}$$

Where:

W_1 = weight of evaporating dish

W_2 = weight of dish + sample

2.3.2. Phytate

Two grams of each sample was weighed into 250ml conical flask 100mls of 2% hydrochloric acid was added to soak each sample in the conical flask for 3 hours. This was filtered through a double layer of hardened filter paper. 50ml of each filtrate was placed in 0.50ml conical flask and 107mls distilled water was added in each case to give proper acidity. 10mls of 0.3% Ammonium Thiocyanate (NH4SCN) solution was added into each solution as indicated. This was titrated with the standard iron (III) chloride solution which contained 0.00195g Iron per ml. the end point was slightly brownish-yellow which persisted for 5 minutes. The % phytic acid was calculated using the formula:

$$\%\text{ Phytic Acid} = \frac{\text{Titre value} \times 0.00195 \times 1.19 \times 100 \times 3.55}{\text{Wt. of sample}}$$

2.3.3 Alkaloid determination

The determination of the concentration of alkaloid in the melon seeds were carried out using the alkaline precipitation gravimetric method described by Harborne (1973).

5g of the powdered sample was soaked in 20ml of 10% ethanolic acetic acid. The mixture stood for four (4) hours at room temperature. Thereafter, the mixture was filtered through Whatman filter paper (No.42). The filtrate was concentrated by evaporation over a steam bath to ¼ of its original volume. To precipitate the alkaloid, concentrated ammonia solution was added in drops to the extract until it was in excess. The resulting alkaloid precipitate was recovered by filtration using previously weighed filter paper. After filtration, the precipitate was washed with 9% ammonia solution and dried in the oven at 600c for 30minutes, cooled in a desiccator and reweighed. The weight of alkaloid was determined by the differences and expressed as a percentage of weight of sample analyzed as shown below.

$$\%\text{Alkaloid} = \frac{W_2 - W_1}{\text{Weight of sample}} \times \frac{100}{1}$$

Where:

W_1 = weight of filter paper

W_2 = weight of filter paper + alkaloid precipitate

2.3.4. Flavonoids

The flavonoid content of the seeds was determined by the gravimetric method as was described by Harborne (1973). Five grams of the powdered sample was placed into a conical flask and 50ml of water and 2ml HCL solution was added. The solution was allowed to boil for 30minutes. The boiled mixture was allowed to cool before it was filtered through whatman filter paper (N0. 42). 10ml of ethyl acetate extract which contained flavonoid was recorded while the aqueous layer was discarded. A pre weighed whatman filter paper was used to filter the sample (ethyl-acetate layer), the residue was then placed in an oven to dry at 60^{o}c. It was cooled in a desiccator and weighed. The quantity of flavonoid was determined using the formula.

$$\%\text{Flavonoid} = \frac{W_2 - W_1 X}{\text{Weight of sample}} \times \frac{100}{1}$$

Where:

W1 = Weight of empty filter paper

W1 = Weight of paper + Flavonoid extract

2.3.5 Tannin determination

The tannin content of the seeds was determined using the Folin Dennis spectrophotometric method described by Pearson (1976).Two grams of the powdered sample was mixed with 50ml of distilled water and shaken for 30 minutes in the shaker. The mixture was filtered and the filtrate used for the experiment. 5ml of the filtrate was measured into 50ml volume flask and diluted with 3ml of distilled water. Similarly 5ml of standard tanuric acid solution and 5ml of distilled water was added separately. 1ml of Folin-Dennis reagent was added to each of the flask followed by 2.5ml of saturated sodium carbonate solution. The content of each flask was made up to mark and incubated for 90 minutes at room temperature. The absorbance of the developed colour was measured at 760nm wave length with the reagent blank at zero. The process was repeated two more time to get an average. The tannin content was calculated as shown below.

$$\%\text{tannin} = 100/W \times AU/AS \times C/100 \times VF/VA \times D$$

Where,

W = Weight of sample analyzed

AU = absorbance of the test sample

AS = absorbance of the standard solution

C = concentration of standard in mg/ml

VA = volume of filtrates analyzed

D = dilution factor where applicable

2.4 Determination of Minerals

The mineral content of the test sample was determined by the dry ash extraction method. 2.0g of samples was burnt to ashes in a muffle (as in ash determination) the resulting ash was dissolved in 100ml of dilute

hydrochloric acid (100ml HCl) and then diluted to 100ml in a volumetric flask using distilled water. The digest so obtained was for the various mineral analyses.

2.4.1. Determinationof Calcium and Magnesium

Calcium and magnesium of the test sample was determined by versanale EDTA complexiometric titration. 20ml of each extract was dispersed into a conical flask, pinches of the masking agents hydroxyl tannin, hydrochlorate, potassium, feryanide were added followed by 20ml of ammonia indicator solution, pH 10.0 the pinch of the incubator: Erich Rome black was added and the mixture was shaken very well. It was titrated against 0.02N EDTA solution titration was from a mauve colour to permanent blue colouration. A reagent blank consisting of 20ml of distilled water was also treated as described above. The titration gave a reading for combing Ca and Mg complexes in sample. A separate titration was then conducted for calcium alone. Titration for calcium alone was a repeat of the previous one with slight change, 10% NaOH solution at pH 12.0 was used in place of the ammonia buffer while solechrome dark blue (calcon) was used as an indicator in place of Erichrome black T. Calcium and Magnesium contents were calculated separately using the formular below:

$$\% \text{ -calcium or Mg} = \left(\frac{100}{W} \times \frac{EW}{100} \times \frac{N}{VA} \times VE\right) T$$

Where;

W -weight of sample analysed

EW - equivalent weight

VF - total volume of extract

N -volume of extract titrated

T - titre valve less blank

VA - volume of fitrateanalysed

2.4.2. Determination of Potassium

Potassium in the sample extract was determined by photometry. The instrument was set up according to the manufactures instruction. The equipment was switched on and allowed to stay for about 10 minutes. The gas and air lets were opened as the start knob was turned on. The equipment being self igniting and the flame was adjusted to a non-luminous level (blue colour).

Meanwhile, standard Potassium solution was prepared and diluted to concentration of 2,4,6,8 and 10ppm. When analyzing for the element Potassium, the appropriate filter was selected and instrument flushed with distilled water. The highest concentrated standard solution was put in place and the reading adjusted to 100ml. Thereafter, starting with least concentration 2ppm, all the standard solutions were sucked into the instrument and caused to spry over the non-luminous flame. The readings were recorded and later plotted into a standard curve used to

extrapolate the Potassium level in the sample. After the standard, the sample digest were siphoned in turns into the instrument, their readings recorded.

The concentration of the test minerals in the sample was calculated with reference to the graph and obtained follows:

$$kmg/100g = \frac{100}{W_1} \times \frac{VT}{10^3} \times 1 \times Xx\ D$$

2.4.3. Determination of Zinc and Iron

Zinc and iron was determined using atomic absorption spectroscopy (AAS) with standard air acetylene flame.

3.0. Result and Discussions

3.1. Mineral Analysis on Melon Seeds

3.1.1. Mineral Analysis of *Citrullus vulgaris*

The result obtained from the mineral analysis of raw ***Citrullus vulgaris*** as shown in table 3.1 were potassium, Magnesium, calcium, iron and zinc (1.11, 0.94, 0.81, 0.38and 0.31mg/100g respectively). The high amount of potassium observed in the sample agreed with the observed of Olaofe and Sanni (1988) andOlaofe*et al*(1994)who reported that potassium is high in plant foods from Nigerian soil. The mineral content of the boiled sample generally showed a decline in the value as compared to that of the raw sample. The decline could be as a result of nutrients leaching out during boiling and also due to the fact that the water was not allowed to dry up in the cooking pot (Oladele and Oshodi, 2008 and Oduse (2013). After the primary fermentation, an increase in the mineral content was observed generally. The increase in potassium, calcium, magnesium, iron and zinc may be due to the contribution from the fermenting microorganisms as stated by Oladele and Oshidi (2008).

At the end of the secondary fermentation, the result showed that the mineral content of the sample significantly ($p<0.05$) reduced as compared to the mineral content at the primary fermentation stage.

The reduction in values of the minerals may be due to the fact that microorganisms utilized these mineral elements for their growth (Bello and Akinyele, 2007).Steinkraus (1995) stated that during fungal fermentation the fermenting fungi utilize mineral salt for metabolic activities.

TABLE 3.1Minerals Analysis of *Citrullus vulgaris*

Sample	Calcium (mg/100g)	Potassium (mg/100g)	Megnesium (mg/100g)	Iron (mg/100g)	Zinc (mg/100g)
CV Raw	$0.85^{a}\pm 0.00$	$1.18^{a}\pm 0.00$	$1.02^{a}\pm 0.00$	$0.44^{a}\pm 0.01$	$0.38^{a}\pm 0.00$
CV Boiled	$0.55^{d}\pm 0.01$	$0.79^{d}\pm 0.01$	$0.72^{c}\pm 0.00$	$0.25^{d}\pm 0.00$	$0.21^{d}\pm 0.00$
CV Primary fermentation	$0.81^{b}\pm 0.01$	$1.11^{b}\pm 0.01$	$0.94^{b}\pm 0.00$	$0.38^{d}\pm 0.01$	$0.31^{b}\pm 0.00$
CV Secondary fermentation	$0.58^{c}\pm 0.00$	$0.85^{c}\pm 0.00$	$0.31^{c}\pm 0.01$	$0.31^{c}\pm 0.01$	$0.25^{c}\pm 0.00$

The values with different superscripts are significantly different (all values are expressed as means ± SD for the determinants).
where
CV = *Citrullus vulgaris* (Egusi)

3.1.2 Mineral Analysis of *Cucumeropsisedulis*

The mineral analysis of raw *Cucumeropisedulis*, are magnesium, potassium, calcium, iron and zinc (0.95, 0.93, 0.75, 0.38and 0.34mg/1000g respectively) as seen in table 3.2. The mineral content of the boiled sample generally showed a decline in the value as compared to that of the raw sample, this is in line with earlier report by Akindahunsi (2004) that processing reduces nutrient composition. These reductions were attributed to solublization of nutrient and leaching as a result of boiling. After the primary fermentation, an increase in the mineral was observed generally. The increase in these minerals may be due to the contribution from fermenting organisms ad stated by Oladele and Oshidi (2008). At the end of the secondary fermentation, the result showed that the mineral content of the sample reduced significantly as compared to the mineral content at the primary stage

Table 3.2 Mineral Analysis of *Cucumeropsisedulis*

Sample	Calcium	Potassium	Magnesium	Iron	Zinc
CE Raw	$0.75^{a}\pm0.00$	$0.93^{a}\pm0.01$	$0.95^{a}\pm0.00$	$0.38^{a}\pm0.00$	$0.34^{a}\pm0.00$
CE Boiled	$0.43^{d}\pm0.00$	$0.65^{d}\pm0.00$	$0.77^{d}\pm0.02$	$0.23^{d}\pm0.01$	$0.27^{b}\pm0.04$
CE Secondary fermentation	$0.51^{c}\pm0.01$	$0.74^{c}\pm0.00$	$0.84^{c}\pm0.00$	$0.26^{c}\pm0.00$	$0.28^{ab}\pm0.00$

- The values with different superscripts are significantly different (all values are expressed as mean + SD for the determinants).
- Where CE = *Cucumeropsisedulis*(Ahuru)
-
- **3.1.3 Mineral Analysis of *Cucurbita pepo***

The result obtained from the mineral analysis of raw *Cucurbita pepo*, are potassium (1.16mg/100g) followed by magnesium, calcium, iron and zinc as seen in table 3.3. The high content of potassium agrees with the report of Olaofe*et al* (1993) which state that potassium is the most abundant mineral. The mineral content of the boiled sample generally showed a decline in the value as compared to that of the raw sample. The large surface of Cucurbita pepo could have aided the loss of mineral contents during boiling as proffered by Omafuvbe, *et al* (2004) and Omafuvbe*etal* (2006). After the primary fermentation, an increase in the mineral content was observed generally. At the end of the secondary fermentation, the result showed that the mineral content of the sample reduced significantly. The changes in nutrient composition during fermentation of melon seed could have been facilitated by enzymatic activities of the fermenting organisms (Enujiugha, 2007).

Table 3.3 Mineral Analysis *Cuburbitapepo*

Sample	Calcium	Potassium	Magnesium	Iron	Zinc
CP Raw	0.81^{a} +0.01	1.16^{a} +0.01	0.94^{a} +0.00	0.43^{a}+.01	0.35^{a}+0.00
CP Boiled	0.51^{d} 0.02	0.83^{d} +0.00	0.80c+0.01	0.24^{d}+0.01	0.19^{d}+0.00
CP Secondary fermentation	0.74^{b} +0.00	1.08^{b} +0.00	0.87^{b}+0.01	0.37^{b}+0.02	0.29^{b}+0.00
CP Secondary fermentation	$0.48^{c}\pm0.01$	$0.78^{b}\pm0.03$	$0.71^{c}\pm0.01$	$0.23^{c}\pm0.01$	0.20^{c}0.00

The values with different superscripts are significantly different (all values are expressed as mean ± SD for the determinants).

Where CP = *Cucurbita pepo(*Ugbogoro)

3.1.4 Mineral Analysis of *Citrulluslanatus*

The result obtained from the mineral analysis of raw *Citrulluslanatus* are potassium, magnesium, calcium, iron and zinc (1.21, 1.06, 0.89, 0.45 and 0.41 mg/100g) respectively as seen in table 3.4. The high amount of potassium observed in the sample agreed with the observation of Olaofe and Sanni (1988) who reported that

potassium is high in plant foods from Nigerian soil. The mineral content of the boiled sample generally showed a decline in the value as compared to that of the raw sample. The decline could be as a result of minerals leaching out during boiling (Akindahunsi 2004). After the primary fermentation an increase in the mineral content was observed generally which may be as a result of reduction in the anti-nutrient content as a result of processing methods. This anti-nutritional content normally binds with some metal like calcium and magnesium and prevents their bioavailability. Oboh and Akindahunsi (2004) and Ganiyu (2005) reported that processing method such as fermentation and blanching greatly reduced anti-nutritional content such as phytate and oxalate that binds with some metal preventing their bioavailability. At the end of the secondary fermentation, the mineral content of the sample reduced significantly ($p< 0.05$) which may be due to microorganisms utilizing the mineral salt for their metabolic activities as stated by El-Adawy and Taha (2001).

Table 3.4 Mineral Analysis of *Citrulluslanatus*

Sample	Calcium	Potassium	Magnesium	Iron	Zinc
CL Raw	0.89^{a} +0.01	1.21^{a} +0.01	0.06^{a} +0.00	0.45^{a}+.01	0.41^{a}+0.00
CL Boiled	0.51^{d} +0.02	0.83^{d} +0.00	0.80^{c}+0.01	0.24^{d}+0.01	0.19^{d}+0.00
CL Secondary fermentation	0.74^{b} +0.00	1.08^{b} +0.00	0.87^{b}+0.01	0.37^{b}+0.02	0.29^{b}+0.00
CL Secondary fermentation	0.59^{c}+0.00	0.94^{c}+0.00	0.85^{b}+0.00	0.30^{c}+0.01	0.25^{c}+0.00

The values with different superscripts are significantly different (all values are expressed as mean ±SD for the determinants).

Where CL = ***Citrulluslanatus****(*watermelon).

3.1.5 Mineral Analysis on *Colocynthiscitrullus*

The result of mineral analysis of raw *Colocynthiscitrullus* are potassium, magnesium, calcium, iron and zinc respectively as seen in table 3.5. The medical content of the boiled sample generally showed a decline in the value as compared to that of the raw sample. The decline could be as a result of minerals leaching out during boiling (Oladele and Oshodi, 2008). After the primary fermentation an increase in the mineral contents was observed generally which may be due to reduction in the microbial load which occur as a result of the decrease of pH as fermentation progresses as reported by Bello*etal.,* (2008). At the end of the secondary fermentation, the result showed that the mineral content of the sample reduced significantly ($p< 0.05$).

Table 3.5 Mineral Analysis of *Colocynthiscitrullus*

Sample	Calcium	Potassium	Magnesium	Iron	Zinc
CC Raw	0.71^{a}±0.00	0.96^{a}±0.00	0.92^{a}±0.01	0.34^{a}±0.00	0.30^{a}±0.00
CC Boiled	0.41^{d}±0.00	0.81^{d}±0.01	0.71^{d}±0.00	0.20^{d}±0.00	0.15^{d}±0.00
CC Secondary fermentation	0.63^{b}±0.00	0.95^{a}±0.01	0.86^{b}±0.00	0.29^{b}±0.00	0.25^{b}±0.00
CC Secondary fermentation	0.48^{c}±0.01	0.78^{b}±0.03	0.71^{c}±0.01	0.23^{c}±0.01	0.20^{c}0.00

The values with different superscripts are significantly different (all values as mean ±SD for the determinant).

Where CC = *Colocynthiscitrullus(*hausaegusi)

3.2 Anti-Nutrient Analysis on Melon Seed Varieties

3.2.1 Anti-Nutrient Analysis on *Citrullus vulgaris*

The result obtained from the anti-nutrient (table 3.6) of raw *Citrullus vulgaris* showed an increase in saponin, alkaloid, tannin, HCN, flavonoid and phylate (0.102, 0.069, 0.054, 0.036, 0.032 and 0.015mg/kg). The high amount of saponin may result to bitter taste and also reduce plant palatability and are toxic. The levels of bitterness and toxicity caused by saponin can be reduced or removed by the process of blanching, boiling and fermentation (Liener, 1980and. Akande, 2010). The anti-nutritional content of the boiled sample generally

showed a decline in the values as compared to the raw sample and this could be as a result of leaching of anti-nutrient in the water used for boiling (Philips and Abbey, 1989). Theprimary fermented sample showed an increase in anti-nutrient content which may be due to the contribution from fermenting organisms. At the anti-nutritional content of the sample reduced significantly ($p< 0.05$). This result was in agreement with the report of Philips and Abbey, (1989) that fermentation and steeping hydrates the food sample and induces the leaching out of water soluble anti-nutrients.

Table 3.6 Anti-Nutrient Analysis of *Citrullus vulgaris*

Sample	Alkolid	Saponin	Tannin	Flavonoid	HCN	Phytate
CV Raw	0.069^{a}±0.000	0.102^{a}±0.000	0.054^{a}±0.000	0.032^{a}±0.000	0.036^{a}±0.000	0.015^{a}±0.001
CV Boiled	0.000^{c}±0.000	0.000^{c}±0.000	0.000^{d}±0.000	0.000_{d}±0.000	0.000^{c}±0.000	0.000^{c}±0.000
CV Prima	0.019^{b}±0.000	0.023^{b}±0.000	0.012^{b}±0.000	0.013^{b}±0.000	0.003^{b}±0.007	0.004^{b}±0.007
CV Second	0.000^{c}±0.000	0.000^{c}±0.000	0.003^{c}±0.007	0.009^{c}±0.001	0.000^{c}±0.000	0.000^{c}±0.000

The vales with different superscripts are significantly different (all values are expresses as means ± SD for the determinants).

Where CV=*Cirullus vulgaris* (Egusi)

CV Prima = *Cirtrullus vulgaris* primary fermentation

CV Sec = *Citrullus Vulgaris* Secondary Fermentation

4.2.2 Anti-Nutrient Analysis on *Cucumeropsisedulis*

The anti-nutrient analysis (table 4.7) of raw *Cucumeropsisedulis*showed an increase in saponin, alkaloid, flavonoid, HNC and hytate(0.064, 0.063, 0.240, 0.036 and 0.015) respectively as compared to the boiled and fermented sample. The anti-nutrient content of the boiled sample generally showed a decline in all the values. The decline could be as a result of leaching of anti-nutrient in the water used for boiling (Philips and Abbey, 1989). It also shows that boiling reduces anti-nutrients as reported by Fasoyiro*et al* (2006). The primary fermented sample showed an increase in the anti-nutrient content which could be due to the contribution from fermenting organisms (Achi, 1992). At the end of the secondary fermentation, the result showed a decline in the anti-nutrient content which may be due to the processing time as stated by Esenwah and Ikenebomeh (2008).

Table 3.7 Anti-Nutrient Analysis of *Cucumeropsisedulis*

Sample	Alkolid	Saponin	Tannin	Flavonoid	HCN	Phytate
CV Raw	0.069^{a}±0.000	0. 064^{a}±0.001	0.060^{a}±0.000	0.240^{a}±0.000	0.036^{a}±0.000	0.015^{a}±0.000
CV Boiled	0.000^{c}±0.000	0.000^{d}±0.000	0.000^{c}±0.000	0.000^{c}±0.000	0.000^{b}±0.000	0.000^{c}±0.000
CV Prima	0.018^{b}±0.000	0.016^{b}±0.000	0.011^{b}±0.000	0.012^{b}±0.000	0.000^{b}±0.007	0.000^{b}±0.000
CV Second	0.000^{c}±0.000	0.003^{c}±0.000	0.000^{c}±0.000	0.000^{c}±0.000	0.000^{b}±0.000	0.000^{c}±0.000

The vales with different superscripts are significantly different (all values are expresses as means ± SD for the determinants).

Where CE = *Cucumeropsisedulis* (Ahuru)

CE = Prima = *Cucumerospsisedulis* Primary Fermentation

CE Sec= *Cucumerospsisedulis* Secondary Fermentation

4.2.3 Anti-Nutrient Analysis on *ColocynthisCirullus*

The result obtained from the anti-nutrient analysis of raw *Colocynthiscitrullus* showed an increase in flavonoid, saponin, tannin, alkaloid, HCN and phytate (0.310, 0.090, 0.073, 0.057, 0.028and 0.017) as seen in table 3.8. The high content of flavanoid affects the quality of food if not processed or removed as stated by Esenwah and Ikenebomeh (2008). The boiled sample showed a decrease in the anti-nutrient content as compared to the raw

which could be as a result of leaching of anti-nutrient in the water used for boiling (Abbey and Philip, 1989). The primary fermented sample showed an increase in the anti-nutrient content which may be due to the contribution from fermenting microorganism. The secondary fermented sample showed a decline in the anti-nutrient content which may be due to enzymatic activities of the fermenting microorganisms as reported by Esenwah and Ikenebomeh (2008). NwosuandOjimelukwe (1993) also stated that fermentation is the most effective processing technique that reduced anti-nutritional factors of fluted pumpkin seed.

Table 3.8 Anti-Nutrient Analysis of *Colocynthiscitrullus*

Sample	Alkolid	Saponin	Tannin	Flavonoid	HCN	Phytate
CC Raw	0.057^{a}±0.001	0.090^{a}±0.001	0.073^{a}±0.000	0.210^{a}±0.014	0.028^{a}±0.000	0.017^{a}±0.001
CC Boiled	0.000^{c}±0.000	0.003^{d}±0.000	0.002^{c}±0.000	0.003^{c}±0.007	0.000^{b}±0.000	0.000^{c}±0.000
CC Prima	0.017^{b}±0.007	0.019^{b}±0.007	0.008^{b}±0.000	0.011^{b}±0.001	0.000^{b}±0.000	0.002^{b}±0.000
CC Second	0.003^{c}±0.000	0.002^{c}±0.000	0.004^{c}±0.000	0.007^{c}±0.000	0.000^{b}±0.000	0.000^{c}±0.000

The vales with different superscripts are significantly different (all values are expresses as means ± SD for the determinants).

Where CC = *Colocynthiscitrullus* (hausaegusi)

CC = Prima = *Colocynthiscitrullus*Primary Fermentation

CC Sec= *Colocynthiscitrullus*Secondary Fermentation

3.2.4 Anti-Nutrient Analysis on *Cucurbita pepo*

The anti-nutrient analysis of raw *Cucurbita pepo*showed an increase of flavonoid, HNC, Phytate, saponin, alkaloid and tannin as seen in table 3.9. The high content of flavanoid affects the quality of food if not processed or removed as stated by Esenwah and Ikenebomeh (2008). The boiled sample showed a decrease in the anti-nutrient content which could be as a result of leaching of anti-nutrient in the water used for boiling (Philips and Abbey, 1989). The primary fermented sample showed an increase in the anti-nutrient content which may be due to the contribution from fermenting microorganisms. The Secondary fermented sample showed as a decline in the anti-nutrient content. The result of this study is in line in agreement with those reported by Wedad*et al* (2008) who stated that fermentation of sorghum produces significant loss in phytate. Healso concluded that fermentation is the most effective technique that reduces phytic acid and other anti-nutritional factors

Table 3.9 Anti-Nutrient Analysis of *Cucurbita pepo*

Sample	Alkaloid	Saponin	Tannin	Flavonoid	HCN	Phytate
CP Raw	0.066^{a}±0.001	0.090^{a}±0.00	0.049^{a}± 0.000	0.290^{a}± 0.000	0.190^{a}± 0.216	0.180^{a}± 0.00
CP Boiled	0.000^{c}± 0.000	0.000^{c}± 0.000	0.000^{c}± 0.000	0.000^{c}± 0.000	0.000^{b}± 0.000	0.000^{c}± 0.000
CP Prima	0.016^{b}± 0.000	0.020^{b}± 0.000	0.010^{b}± 0.000	0.096^{b}± 0.000	0.000^{b}± 0.000	0.050^{b}± 0.000
CP Second	0.001^{c}± 0.000	0.002^{c}± 0.000	0.000^{c}± 0.000	0.000^{c}± 0.000	0.000^{b}± 0.000	0.000^{c}± 0.000

The values with different superscripts are significantly different (all values are expressed as mean ± SD

for the determinants)

Where CP = *Cucurbita pepo* (Ugbogoro)

CP Prima = C*ucurbita pepo* primary fermentation

CP Sec = *Cucurbita pepo* secondary fermentation

3.2.5 Anti- Nutrient Analysis on *CitrullusLanatus*

The result obtained from the anti- nutrient analysis of raw *Citrulluslanatus*showed an increase in flavonoid, saponin, tannin, alkaloid, HCN and phytate (0.280, 0.084, 0.060, 0.057, 0.030and 0.016 respectively) as seen in table 3.10 the result showed a significant decrease in the boiled sample as compared to the raw sample. The

decrease could be as a result of leaching of anti-nutrient in the water used for boiling (Philips and Abbey, 1989). The primary fermented sample showed an increase in anti- nutrient content which may be due to the contribution from fermenting organisms.At the end of the secondary fermentation, the result showed that the anti- nutrient content of the sample reduced significantly ($p<0.05$). This was in agreement with the report of Philips and Abbey, (1989) that fermentationand steepinghydrates the food sample and infuces the leaching out of water soluble anti- nutrients.

Table 3.10 Anti-Nutrient Analysis of *Citrulluslanatus*

Sample	Alkaloid	Saponin	Tannin	Flavonoid	HCN	Phytate
CL Raw	0.057^{a}±0.001	0.084^{a}±0.00	0.060^{a}± 0.000	0.250^{a}± 0.000	0.0300^{a}± 0.000	0.0160^{a}± 0.01
CL Boiled	0.000^{c}± 0.001	0.000^{c}± 0.000	0.009^{b}± 0.000	0.000_{c}± 0.000	0.000^{b}± 0.000	0.000^{c}± 0.000
CL Prima	0.014^{b}± 0.000	0.021^{b}± 0.000	0.009^{b}± 0.000	0.090^{b}± 0.000	0.000^{b}± 0.000	0.004^{b}± 0.000
CL Second	0.000^{c}± 0.000	0.000^{c}± 0.000	0.000^{c}± 0.000	0.000^{c}± 0.000	0.000^{c}± 0.000	0.000^{c}± 0.000

The values with different superscripts are significantly different (all values are expressed as mean

± SD for the determinants)

Where CL = ***CitrullusLanatus****(*watermelon)

CL Prima = ***CitrullusLanatus***primary fermentation

CL Sec = ***CitrullusLanatus***secondary fermentation

Conclusionand Recommendation

4.1 Conclusion: The mineral compositions and anti-nutritional factors ofraw, boiled and fermented underutilized melon seeds were successfully determined and compared with regular substrate *Citrullus vulgaris*. Among all the species of melon seeds, *Citeruslanatus* has the highest nutritional and mineral quantities as well as the lowest anti-nutritional factors. Fermentation affected all the mineral and anti-nutritional content of the melon sample apart from hydrogen cyanide (HCN) in *Citrulluslanatus*. Comparatively *Citrullus vulgaris* showed a decrease in all the anti-nutritional factors and has good nutritional and mineral quantities compared with the other underutilized melon seeds. These suggest that *Citrullus vulgaris* can be of good quality for human consumption and for production of good quality ogiri.

4.2 Recommedation

Due to inherent problem associated with sensory characteristics variation in ogiri-egusi,its utilization is limited to traditional level. I therefore recommend that further work should be done on the effect of processing both subjectively and objectively so as to standardize the nutritional compositionof ogiri- egusi. This will help in the industrialization of ogiri production.

References

Achi O.K. (2005). The upgrading of traditional fermented foods through biotechnology.*African Journal of* Biotechnology.4:375 -380.

Achi, O. K. (1992). Microorganisms associated with natural fermentation ofProsopisafricana seeds for the production of okpiye. *Plant Foods for Human Nutrition*, *42*(4), 297-304.

Achi, O. K. (2013). The potential for upgrading traditional fermented foods through biotechnology. *African Journal of Biotechnology*, *4*(5), 375-380. .

Akande, K. E., Doma, U. D., Agu, H. O., &Adamu, H. M. (2010). Major antinutrients found in plant protein sources: their effect on nutrition. *Pakistan Journal of Nutrition*, *9*(8), 827-832.

Anjorin, I. B., Sanusi, M. S., & Hussein, J. B. (2012) Energy Usage and Conservation Approaches in Production of Condiment (ogiri) from Melon seeds (Citrullus vulgaris). *Plant foods for human*

Bello, B. K., &Akinyele, B. J. (2007).Effect of Fermentation on the Microbiology and Mineral Composition. *International Journal of Biological Chemistry*, *1*(4), 237-243.

Bello, M. O., Falade, O. S., Adewusi, S. R. A., &Olawore, N. O. (2008).Studies on the chemical compositions and anti nutrients of some lesser known Nigeria fruits. *African Journal of Biotechnology*, *7*(21).

Campbell platt G. (2004). Fermented Foods In Encyclopedia of Food Microbiology ed. Robinson, R.K Academic press. London, UK; 736 -739.

El-Adawy, T. A., &Taha, K. M. (2001).Characteristics and composition of watermelon, pumpkin, and paprika seed oils and flours. *Journal of Agricultural and Food Chemistry*, *49*(3), 1253-1259.

Enujiugha V.N. Badejo A.A (2007). Cultural Alteration for the improvement of *Bacillus subtilis in the* Fermwntation of African oil bean seeds (*pentaclethramacrophyllabenth).* Journal of Applied Tropical Agriculture, 2007; 7: 6 – 11.

Esenwah, C. N. and Ikenebomeh, M. J. (2008).Processing effects on the nutritional and anti-nutritional contents of African locust bean (ParkiabiglobosaBenth.) seed. *Pakistan Journal of Nutrition*, *7*(2), 214-217.

Fasoyiro, S. B., Ajibade, S. R., Omole, A. J., Adeniyan, O. N., &Farinde, E. O. (2006). Proximate, minerals and antinutritional factors of some underutilized grain legumes in south-western Nigeria. *Nutrition & Food Science*, *36*(1), 18-23.

Ganiyu, O. B. O. H. (2005). Effect of some post-harvest treatments on the nutritional properties of Cnidoscolusacontifolus leaf. *Pak. J. Nutr*, *4*(4), 226-230.

Harborne, J. B. (1973). Methods of plant analysis. In *Phytochemical methods*(pp. 1-32). Springer Netherlands.

Harborne, J. B. (1973). Phenolic compounds.In *Phytochemical methods* (pp. 33-88).Springer Netherlands.

Liener, I. E., & Thompson, R. M. (1980).In vitro and in vivo studies on the digestibility of the major storage protein of the navy bean (Phaseolus vulgaris).*Plant Foods for Human Nutrition*, *30*(1), 13-25.

Motarjemi, Y. (2002). Impact of small scale fermentation technology on food safety in developing countries. *International Journal of Food Microbiology*,*75*(3), 213-229.

Nout, M.J.R and Rombout, F.M (1990).Rcent development in tempe research. J. Appl. Bacteriol. 69; 609-633.

Nwosu, C. D., &Ojimelukwe, P. C. (1993). Improvement of the traditional method of ogiri production and identification of the micro-organisms associated with the fermentation process. *Plant foods for human nutrition*, *43*(3), 267-272.

Oboh, G., &Akindahunsi, A. A. (2004). Change in the ascorbic acid, total phenol and antioxidant activity of sun-dried commonly consumed green leafy vegetables in Nigeria. *Nutrition and Health*, *18*(1), 29-36.

Odibo, F.J.C., Nwabuma, E and Osigwe D. (1990). Biochemical changes during fermentation of telfaria seeds for ogiri production. World .J. Microboil.Biotechnol. 6; 425-427

Odunfa, S.A. (1985). Microbiological and topological aspects of fermentation of castor oil seeds for ogiri production. In. J. Food Sci. 50: 1950-1959.

Oduse, K. A. (2013). Quality assessment profile of Jatropha curcas (L) seed oil from Nigeria. *Magnesium*, *163*, 4-00.

Oladele Oand Oshodi A.A.2008. Quality assessment profile of Jatropha curcas (L) seed oil from Nigeria. *Magnesium*

Olaofe, O., Adeyemi, F. O., &Adediran, G. O. (1994).Amino acid and mineral compositions and functional properties of some oilseeds. *Journal of Agricultural and Food Chemistry*, *42*(4), 878-881.

Omafuvbe, B.O., Honukan, O.O and Abiose, S.H. (2006). Microbiological and biochemical change in the traditional fermentation of soybean. For soy dawadawa a Nigeria food condiment.Food Microbial, 17; 469.

Omafuvbe, B. O., Falade, O. S., Osuntogun, B. A., &Adewusi, S. R. (2004). Chemical and biochemical changes in African locust bean (Parkiabiglobosa) and melon (Citrullus vulgaris) seeds during fermentation to condiments. *Pak. J. Nutr*, *3*(3), 140-145.

Pearson, D. (1976). *The chemical analysis of foods* (No.Ed. 7). Longman Group Ltd..

Phillips, R. D., & Abbey, B. W. (1989).Composition and flatulence-producing potential of commonly eaten Nigerian and American legumes. *Food chemistry*,*33*(4), 271-280.

Sarkar, P. K., &Nout, M. R. (Eds.).(2014). *Handbook of Indigenous Foods Involving Alkaline Fermentation*.CRC Press.

Steinkraus, K. (1995). *Handbook of Indigenous Fermented Foods, revised and expanded*. CRC Press.

Steinkraus, K. H. (2002). Fermentations in world food processing.*Comprehensive Reviews in Food Science and Food Safety*, *1*(1), 23-32

Wedad, H. A., El Tinay, A. H., Mustafa, A. I., &Babiker, E. E. (2008). Effect of fermentation, malt-pretreatment and cooking on antinutritional factors and protein digestibility of sorghum cultivars. *Pak J Nutr*, *7*(2), 335-341.

Uematsu, Y., Hirata, K., Saito, K., & Kudo, I. (2000). Spectrophotometric determination of saponin in Yucca extract used as food additive. *Journal of AOAC International*, *83*(6), 1451-1454.