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EFFECT OF FERMENTATION DURATION ON THE NUTRITIONAL AND ANTINUTRITIONAL CONTENT OF WATERMELON SEEDS AND SENSORY PROPERTIES OF THEIR *OGIRI* PRODUCTS

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ABSTRACT: *The proximate composition and antinutrients of fermented watermelon seeds (24-120h (1-5 days)) as well as the sensory attributes of soup prepared with the condiment (ogiri), produced from the fermented watermelon seeds were determined using standard methods. Protein increased from 11.79% in the fresh sample to 13.77% (96h fermented watermelon seeds) while the ash increased from 4.95% to 5.75% in the same sample. The comparative assessment of the proximate composition of the watermelon ogiri and commercial ogiri (control) showed that the watermelon ogiri had higher protein and fat content, 13.77% and 15.40% respectively than the commercial ogiri (9.98% and 7.96% respectively). The 96h fermented watermelon seeds had optimum increase in nutrients and was used as a condiment alongside with commercial ogiri from castor oil bean for oha soup preparation, both of which were subjected to sensory evaluation and they differed significantly (P<0.05). However, the control soup was most preferred by the panelists (7.68).*

KEYWORDS: Watermelon Seed, Ogiri, Fermentation, Antinutrients, Sensory

INTRODUCTION

Watermelon is a tropical fruit which grows in almost all part of Africa and South East Asia [1]. It belongs to the family of cucumber (*cucurbitacca*). It is large, oval, round or oblong in shape. The skin is smooth with dark green rind or sometimes pale green strips that turn yellowish green when ripe [2]. Watermelon is a type of melon, member of the gourd family, cultivated extensively for its pleasant tasting fruit is one of the most economically important fruit in the cucurbitaceae family. Watermelon is reported to be rich in water content with high sugar for energy boosting as well as for its rich in mineral and vitamin [3].

Watermelons are consumed fresh, leading to the rejection of watermelons that have any visible defect [4]. It serves as a good source of phytochemicals and lycopene, a red carotenoid pigment which acts as antioxidant during normal metabolism and protects against cancer [5]. Some other carotenoids in it include phytofluene, phytoene, beta-carotene lutein-lycopene make up the majority of the carotenoids in watermelon [6]. Watermelon helps to regulate acid – base equilibrium which lowers the cholesterol level, which has strong diuretic tendencies (ie increases the amount of water in the urine) remove excess water from the body, contribute to clearing the kidney or prevent the formation of bladder stones, kidney stones among other [7]. Watermelon contains 96% water, and vitamin C and traces of cholesterol, watermelon also contains thirst quencher and also some anti-inflammatory compounds responsible for asthma, atherosclerosis, diseases, diabetes, colon cancer and arthritis [8]. It is also an important source of potassium and many micronutrients [9]. The potassium and magnesium present in

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watermelon helps in reducing blood pressure, the carotenes present in them assist greatly in preventing hardening of walls of arteries and vein thereby helping in that regard [10]. Watermelon is effective in reducing ones blood pressure and many people in the tropical region eat the fruit daily in the afternoon to protect themselves from heat burn. It also helps in proper functioning of insulin in the body thus lowering the blood sugar level [9].

Watermelon is used amazingly for it nutritional and medicinal value because of its high water content which contain sugar and energy booster, which hydrate body in the case of dehydration, especially during the hot season. In Nigeria many types of watermelon are cultivated especially in the Northern region, but the consumption of watermelon in nationwide, not much has been recorded on the utilization of watermelon seeds partly in Nigeria [11]. However, report has shown that the seeds are consumed in different ways as snacks in Asia as well as utilized as significantly in livestock feeds [12] watermelon seeds are flat having marginal groove on each side near the base and white black margins 10-15mm long [13]. Watermelon seeds are rich in macro and micro nutrients such as magnesium, calcium, potassium, iron, phosphorus and zinc etc. which assist in the growth and development of the healthy body which take part in metabolic activities of all living organisms [14]. Watermelon seeds are excellent sources of protein it contains phytonutrients which have very good on the health and proper functioning of internal organs [5].

Watermelon seed contain many beneficial minerals like phosphorus (mg /100,705-755g) potassium (648-689mg/1100g) calcium (54-116mg/100g) sodium (2\3-99mg/100g) iron (677-720\8mg/100g) and copper (069-175mg/100g) [15]. Watermelon seed are rich in good fats and proteins, it contain phytonutrient which very good effect in the health. Most American price the sweet and juicy fresh of watermelon, but remove or spit out the seeds has led to the development of "seedless" watermelon which produce much smaller seeds are consumed in many cultures around the world, because they are relatively rich source of certain nutrient [16].

Many nutrients are beneficial for our body. Health nutrients in watermelon seeds are able to ward off cancer improve or prevent cardiovascular disease, hypertension and reduces level of bad cholesterol [17]. However, in order to create more report on the importance of usually discarded watermelon seed, it is necessary to assess the quality of watermelon seed with a view of harnessing them for consumption and possible industry usage [18].

Ogiri is a fermented food condiment of wide application and use in Nigerian cuisines [19]. *Ogiri* is an oily paste produced mainly from melon seeds and consumed widely within the West Africa. It is a cheap soup condiment among the rural dwellers [20]. Many different seeds have been used successfully in the production of *ogiri* using chance inoculated microorganisms to effect fermentation [21]. In the South East, the Igbo's use seeds of the castor plant, (*Rianus comminis*) for *ogiri* production [22] as well as fermented pumpkin, (*Telferia ocidentalis*) for the same purpose [23]. [24] observed the existence of many different varieties of melon seeds (other than the popular Egusi (Colanatus) which are correctly underutilized and which world same as alternative to egusi in the production of *ogiri*, the popular widely consumed condiment for soups and stews. *Ogiri* is a product of the fermentation of boiled melon seeds. It is a food flavouring condiment used in sauces and stews that serves as accompaniment to starchy root and vegetable diets [25]. It is also added to other preparations seasoning example in boiled meat and staple foods such as Ikokore a Nigeria local meat and staple foods such as Ikokore - a Nigeria local pottage [26]. The traditional preparation of *ogiri* from melon seeds is by the method of uncontrolled solid state fermentation then boiled again to soften seeds for

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fermentation.A host of fermented seeds are found across Nigeria they are as follows: Une, Iru, produced from locust beans, *Ogiri*, produced from melon seeds, Dawadawa from soybeans,

Okpehe from African mesquite seeds, *Ogiri*- igbo produced from Caster oil seeds (*Ricinuscomnunis*), Oweoh, from cotton seed (*Crossypiumhisutum*), Mmanza, ntuza, from *Hibiscus sadariffa*, 080 from seed of *Cathormionaltissium*. [27].

Watermelon seed readily fits into the same picture for possible use in the production of *ogiri* when reported fermented [28]. Seeds of watermelon have been reported to be rich in protein, minerals and vitamins as well as contain a wide variety of phytochemicals stone of which have been shown to posses pharmacological and other health benefits[29]. However, the practice of throwing watermelon seeds away during the fruit consumption is common in the South East Nigeria [19]. Therefore, there is a dearth of information on the fermented watermelon seeds and its food utility. A successful utilization of the watermelon seeds in production of consumables will no doubt increase and diversify its utility value [30]. Against this background, this study was designed to ascertain the duration of fermentation on the nutritive value of the watermelon seed, in view of establishing an optimum fermentation time which will be utilized in the production of *ogiri* and subsequent determination for the acceptability of the *ogiri* produced through sensory evaluation.

MATERIALS AND METHODS

The watermelon seeds were extracted from watermelon fruits purchased from Umuahia Central market Ubani, Umuahia. Analyses were carried out at National Root Crop Research Institute Laboratory and the Food Therapy Laboratory of Home Science Department, Michael Okpara University of Agriculture, Umudike.

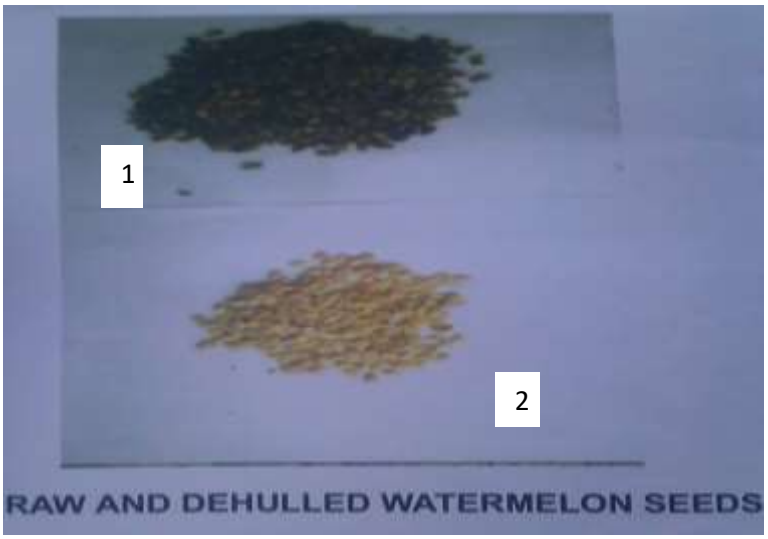

Plate 1: undehulled (1) and dehulled (2) watermelon seeds

Sample preparation

Exactly 200g of the watermelon seeds were cleaned, dried and dehulled (Plate 1). The dehulled seeds were boiled in distilled water (1: 2) with a pot, for 6h to aid softening. Intermittently, water was added to the pot to prevent burning. Then, on completion of boiling, the seeds were

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drained and allowed to cool for 30 minutes. After cooling, the seeds were mashed into a pulp which was divided into five (5) portions, then, each of the sample portions was wrapped in plantain leaves (Musa spp).The plantain leaves before usage, were flamed to make them pliable in order to prevent breakage. After that, samples were put into a clean sack bag and incubated at ambient temperature for 24-120h. Samples of fermented watermelon seeds were collected at different processing periods of 24, 48, 72, 96 and 120h on 24 hourly basis to determine the duration of fermentation on the watermelon seed (Plate 2). The flow chart for the fermentation of watermelon seed is shown in fig. 1below:

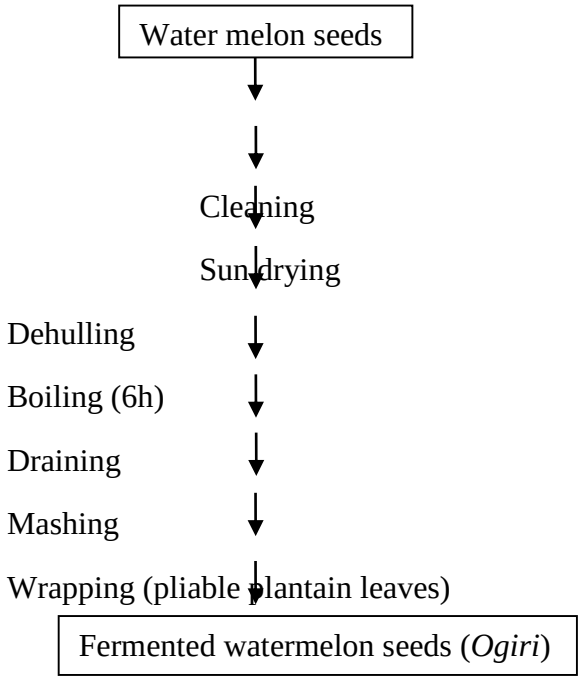

Fig. 1: Flow diagram for fermented watermelon seed (*Ogiri*)

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Plate 2: Fermented watermelon seeds *ogiri* of duration 24-120days

Sample analyses

Proximate compositions of the raw and fermented water melon seeds were determined. The moisture content, crude protein, crude fat, crude fiber and ash were determined using standard methods of [31]. The carbohydrate content was estimated as the nitrogen free extractive (NFE) using the method of [32]. The NFE was given as the difference between 100 and the sum of protein, fat, fiber and ash and moisture. % of NFE is given by 100-% (a+b+c+d+e) where the letters represent protein, fat, fiber, ash and moisture.

MINERAL DETERMINATION

The mineral content of the test samples (raw and fermented water melon seeds) was determined by the dry ash extraction method described by [33] after which specific mineral elements were determined. A 2g portion of the watermelon seed sample was burnt to ashes in a muffle furnace and the resulting ash was dissolved in a 100ml of dilute to 100ml with distilled water in a volumetric flask the digest obtained was used for the various elements analyzed.

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Determination of Phosphorus

Phosphorus in the water melon seed samples was determined by vanadomolgbate (yellow) spectrometry described by [34] then, 1ml extract from each sample was dispensed into a test tube similarly the same volume of standard phosphorus solution as well as water was put into other test tube to serve as standard and blank respectively. The content of each test tube was mixed with equal volume of the vanadomolgbate colour reagent. They were left to stand for 15 minutes at room temperature before their absorbance were measured in Genway spectrophotometer at a wave length of 420nm. Measurement was given with the blank at zero phosphorus content was calculated with the formula.

Where: W = Weight of the sample

Au = Absorbance of test sample

As = Absorbance of standard

Solution:

C = Concentration of the standard

UF = Absorbance of test sample

VA = Volume of filtrate analyzed

Determination of Calcium and Magnesium

This method was described by [33] calcium and magnesium complex metric titration.

Here, 20ml of each extract was dispersed into conical flask pinches of the masking agents, hydroxytannin hydrochloride and potassium of pH 10.0 a pinch of indicators err chrome black was shaken well. Then it was titrated against 0.02N EDTA solution: the titration colour charged form a mauve colour to a permanent blue coloration. A reagent blank consisting of 20ml distilled water was also treated as described above. The titration gave a read for combined ca & mg complexes in the sample. Then a separate titration was conducted for calcium.

DETERMINATION OF ANTINUTRIENTS

Phytate determination

This was determined using the method described by [34]. The samples were first extracted with 0.2N HCL, 0.5ml of the extract solution was pipetted into test tube fitted with a ground glass stopper. 1ml ferric acid solution was later heated in a boiling water bath for 30 minutes after heating the tube was cooled in ice water for 15 minutes and allowed to adjust to room temperature. The tube was then mixed and centrifuged for 30 minutes at 3,000 rpm 1ml of the supernatant was transferred to another tube and 1.5 ml of 2, 2 bipyridine solution was added. The absorbance was measured at 510mm against distilled water. A standard solution (1ml of phytate was repeated as described above for the sample as:

$$\% \text{ phytate} = \frac{100}{} \times \frac{au}{} \times C \times \frac{uf}{} \times n$$

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10 as va

Where C = concentration of standard phytate solution

Uf = Total volume of extract used

Vx = volume of extract used

W= Weight of sample used

Tannin Determination

The folin – Denis spectrophotometer method was used. The method was described by [35], a measured weight of each sample and agitated. This was left to stand for 30 min at room temperature, being shaken every 5 min, at the end of the 30 min, it was centrifuged and the extract obtained. Exactly 2.5ml of the supernatant (extract) was dispersed into a 50ml volumetric flash. Similarly, 25ml of standard tannic acid and 1.0ml. folin – Denis reagent was measured into each flask, following by 2.5ml of saturated sodium bicarbonate (Na_2Co_3) solution. The mixture was diluted to mark in the flask (50ml) and incubated for 90 min at room temperature. The absorbance was measured at 250 nm in a Genway model 6000 electronic spectrophotometer. Readings were taken with the reagent blank at zero.

AU x C x 100 x VF

As W Va

Where:

Au = Absorbance of test sample

As = Absorbance of standard solution

C = Concentration of standard solution

W = Weight of sample used

Uf = Total volume of extract

Va = Volume of extract analyzed

Saponin Determination

The saponin was determined by the double solvent extraction gravimetric method as described by [36]. Exactly 5g of the powered water melon seeds was weighed out and mixed with 50ml of 20% aqueous ethanol solution. The mixture was heated with periodic agitation on a water bath for 90 mins at 55^{o}C. It was filtered through what man filter paper and the residues re-extracted with 80mls of the 20% ethanol, both extracts were combined together. The combined extract was reduced to 40ml over a water bath at 90^{o}C. Separation was by partition during which the aqueous layer was recovered and the other layer was discarded. The saponin content was determined and extracted as percentage of the weight analyzed given by the formula.

% Saponin= W_2 W_1 x 100

W 1

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Where:

W = Weight of sample

W_1 = Weight of empty evaporating dish

W_2 = Weight of dish + saponin extract

Recipe for the soups prepared with fermented water melon seeds (*Ogiri*)

The underlisted, formed the major ingredients used for soups.

Fermented Watermelon Seeds *(Ogiri*)

Ingredient	**quantity**
Fermented seed	1 mould
Stock fish	½ medium size
Dry pepper	I table spoon
Magi cube	1 cube
Crayfish (grounded)	2 table spoons
Salt	to taste
Onions	1 medium size
Ofo	2 table spoon
Beef	5 medium pieces
Water	1½ liters
Oha	1 bunch
Palm oil	2 cooking spoons

Preparation of the Fermented Watermelon Seed Soup and Ogiri Soup

The beef, stockfish and smoked fish were washed with water and the beef was seasoned with seasonings and boiled until the water dried up. The stockfish and smoked fish also boiled and added to the pot containing the seasoned beef and were then boiled for about 5 min.

Two (2) cooking spoons of palm oil and 1½ liters of water were added to the pot before adding the fermented watermelon seed. Then the pot was covered and allowed to boil for 5 min.

It was stirred, crayfish and pepper were added and then cooked for 10 minutes.

The ofo which served as a thickener was added. Salt was added to taste. The Oha leaves were cut and washed thoroughly with water and salt. Finally, the washed Oha leaves were added and allowed to boil for a minute, before bringing the pot of soup down and served hot.

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The above process was equally followed in the preparation of the soup with commercial *ogiri*, to serve as a control. Care was taken to ensure that both soups contained exactly the same ingredients except that the different condiments (*ogiri* and fermented watermelon seeds) were used for the different soups (Plate 3). The prepared soups were later used for the sensory evaluation tests.

Plate 3: Fermented watermelon seeds *ogiri* soup (sample A) and commercial *ogiri* soup (sample B)

Sensory Evaluation

The sensory evaluation of the water melon ogiri soups and the commercial ogiri soup (control) was carried out using the method [37]. A standard 9 point hedonic scale ranging from 9 (like extremely) to 1 (dislike extremely) was used. The attributes evaluated included colour, taste, flavor, mouth feel and general acceptability. The first sample coded (A) was a soup prepared with a fermented watermelon seed and another sample coded (B) was a soup prepared with commercial *ogiri* to serve as a control. A set of 20 panelists which were semi- trained students were used for the evaluation. Water was provided for the judges to rinse their mouth in-between evaluation so as to draw unbiased conclusion.

Statistical analyses

The data was subjected to one-way analysis of variance (ANOVA) to determine the significant difference using the Duncan Multiple Ranging Test using the SPSS version 20. Results were expressed as the means ± standard deviation of duplicate determinations.

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RESULTS AND DISCUSSION

The result of the proximate composition of water melon seeds (*Citrullus lanatus*) was presented in table 1. The result showed that there were significant variations ($p<0.05$) between the proximate composition of the fermented water melon seeds and the fresh (unfermented) ones. Similar observations were made by [38] who studied the proximate composition of the fresh and fermented watermelon seeds (*Citrullus lanatus*).From table 1, it was evident that protein increased with fermentation time from (11.79%) in the fresh (unfermented) seeds to (13.77%) recorded on the 4^{th} day (96hours) of fermentation. However, the protein content reduced to 13.24% on the fifth day, thus making 4 days (96hours) the optimum fermentation period for maximum protein content. According to [39], watermelon seeds are the only good sources of highly absorbed and complete plant protein with an excellent quality. The increase in crude protein values could be attributed to increase in microbial mass during fermentation causing extensive hydrolysis of the protein molecules to amino acid and other simple peptides [40]. [41] in their own report, attributed increase in protein during fermentation might be due to some anabolic processes leading to polymer build-up or due to microbial cell proliferation

Fat content, unlike the protein, decreased from 18.63% to 14.5%, although there was no significant ($p>0.05$) fat reduction among the samples. The fat reduction was attributed to possible degradation of fat by lipase enzymes produced by micro organisms during the fermentation [42].

The crude fiber content was significantly decreased as the fermentation hours increased (3.12% to 2.51%) except for the crude fiber of 120h fermented sample (2.45%) which did not differ ($p>0.05$) significantly from that of 96h fermented sample (2.51%). Watermelon seed fibre can help to provide dietary fibre that would offer protection against cardiovascular disease, obesity and colon cancer and promote the effective functioning of the human digestive tract as reported by [43]. The highest ash content was observed in the 96h fermented sample (5.75%) while the raw (unfermented) sample had the least (4.39%).

As shown in table 1, the moisture content of the water melon seeds increased as fermentation period increased (12.04-34.25%). The raw (unfermented) sample had a moisture content of 12.04% while the highest moisture (34.25%) was observed in day 5. The changes in the various proximate compositions resulted in commensurate changes in the carbohydrate content of the fermented water melonseeds which decreased significantly ($p<0.05$) from 50.08% to 29.28%. It was observed that the 96h fermented sample had the lowest carbohydrate content than the other samples. The low carbohydrate content of watermelon seeds implies that the risk of diabetes and insulin insufficiency is absent [9].The decrease in carbohydrate content could be attributed to the conversion of oligosaccharides to simple sugars or the utilization of the carbohydrate nutrient as source of energy by the fermenting microorganisms for growth and metabolism [44]. From the result, it was observed that the optimum fermentation time for watermelon seed was 4 days (96hours). The sample fermented for 96hours was preserved and used for comparative sensory evaluation with the commercial *ogiri.*

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SAMPLES	TANNIN (%)	PHYTATE (%)	SAPONIN (%)
Raw watermelon seeds	0.35	0.43	0.24
Fermented watermelon seeds	0.04	0.12	0.06

Table 1: Proximate composition of watermelon seeds fermented for 24 -120 h

SAMPLE	PROTEIN (%)	FAT (%)	FIBRE (%)	ASH (%)	MOISTURE (%)	CHO (%)
Fresh	$11.79^{a}\pm0.10$	$18.63^{a}\pm0.02$	$3.12^{e}\pm0.07$	$4.39^{a}\pm0.003$	$12.04^{a}\pm0.09$	$50.08^{e}\pm0.06$
24h	$12.14^{b}\pm0.10$	$18.61^{a}\pm0.10$	$3.01^{d}\pm0.08$	$4.95^{b}\pm0.11$	$22.79^{b}\pm0.14$	$38.52^{b}\pm0.18$
48h	$12.63^{c}\pm0.58$	$17.42^{a}\pm0.08$	$2.81^{c}\pm0.05$	$5.37^{c}\pm0.01$	$25.71^{c}\pm0.52$	$36.05^{f}\pm0.59$
72h	$13.24^{d}\pm0.10$	$16.64^{a}\pm0.15$	$2.64^{b}\pm0.025$	$5.52^{d}\pm0.004$	$28.69^{d}\pm0.31$	$33.2^{b}\pm0.45$
96h	$13.77^{e}\pm0.10$	$15.40^{a}\pm0.09$	$2.51^{a}\pm0.06$	$5.75^{d}\pm0.01$	$33.15^{f}\pm0.92$	$29.28^{a}\pm0.69$
120 h	$13.24^{d}\pm0.10$	$14.57^{a}\pm0.03$	$2.45^{a}\pm0.01$	$5.45^{cd}\pm0.01$	$34.25^{e}\pm0.10$	$30.10^{a}\pm0.08$

Values are means ± standard deviations of triplicate determinations. Means on the same column with different superscripts are significantly different (P<0.05).**CHO-** carbohydrates

The antinutrients in the raw (unfermented) and fermented watermelon seeds have been shown in table 2. The data showed that the raw watermelon seeds had tannin, phytate and saponin concentrations of 0.35%, 0.43% and 0.24% respectively which was drastically reduced and significantly differed from each other in the fermented watermelon seeds with values of 0.04%, 0.12% and 0.06% for tannin, phytate and saponin respectively. This represented 88.57% reduction in tannin content, 72.09% in phytate and 75% in saponin. The very significant reduction of the anti-nutrient was attributed to the combined effect of boiling and fermentation during boiling heat destroys anti-nutrients. These agree with [34] who observed that a thermal treatment reduces and sometimes eliminate anti-nutrients in food. The reduced levels of the anti-nutrient, makes the fermented watermelon seeds relatively safe for consumption.

Antinutrients are known to interfere with or inhibit the availability, digestion and absorption of food nutrients in animals and humans [45].

Table 2: Antinutrient content of raw and fermented watermelon seeds

Values are means ± standard deviations of triplicate determinations. Means on the same column with different superscripts are significantly different (P<0.05).

Tannins interfere with deposition and absorption of proteins, while phytates chelate minerals making team insoluble and unavailable for absorption.

The very significant reduction of the anti-nutrient was attributed to the combined effect of boiling and fermentation during boiling heat destroys anti-nutrients. This agrees with [34] who observed that thermal treatments reduces and sometimes eliminate anti-nutrients in food. The reduced levels of the anti-nutrient, makes the fermented watermelon seeds relatively safe for consumption.

The proximate composition of the 96h fermented water melon seed *ogiri* and commercial *ogiri* is presented in table 3.

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As evident in the result, there were significant differences ($p<0.05$) in the nutrients of the two condiments. The fermented watermelon seed *ogiri* contained significantly higher protein (13.77%) than the commercial *ogiri* (9.98%). The result confirms the earlier report of [46] that the fermented food increased in protein due to the help of micro organisms in the food. Fermented watermelon seed was also observed to be higher in fat content (15.40%) than the commercial *ogiri* (7.96%). However, the commercial *ogiri* contained more fiber (2.87%) than the fermented watermelon seed *ogiri*(2.51%). The ash content of the two condiments were found to be 5.75% and 7.05%for the fermented watermelon seed *ogiri* and the *ogiri* respectively. The commercial *ogiri* also had higher moisture content of 35.98% than fermented water melon seed which had 33.15%. Commercial *ogiri* increased in carbohydrate (36.16%) more than the fermented watermelon seed *ogiri* (29.28%). These results showed that the fermented watermelon seed *ogiri* compared favorably with the commercial *ogiri*.

Table 3: proximate composition of 96h fermented watermelon seed (*ogiri*) and commercial *ogiri*

Sample	Protein	Fat	Fiber	Ash	Moisture	CHO
Fermented watermelon seed (*ogiri*)	$13.77^{b}\pm0.10$	$15.40^{b}\pm0.09$	$2.51^{a}\pm0.06$	$5.75^{a}\pm0.01$	$33.15^{a}\pm0.92$	$29.28^{a}\pm0.69$
Ogiri commercial	$9.98^{a}\pm0.35$	$7.96^{a}\pm0.24$	$2.85^{b}\pm0.07$	$7.05^{b}\pm0.32$	$35.98^{b}\pm0.18$	$36.16^{b}\pm0.35$

Values are means ± standard deviations of triplicate determinations. Means on the same column with different superscripts are significantly different ($P<0.05$).

The fermented seeds *ogiri* had higher protein and fat content while the commercial *ogiri* contained higher fiber, ash and moisture contents.

The sensory attributes of the soup prepared with the 96h fermented water melon seed *ogiri* and commercial *ogiri* is presented in table 4. The result showed an outright preference of the fermented watermelon seed *ogiri* soup over the soup prepared with the commercial *ogiri* had significantly higher ($p<0.05$) mean sensory scores than the one from commercial *ogiri*. The scores for the test soup (fermented watermelon seeds *ogiri* soup) were from 7.07(mouthfeel), 8.15(taste), 7.75(flavor), with a general acceptability of 8.07. However, the scores of the commercial *ogiri* soup were significantly lower than those of its counterpart, 6.05(mouth feel), 7.50 (taste), 7.05 (flavor), with a general acceptability score of 7.08.It was believed that the fermented watermelon seed was more acceptable to the panelist as the results indicated probably due to its peculiarity and characteristic difference from the local *ogiri* which most people were used to. The acceptance level of the fermented watermelon seed *ogiri* soup was calculated to be 89.7% (8.07/9.0) while that of the commercial *ogiri* soup was calculated to be 85.3% (7.68/9.0). The higher mean score of the sensory attributes recorded in the fermented watermelon seed soup compared to commercial *ogiri* could also be probably be due to the high protein content and lower fat content of the fermented watermelon seed *ogiri* used in the soup preparation. The lower fat content in fermented watermelon seed may have accrued to the better taste, flavor and aroma of the fermented watermelon seed soup prepared. According to [46], during fermentation there was evidence of lipase activity which indicated production of free fatty acids. This may react with some other components of the fermenting mash to form esters which produce the characteristics aroma of the food condiment. [21] also reported that high

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protein content in fermented foods caused increased proteinase activity during fermentation which

Table 4: Sensory attributes of fermented watermelon seed *ogiri* and commercial *ogiri* soups

Sample	Taste	Colour	Flavor	Mouth feel	Acceptability
Fermented watermelon seed *Ogiri*	8.15^{b}±0.15	7.93^{b}±0.50	7.75^{b}±0.13	7.07^{b}±0.06	8.07^{b}±0.31
Commercial Ogiri	7.50^{a}±0.50	6.73^{a}±0.25	7.05^{a} ±0.05	6.0^{a}±0.05	7.68^{a}±0.03

Values are means ± standard deviations of triplicate determinations. Means on the same column with different superscripts are significantly different ($P<0.05$).

Released more amino acid and nitrogenous compounds which may probably produce odour or smell depending on the fermentation period. Generally, it was observed that the fermented watermelon seed *ogiri* soup was found to compete very favorably well with commercial *ogiri* in its sensory attributes when used for soup preparation.

CONCLUSION

It was observed that there were changes in the nutritional value of water melon seeds during fermentation. Fermentation caused significant reduction in the anti-nutrient content of the watermelon seeds. The watermelon seeds fermented for 96 h (4 days) had highest level of nutrients especially protein content and the fermentation time was used as the optimum. Comparatively, the fermented watermelon seed condiment had higher nutrients and its soup had better consumer acceptability than the commercial ogiri soup.

Therefore, fermentation of watermelon seeds for *ogiri* should be encouraged as it can add to the variety of condiments already in existence in the market. This also minimized the wastage of watermelon seeds and converts them to value-added products i.e from waste to wealth. It can also serve as a promoter of good health and lead to economic empowerment because it could be produced at a commercial level. It is also recommended that further studies be carried out on the microbial load and safety as well as shelf life of the fermented watermelon seed *ogiri.*

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