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Effect of fermentation process on nutritional composition of condiments from seeds of *P. Biglobosa, G. max and H. sabdariffa*

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Huge amount of foreign reserve is spent annually on the import of food flavours into Nigeria despite the fact that traditional condiments also suitably play the same role as imported food flavours. In this study, the proximate and mineral composition of local condiment 'Daddawa' produced by the fermentation of the seeds of locust beans (*Parkia biglobosa*), soya beans (*Glycine max*) and roselle (*Hibiscus sabdariffa*) was determined by the AOAC methods. The lipid values for the three seeds range from 8.10±0.07 to 10.30±0.03% with *H. Sabdariffa* having the highest value. The crude protein value was 11.70±0.19% for *P. biglobosa*, 10.70±0.32% for *H. Sabdariffa* and 9.50±0.25 % for *G. max*. *P. biglobosa* had the highest value for carbohydrate (by difference) which was 70.50±0.35% when compared to the least value of 61.10±0.2 for *H. sabdariffa*. Potassium was the highest mineral with a value of 3923.3±0.38% for *P. biglobosa*, 3433.3±0.40 for *H. Sabdariffa* and 2666.6±0.30% for *G. max*. Calcium and magnesium were low in all the seeds with least value for calcium observed in *H. sabdariffa* (0.4±0.01%) while *G. max* had least value of 0.1±0.09% for magnesium. Although, potassium was the highest mineral, the value increased in the fermented seeds to a range of 5566.6±0.30 to 9433.3±0.35% and *H. sabdariffa* had the highest value of with a value of 9433.3±0.35% and the least value of 5566.6±0.30 for *P. biglobosa*. *Glycine max* had the highest value of 933.3±0.33% for sodium while *P. biglobosa* had the least value of 60.8±0.30%. Magnesium was the lowest mineral even after the fermentation of the seeds with a range of 0.3±0.03 to 0.8±0.01%. Uncontrolled fermentation of the three seeds increased some proximate composition of the condiments.

Keywords: Daddawa, Fermentation, Proximate analysis, Locust beans, Soya beans, Roselle seeds.

1. Introduction

Legumes are plants with seed pod that split into two halves. Edible seed from plant in legumes family include bean, peas, lentils, soybeans and peanut. Although legumes are an essential part of traditional diet around the world, they are often neglected in the typical Western diet. Legumes are an inexpensive nutrient-dense source of protein that can be substituted for dietary animal protein (Anderson *et al*., 1999). While the source of animal protein is often rich in saturated fats, the small quantities of lipids in legumes are mostly unsaturated fats. Not only are legumes excellent essential minerals source, they are also rich in dietary fibre and other phytochemicals that may affect health.

Legumes play an important role in human nutrition as they are rich source of protein, calories, certain minerals and vitamins (Baloch and Zubair, 2010). In Nigeria two popular condiments used as taste enhancer in soups are fermented locust beans popularly known as Iru and fermented soybean popularly known as soybean daddawa.

Huge amount of Nigeria foreign reserve is spent annually on food flavour importation and this is projected to increase by 15% in the future (NBS, 2003). Traditional fermented condiment hold huge potential to cut down the amount of money Nigeria is spending on the importation of food flavor for soup. This can only be achieved if the production of condiment which largely depends on a traditional small-scale household basis under highly variable conditions can be improved. The improvement can be achieved if the production process, product stability and quality are

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standardized and reproducible in large scale. This has been achieved for similar condiment production in China, Indonesia etc

Legumes like *Parkia biglobosa* and *Glycine max* offer a singular advantage of providing plant proteins with reduced cost of production, less difficulty of processing and with higher energy values than those supplied by animal proteins (Balogun and Fetuga, 1986). The use of starter cultures has generally been recognized as one major way of ensuring product consistency and to a reasonable extent eliminates the problem of food-borne pathogens (Eman, 2009).

The aim of this research work is to determine and compare nutritional composition of fermented *Parkia biglobosa* (locust bean) *Glycine max (soya beans)* and Roselle seed (*Hibiscus sabdariffa*), produced from local and laboratory methods.

2. Materials and Methods

2.1 Sample Collection

Locust bean *(Parkia biglobosa)*, Soybean *(Glycine max) and* Roselle seed *(Hibiscus sabdariffa)* were obtained from Sokoto Central Market. The seeds were authenticated at Herbarium of Biological science UDUS and assigned the number: UDUH/ANS/0184,0185 and UDUH/ANS/0186. The samples were taken to Postgraduate Laboratory, Department of Microbiology, Usmanu Danfodiyo University, Sokoto, for further Analysis.

2.2 Traditional production of daddawa from locust beans

For the production of daddawa, method of Waters-Bayer (1988) was followed. Locust beans was boiled for at least 24 hours with water being added frequently. Cooked beans was mixed with wood ash and pounded, then washed several times to remove the seed coats. The beans was boiled for another 3-4 hours until they become softer, and was spread in a large flat basket covered with leaves and was allowed to ferment for two days. On the third day, the locust bean mass was transferred to a deep bowl and allowed to ferment for another 24 hours. The locust bean was spread out again in a large flat basket and partially in sun for several hours. The bean was pounded with mortar and pestle into a paste and formed by hand into balls or wafers.

Locust bean seeds
↓
Cleaning
↓
Boiling
↓
Dehulling
↓
Washing
↓
Re-cooking
↓
Fermentation
↓
Food condiment

Figure 2: Flow chart for traditional processing of African Locust Bean seeds to food condiment (Akande*et al.*, 2010)

2.3 Traditional production of daddawa from soya bean

To make traditional soya daddawa, soybean seeds were cleaned, soaked overnight in tap water, dehulled manually and cooked bboiling for two hours (Omafuvbe *et al*., 2000). The dehulled cooked beans are then placed in calabashes or bamboo baskets lined with banana or plantain leaves and left to ferment spontaneously in a warm place for up to 72 hours.

2.4 Production of Daddawan Botso from Roselle seeds

Daddawan botso was produced as previously described (Ibrahim *et al*. 2011) as follows:

The pre-processing consists of a selection by manually sorting. The seeds were winnowed to eliminate stones, part of calyx, and other impurities and were repeatedly washed with water (2 to 3 times). After the initial cleaning process, the seeds were cooked for 8-12 hours according to intensity of the fire. Seeds were considered as well cooked when soft and easily crushed with fingers. The water is allowed to dry without allowing the cooked seeds to burn.

Fermentation was in two phases; in the first phase, the cooked seeds were allowed in the pot to ferment naturally for two days. The pot was closed tightly to ensure that air does not gain access. After the first fermentation, the cooked seeds are pounded nearly to paste in a mortar with the addition of ash leachate and mixed. This was returned to the pot for second fermentation for 1 day. The pot was also tightly closed in this phase.

At the end of the second fermentation, the condiment is sun dried for 2 to 3 days according to the intensity of sunshine by repeated turning to form balls. The condiment is then packaged in polythene bags (Ibrahim *et al* 2011)

2.5 Proximate composition

The condiments samples were analyzed in triplicate for proximate composition as described

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previously (AOAC, 1995). Ash was determined by incinerating two grams (2 g) each of unfermented seeds and fermented condiments at 550 °C in lenton furnaces (England) over night. Fiber was determined by drying two gram (2 g) each of unfermented seeds and fermented condiments over night at 105 0C in the oven (Gallenhamp Oven BS) and incinerated at 550 0C for 90 minutes in lenton furnaces (England). Moisture Content was determined by drying two gram (2 g) each of unfermented seeds and fermented condiments over night at 105 0C in the oven (Gallenhamp Oven BS). Crude lipid was determined using saturated method. Two grams (2 g) of unfermented seeds and fermented condiments were weighed into 50 ml conical flask and Nhexane was added and allowed to stand at room temperature overnight. It was drained into an empty flask, earlier weighed and designated W1. It was placed in an oven to allow the N-hexane to evaporate in the oven (Gallenhamp Oven BS). Protein (% N * 6.25) was determined by the Micro-kjeldahl Method. Soluble carbohydrate is not directly determined but obtained as a difference between the sum of ash, protein, crude lipid and crude fiber.

2.6 Mineral content

Analysis of minerals in unfermented, locally fermented and laboratory fermented condiments were performed in triplicate according to methods described by Anhwange*et al.* (2006) and Walinga *et al*. (1989). The investigated minerals include Phosphorus, Potassium, Sodium, Calcium and Magnesium. Phosphorus was determined using Spectrophometer (JENWAY 6100) at 660 □ (wavelength), Potassium, Sodium was determined using flame photometer (Corning 400 Essex. England), determination of calcium and Magnesium was performed by ethylene diamine tetra acetic acid (EDTA) Titration Method.

2.7 Isolation of the fermenting microorganisms

The isolated microorganisms involved in the fermentation of the legumes for fermented Daddawa production using traditional methods were used as starter culture.

2.8 Laboratory Fermentation of Locust Bean

The dried seeds of African locust bean was cooked in a pressure pot for about 2 hours and the hard seed was removed during washing.The cotyledons were boiled for another 30 minutes and drained in a sieve. Fifty (50 g) grams of boiled dehulled seeds were weighed into small plastic buckets with air tight cover and sterilized 0.5ml of inoculum was be used to inoculate the cooked beans. The inoculated beans was incubated at 37 ^{0}C for 40 hours. The experiments were carried out in triplicate (Amao, 2013).

2.9 Laboratory Fermentation of Soya Daddawa

Soybeans was cleaned and soaked overnight until they double in weight. The soaked soybeans was steamed at 115 ^{O}C for 60 min in an autoclave and cooled to room temperature. The cooled soybean was inoculated with Bacillus subtilis as a starter culture (106 CFU/g) and was incubated at 30 ^{O}C for 24 hours (Lee *et al.*, 2007).

2.10 Laboratory fermentation of Daddawan Botso

The same method used in traditional fermentation was also employed in laboratory production with some modification. Roselle seeds were cooked in pressure cooker for 4 hrs at temperature of over 100 ^{O}C. The seeds were allowed to cooled and inoculated with starter culture (both singly and in consortium) and incubated at 30 ^{o}C. After the first fermentation ash leachate was added and incubated again for 24 hours at 30 ^{O}C.

3. Results and Discussion

3.1 Results

The results of proximate compositions of unfermented seeds of *P. biglobosa*, *G. max* and *H. sabdariffa*are presented in **Table 1**. When compared among the unfermented seeds, the moisture, ash, lipid and fiber content was significantly ($p<0.0001$) lower in *P. biglobosa* compared with *G. max*. While the moisture and ash content was significantly ($p<0.0001$) observed to be higher in the unfermented seed of *G. max* when compared with *H. sabdariffa*, the lipid content was significantly ($p<0.0001$) higher among the unfermented seeds. It was further observed that the fiber content was not significantly ($p>0.0001$) in the unfermented seed of *H. sabdariffa* when compared with G*. max*, but significantly ($p<0.0001$) higher when compared with *P. biglobosa*. On the other hand, a significant ($p<0.0001$) decrease in the crude protein and carbohydrate content was observed in the unfermented seed of *G. max* and *H. sabdariffa*when compared with *P. biglobosa*. The unfermented seed of *G. max* was observed to have the lowest crude protein among the unfermented seeds.

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Table 1: Proximate Composition of Unfermented Seed of *P. biglobosa, G. max* and *H. sabdariffa*

Sample	Proximate composition (%)					
	Moisture	**Ash**	**Lipid**	**Fiber**	**Crude Protein**	**CHO**
Parkiabiglobosa	1.50±0.09^{a}	4.60±0.05^{a}	8.10±0.07^{a}	5.10±0.15^{a}	11.70±0.19^{a}	70.00±0.35^{a}
Glycine max	7.50±0.10^{d,d}	5.30±0.07^{d,d}	9.00±0.02^{d,d}	13.80±0.29^{d,ns}	9.00±0.25^{d,d}	62.10±3.00^{c,ns}
Hibiscus sabdariffa	4.60±0.05^{d}	4.30±0.10^{c}	10.30±0.03^{d}	13.60±0.10^{d}	10.70±0.32^{c}	61.10±0.20^{c}

Values are mean ± SD of three replicates. Mean value with different superscript letters in columns are significantly (p<0.05) different to one another (one-way ANOVA followed by Bonferroni's Multiple Comparison Test). ns: non-significant (p>0.05); b: significant (p<0.05); c: significant (p<0.001); d: significant (p<0.0001).

Table 2: Mineral Composition of Unfermented Seed of *P. biglobosa, G. max* and *H. sabdariffa*

Sample	Mineral composition (mg/kg)				
	Sodium	**Potassium**	**Calcium**	**Magnesium**	**Phosphorus**
Parkiabiglobosa	114.00±0.11^{a}	3923.30±0.38^{a}	0.90±0.03^{a}	5.10±0.15^{a}	4.10±0.29^{d}
Glycine max	475.00±0.16^{d,d}	2666.60±0.30^{d,d}	0.50±0.05^{d,b}	13.80±0.29^{d,ns}	6.80±0.20^{d,d}
Hibiscus sabdariffa	103.00±0.20^{d}	3433.30±0.40^{d}	0.40±0.03^{d}	13.60±0.10^{d}	5.30±0.25^{c}

Values are mean ± SD of three replicates. Mean value with different superscript letters in columns are significantly (p<0.05) different to one another (one-way ANOVA followed by Bonferroni's Multiple Comparison Test). ns: non-significant (p>0.05); b: significant (p<0.05); c: significant (p<0.001); d: significant (p<0.0001).

Table 3: Proximate Composition of Daddawa Produced by Local Fermentation of the Seeds of *P. biglobosa, G. max* and *H. sabdariffa*

Sample	Proximate composition (%)					
	Moisture	**Ash**	**Lipid**	**Fiber**	**Crude Protein**	**CHO**
Parkiabiglobosa	11.00±0.51^{a}	4.10±0.26^{a}	4.70±0.19^{a}	15.60±0.20^{a}	17.30±0.44^{a}	58.30±0.28^{a}
Glycine max	7.50±0.48^{d,ns}	7.90±0.20^{d,d}	5.30±0.22^{b,d}	18.54±0.12^{d,d}	13.20±0.40^{d,ns}	55.06±0.30^{c,d}
Hibiscus sabdariffa	7.80±0.05^{d}	15.30±0.25^{d}	3.00±0.15^{d}	12.80±0.18^{d}	13.00±0.50^{d}	35.90±0.20^{d}

Values are mean ± SD of three replicates. Mean value with different superscript letters in columns are significantly (p<0.05) different to one another (one-way ANOVA followed by Bonferroni's Multiple Comparison Test). ns: non-significant (p>0.05); b: significant (p<0.05); c: significant (p<0.001); d: significant (p<0.0001).

Table 4: Mineral Composition of Daddawa Produced by Local Fermentation of the Seeds of *Parkia biglobosa, Glycine max* and *Hibiscus sabdariffa*.

Sample	Mineral composition (mg/kg)				
	Sodium	**Potassium**	**Calcium**	**Magnesium**	**Phosphorus**
Parkiabiglobosa	60.80±0.30^{a}	5566.60±0.30^{a}	1.30±0.22^{a}	0.40±0.05^{a}	4.70±0.39^{a}
Glycine max	93.30±0.33^{d,d}	8333.30±0.40^{d,d}	1.20±0.18^{ns,b}	0.30±0.03^{b,d}	7.20±0.30^{d,ns}
Hibiscus sabdariffa	130.80±0.38^{d}	9433.30±0.35 ^{d}	0.50±0.20^{c}	0.80±0.01^{d}	7.40±0.34^{d}

Values are mean ± SD of three replicates. Mean value with different superscript letters in columns are significantly (p<0.05) different to one another (one-way ANOVA followed by Bonferroni's Multiple Comparison Test). ns: non-significant (p>0.05); b: significant (p<0.05); c: significant (p<0.001); d: significant (p<0.0001).

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Table 5: Proximate Composition of Laboratory Produced Daddawa from *P. biglobosa, G. max* and *H. sabdariffa* seeds

Sample	Proximate composition (%)					
	Moisture	Ash	Lipid	Fiber	Crude Protein	CHO
Parkiabiglobosa	11.50±0.04[a]	15.60±0.04[a]	11.30±0.33[a]	12.20±0.22[a]	14.70±0.12[a]	46.20±0.33[a]
Glycine max	10.30±0.03[d,d]	16.10±0.31[ns,d]	9.50±0.10[d,d]	11.50±0.20[b,ns]	17.70±0.19[d,d]	45.20±0.25[b,ns]
Hibiscus sabdariffa	6.60±0.10[d]	11.60±0.30[d]	11.80±0.13[ns]	11.30±0.17[c]	14.20±0.30[ns]	45.10±0.30[c]

Values are mean ± SD of three replicates. Mean value with different superscript letters in columns are significantly (p<0.05) different to one another (one-way ANOVA followed by Bonferroni's Multiple Comparison Test). ns: non-significant (p>0.05); b: significant (p<0.05); c: significant (p<0.001); d: significant (p<0.0001).

Table 6: Mineral Composition of Laboratory Produced Daddawa from *Parkiabiglobosa, Glycine max* and *Hibiscus sabdariffa* seeds

Sample	Mineral composition (mg/kg)				
	Sodium	Potassium	Calcium	Magnesium	Phosphorus
Parkiabiglobosa	236.20±0.01[a]	2566.70±0.15[a]	1.10±0.03[a]	0.50±0.07[a]	4.40±0.02[a]
Glycine max	83.30±0.05[d,d]	2333.30±0.03[d,d]	0.80±0.02[d,d]	0.30±0.05[ns,d]	7.80±0.10[d,d]
Hibiscus sabdariffa	66.70±0.09[d]	9966.60±0.07[d]	0.40±0.03[d]	1.40±0.02[d]	5.50±0.05[c]

Values are mean ± SD of three replicates. Mean value with different superscript letters in columns are significantly (p<0.05) different to one another (one-way ANOVA followed by Bonferroni's Multiple Comparison Test). ns: non-significant (p>0.05); b: significant (p<0.05); c: significant (p<0.001); d: significant (p<0.0001).

In the mineral composition of unfermented seed of *P. biglobosa*, *G. max* and *H. sabdariffa* (Table 2), *G. max* significantly (p<0.0001) have the highest amount of sodium, magnesium and phosphorus content among the unfermented seeds, but non significantly (p>0.05) amount was observed when compared with *H. sabdariffa*. While the potassium and phosphorus content was observed to be higher in *P. biglobosa* among the unfermented seeds, *G. max* was observed to cotained lower potassium when compared to the value of unfermented seed of *H. sabdariffa*.

The results of proximate compositions of Dawadawa' produced by fermentation of the seeds of *P. biglobosa*, *G. max* and *H. sabdariffa*are presented in Table 3. It was found that moisture, crude protein and carbohydrate content was significantly (p<0.0001) higher in *P. biglobosa* when compared with the Dawadawa' produced by fermentation of the seeds of *G. max* and *H. sabdariffa*. A non significant (p>0.05) amount of moisture and crude protein was observed in Dawadawa' produced by fermentation of the seeds of *G. max* and *H. sabdariffa*. In the ash content, *H. sabdariffa* was found to have the highest ash content among Dawadawa' produced by the fermented seeds. *G. max* on the other hand, was found to significantly (p<0.0001) contain higher lipid and fiber when compare with *P. biglobosa* and *H. sabdariffa*

The results of mineral compositions of *Dawadawa*' produced by traditional fermentation of the seeds of *P. biglobosa*, *G. max* and *H. sabdariffa* are summarized in Table 4. The results shows that *H. sabdariffa* significantly (p<0.0001) contain the highest amount of sodium, potassium, magnesium and phosphorus when compared with the *Dawadawa*' produced by traditional fermentation of the seeds of *P. biglobosa*. The results also indicate that the *Dawadawa*' produced by traditional fermentation of the seeds of *H. sabdariff*ais significantly (p<0.0001) higher than that of *G. max*, but the non signifant (P>0.05) result was observed in the amount of phosphorus when compared with the *G. max*. Additionally, calcium content *Dawadawa*' produced by traditional fermentation of the seeds of *P. biglobosa* was found to be higher than *H. sabdariffa*, but the non signifant (P>0.05) was observed when compared with *G. max*.

In the proximate compositions of Dawadawa' produced in the laboraotry (Table 5), the analysis shows that moisture, ash, lipid, fiber and carbohydrate content was significantly (p<0.0001, 0.01, 0.05) higher in *P. biglobosa*, but a non significant (p>0.05) amount was observed in ash, lipid and crude protein content when compared with Dawadawa' produced from *G. max* and *H. sabdariffa*. While *G. max* showed significant (p<0.05) higher amount of moisture, ash and crude protein, the content of fiber and carbohydrate produced was observed to be non significant (p>0.05) when compared with *H. sabdariffa*.

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The results of mineral compositions on the other hand shows that *Dawadawa*' produced in the laboraotry from *P. biglobosa* significantly ($p<0.0001$) contain higher amount of sodium and calcium when compared with *Dawadawa*' produced from *G. max* and *H. sabdariffa* (Table 4.6). In *Dawadawa*' produced from *G. max* was also observed to significantly ($p<0.0001$) contain higher sodium, calcium and magnesium when compared with *H. sabdariffa*. Additionally, *Dawadawa*' produced from *H. sabdariffa* was found to significantly ($p<0.0001$) contain more potassium and magnesium compared to *Dawadawa*' produced from *P. biglobosa* and *G. max*.

3.2 Discussion

Significant increase was recorded following traditional and laboratory fermentation of seeds. Ash content was found to increase in all the three seeds, this result is in agreement of Parkouda *et al*, (2008) who reported a substantial increase in ash content in fermented seeds of *H. Sabdariffa*. Moisture content also increased in all the three seeds, this is also in line with Parkouda *et al.*, (2008) who reported that moisture content increased in fermented seeds. The increase in moisture is probably due to the long cooking period. The result is also in agreement with the work of Antai and Ibrahim (1986) Ogunjobi *et al.,* (2005) and Jonathan *et al.*, (2011) who reported an increase in the moisture content of bambara nuts after fermentation. The result differs from the report of Omafuvbe et al (2004), who reported a decrease in the moisture content of African locust beans after 72 h of fermentation. Significant increase in crude protein was observed after traditional and laboratory fermentation of *Parkia biglobosa*, *Glycine max* and *Hibiscus sabdariffa* seeds. This increase in the crude protein of the products is in agreement with the works of Pelig-Ba (2009), Dakwa *et al.,* (2005), Azokpota*et al*., (2006), Antai and Ibrahim (1986) Ogunjobi *et al*., (2005) and Jonathan *et al.,* (2011). The increase in crude protein may be linked to the organisms involved in fermentation of the seeds.

Significant decrease ($p<0.001$) were found in lipid content of all the three (3) seeds after traditional fermentation, but there was an increase($p> 0.1$) in lipid content after laboratory fermentation. The progressive decrease in crude lipid during the fermentation for all the samples is expected because the fermenting organisms would breakdown the lipid into fatty acids which have been found to enhance the digestibility of the product in human body. This is also similar to the work of Odunfa (1985) who reported low fat content to be desirable, since high amounts of fatty acids in foods can cause rancidity there by making the food taste sour. However, this result is not in agreement with the work of Gernah*et al*., (2005) who reported an increase in fat content of iru during fermentation. The progressive increase in lipid content after laboratory fermentation of the seeds agrees with other findings (Ibrahim and Antai, 1986, Yaqoub*et al*, 2004, Bengaly*et al*, 2006, Parkouda*et al*., 2008) who reported an increase of lipid content during the fermentation of African locust beans for soumbala production.

There is sharp decrease ($p< 0.01$) in carbohydrate content in all the seeds after traditional and laboratory fermentation. The decrease may be due to the hydrolytic effect of microbial amylase converting the carbohydrate into sugars easily utilizable by the microorganisms during fermentation. Similar result was obtained by Gernah *et al*., (2005) after fermenting iru for 72 hours. Bacillus species are important sources of amylases therefore the high recovery rates of these organisms from the fermentation may account for their high amylase activity (Ogunshe*et al*., 2007) therefore leading to a reduction in the carbohydrate as fermentation progressed.

Similarly, fiber content has significantly increased($p> 0.001$) after traditional and laboratory fermentation of the seeds. Anhwage *et al.,* (2006) reported that the seeds of *H. Sabdariffa* contain an appreciable fibre content which falls within reported values (6-7%) for most legumes (Saddhuraju *et al*., 1998). However these values have been observed to increase after fermentation (Yaqoub *et al*., 2004,Bengaly *etal*., 2006)

Significant differences was recorded from mineral analysis of the seeds after traditional and laboratory fermentation. The significant variation in mineral content can be related to the type of soil from which the seed were harvested in the case of raw seeds and mainly to the addition of ash leachate for the fermented seeds (Parkouda *et al.,* 2008). Infact, the amount and type of the alkalinizing leachate to be added as well as the precise step during the process where it should be added varied significantly from one producer to another according to the organoleptic characteristics expected (Parkouda *et al.,* 2008). Harper and Collin (1992) reported that dried leachate of ash from sorghum is largely composed of potassium bicarbonate with smaller quantities of potassium chloride, silicate and sulphate, explaining then the reason for the increase and the large variation for some minerals especially potassium. Leachate from other plants might be composed differently by large amount of other alkalinizing compounds as sodium, calcium, iron derivates leading then to different mineral content and balance. Another origin of minerals could be attributed to the fermentation recipients (Harper and Collin, 1992). Calcium was found to

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be the second highest mineral increased after fermentation for all the samples. Similar result was obtained by Aremu *et al.,* (2006) on *P. Africana* flour.

4. Conclusion

The traditional production of most fermented condiment is a laborious and time consuming process. These condiments have been meeting the nutritional needs of the low and average income earners for centuries. In this research, fermentation was found to increase the lipid value for the three seeds range from 8.10±0.07 to 10.30±0.03% with *H. Sabdariffa* having the highest value. The crude protein value was in the range 9.50±0.25 -11.70±0.19%. Potassium was the highest mineral and the value increased in the fermented seeds to a range of 5566.6±0.30 to 9433.3±0.35% and *H. sabdariffa* had the highest value of 9433.3±0.35%. The concentration of magnesium did not increase even after the fermentation of the seeds with a range of 0.3±0.03 to 0.8±0.01%.

Conflict of Interest

The author declares that there is no conflict of interest.

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