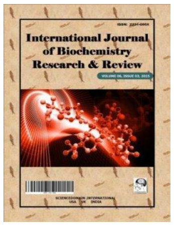

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Proximate and Antinutrient Composition of Some Local Food Condiments in Their Raw and Fermented Forms

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Authors' contributions

This work was carried out in collaboration between both authors. Authors MNN and MDS designed the study, wrote the protocol and wrote the first draft of the manuscript. Author MNN managed the analyses of the study, managed the literature searches and performed the statistical analysis. Both authors read and approved the final manuscript.

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ABSTRACT

Aim: The aim of this study was to survey the proximate and anti-nutrient components of some local food condiments and their seeds.

Study Design: Ability to compare the nutrient and anti-nutrient components in some local food condiments after processing. Five (5) samples in their raw and fermented forms were used for the study. The samples are *Parkia biglobosa*, oil bean seed, Sorel been seed, soybean and African locust bean.

Study Area: Department of Biochemistry, University of Jos, Nigeria and National Veterinary Research Institute (NVRI), Vom, Plateau State. The study was carried out between March, 2016 to October, 2016.

Methodology: Analysis on the proximate and anti-nutrient parameters was conducted using methods described by AOAC (Association of Official Analytical Chemicals).

Results: The results show that fermented Oil bean seed (Ugba) had the highest moisture content and crude fibre (46.16±0.58) and (27.63±0.35) respectively while fermented *Parkia biglobosa* (Okpehe) had the highest content of crude protein (54.50±0.06). Fermented sorel bean seed

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(dawadawa botso) had the highest content of crude fat, Ash, Calcium and phosphorus (46.83±0.03), (7.69±0.04), (0.87±0.35) and (0.33±0.15) respectively while raw soybean dawadawa had the highest content of nitrogen free extract (NFE) (24.26±0.30).
Raw *Parkia biglobosa* (Okpehe) had the highest content of tannin (10.45±0.52) while raw African locust bean dawadawa had the highest content of the anti-nutrients; oxalate and phytic acid (164.99±0.06 and 44.51±0.06) respectively.
Conclusion: The results of this study suggest that fermentation improved the proximate components of these local food condiments and also significantly ($P<0.05$) reduced their anti-nutritional concentration.

Keywords: Parkia biglobosa; oil bean seed; sorel bean; soybean seed; African locust bean; fermentation; proximate; antinutrient.

1. INTRODUCTION

Local food condiments (*okpehe, soybean dawadawa, sorel bean dawadawa, locust bean dawadawa and ugba*) consumed by different ethnic groups in Nigeria have been the pride of culinary traditions for centuries. It is evident that these products have played a major role in the food habits of communities in the rural regions serving not only as a nutritious non-meat proteins substitute but also as condiments and flavouring agents in soups [1]. These condiments are being increasingly marketed throughout the country and beyond in informal ways. Differences in the chemical composition of local condiments are evident mainly because different ingredients have been used in their preparation. Traditional method of manufacture has taken advantage of biotechnological progress to assure reasonable quality and at the same time assure safety of these products. Fermented condiments often have a stigma attached to them; they are often considered as food for the poor.

Food plants are the most important dietary sources for meeting the nutritional needs of majority of the population in Nigeria [2]. A variety of plant foods are consumed in Nigeria. However, where the food is in abundance and the choice wide, men eat first for palatability and nutritional value. Of all durable plants, legumes represent the most effective source of vegetable and provide a significant portion needed in many parts of the world [3]. These differences are related in part to ethnic backgrounds, customs and traditions. [4,5] also indicated that in spite of the variety and diversity in diets, malnutrition would only be curbed if indigenous food production, capacity and knowledge of the nutritional value of some local foods and their /production improved drastically. Some of these local foods include seasonings. Over 500 seasonings are made up from plants; some are cultivated while some grow wild.

Despite the huge nutritional values and availability of local food condiments such as Oil bean seed, *Prosopis africana*, locust bean seed, sorel seeds and soybeans as food condiments, some developing countries like Nigeria require more information on the needs for increasing their utilization. Most of the consumers do not know much about the nutritional values; therefore use them as functional ingredient in foods for the purposes of tastes or aromatic characteristics.

Nutritionally, the main effects of processing are detoxification, increasing palatability and bioavailability of nutrients. However, there are still other individual effects caused by specific process [6].

Hence strong emphasis on the nutritional and antinutritional values of “ugba” Oil bean seed, “okpehe” *Prosopis africana,* “dawadawa” locust bean seed, “dawadawa” soybeans and “dawadawa botso” sorel seed are required in Nigeria so as to reduce the intake of industrial seasoning such as maggi.

2. MATERIALS AND METHODS

2.1 Sample Collection

The raw and fermented forms of okpehe, soybean dawadawa, sorel bean dawadawa and locust bean dawadawa used for the study were bought from Tildey market along bauchi. Also both the raw and fermented forms of ugba were bought from Chobe market in Jos. Both the raw and fermented forms of the samples were taken to National Veterinary Research Institute (NVRI), Vom in Plateau State for proximate and antinutrient analysis. The samples were kept under room temperature until analysis.

2.2 Proximate Analysis of Raw and Processed Samples

The method used for proximate composition analysis was the AOAC method (2000) [7].

Proximate analysis has to do with partitioning of compounds in a feed into six categories based on their chemical properties. The proximate constituents determined during the analysis are as follows: moisture, ash, crude protein (or Kjeldahl protein), crude lipid, crude fibre and nitrogen-free extracts (digestible carbohydrates).

2.3 Antinutrient Composition of Raw and Processed Samples

Tannins, oxalates and phytic acids were determined in the raw and processed samples. The method used in phytic acids and oxalates determination was the AOAC method (1990) [8] while the Joselyn's method was used in tannin determination.

2.4 Statistical Analysis

The data obtained were expressed as mean ± standard deviation (n=3). One-way analysis of variance was used to test for the difference in means. Post-Hoc test using Duncan Multiple Range Test (DMRT) was used to test for the means that are significantly different from each other at ($P<0.05$), which are presented by alphabets in superscripts using the SPSS for Windows.

3. RESULTS

3.1 Proximate Composition of the Raw and Fermented Samples

The mean proximate compositions of raw and fermented forms of soybean dawadawa, African locust bean dawadawa (*Parkia biglobosa)*, okpehe *(Prosopis africana)*, *Cassia sieberiana* Seeds (Dawadawan botso) and oil bean seed (Ugba) are presented in Tables 1 and 2 respectively.

Moisture content had significant difference ($p<0.05$) in all the samples (soybean dawadawa, African locust bean dawadawa, okpehe, dawadawa botso and oil bean seed) after fermentation. Fermented oil bean seed (ugba) had the highest moisture content (46.16±0.58).

Also there were significant differences in crude protein content in all the samples (soybean dawadawa, African locust bean dawadawa, okpehe, dawadawa botso and oil bean seed). The fermented okpehe had the highest content of crude protein (54.50±0.06).

It was also observed that there were significant differences in crude fibre content in all the samples (soybean dawadawa, African locust bean dawadawa, okpehe, dawadawa botso and oil bean seed). Fermented Oil bean seed (Ugba) had the highest content of crude fibre (27.63±0.35).

Significant differences were also observed in crude fat content in all the samples (soybean dawadawa, African locust bean dawadawa, okpehe, dawadawa botso and oil bean seed). Fermented sorel bean seed (dawadawa botso), had the highest content of crude fat (46.83±0.03).

There were significant differences in Ash content in all the samples (soybean dawadawa, African locust bean dawadawa, okpehe, dawadawa botso and oil bean seed). Fermented sorel bean seed (dawadawa botso) had the highest Ash content (7.69±0.04).

Also, the nitrogen free extract (NFE) content significantly differed ($p<0.05$) in all the samples after processing (soybean dawadawa, African locust bean dawadawa, okpehe, dawadawa botso and oil bean seed). Raw soybean dawadawa had the highest content of NFE (24.26±0.30).

There were significant differences in calcium content in all the samples (soybean dawadawa, African locust bean dawadawa, okpehe, dawadawa botso and oil bean seed). Fermented sorel bean dawadawa (dawadawa botso) had the highest calcium content (0.87±0.35).

Also significant differences were observed in phosphorus content of all the samples (soybean dawadawa, African locust bean dawadawa, okpehe, dawadawa botso and oil bean seed). Fermented sorel bean seed (dawadawa botso) also had the highest phosphorus content 0.33±0.15.

Carbohydrate content in all samples differed significantly ($p<0.05$) after fermentation.

3.2 Antinutrient Compositions

The mean antinutrient composition of raw and fermented forms of soybean dawadawa, African locust bean dawadawa (*Parkia biglobosa)*, okpehe *(Prosopis africana)*, *Cassia sieberiana* seeds (Dawadawanbotso) and Oil bean seed (Ugba) are presented in Tables 3 and 4 respectively.

Tannin content differed significantly ($p<0.05$) in soybean dawadawa, okpehe, oil bean seed, dawadawa botso and African locust bean dawadawa after fermentation.

There were also significant differences in Oxalate content also ($p<0.05$) in soybean dawadawa, African locust bean dawadawa, okpehe, dawadawa botso and oil bean seed after fermentation.

It was also observed that phytic acid content differed significantly in soybean dawadawa, okpehe, dawadawa botso, African locust bean dawadawa and oil bean seed dawadawa.

Raw African locust bean dawadawa had the highest content of anti-nutrients; oxalate and phytic acid i.e. 164.99±0.06 and 44.51±0.06 respectively while raw *Parkia biglobosa* (Okpehe) had the highest content of tannins (10.45±0.52).

4. DISCUSSION

4.1 Proximate Composition

The proximate composition indicates that moisture content of all the processed samples were higher when compared with the raw samples. The increase in moisture content of these fermented food condiments may be due to the hydrolytic activity of the fermenting of the cotyledons. It is also believed to be likely due to the hydrolytic activity of the fermenting organisms on the substrates releasing moisture as part of their metabolic products. The high moisture content may make the condiments highly vulnerable to microbial attack and reduce their shelf-life during storage. Low moisture in the raw samples will increase the shelf-life for longer storage periods especially when out of seasons.

Crude protein content appeared to be lower in the processed local food condiments except okpehe and oil bean seed. The crude protein content is dependent on the processing method [9]. High content of crude protein in okpehe and oil bean seed may have been enhanced due to the processing method used which include soaking, boiling/cooking and fermentation. The increase observed may also be due to the ability of the organisms to secrete extracellular protease during the fermented process [10]. Also, the multiplication of the fungi in the form of single cell protein could also contribute to the increase in the protein contents of these condiments [11]. The decreased protein contents in fermented soybean dawadawa, African locust bean and dawadawan botso has been observed in other local condiments [12,13]. This reduction may be due to denaturation/leaching of the protein in the cooked samples.

The crude fat and crude fibre contents are higher in fermented soybean dawadawa and oil bean seed. The high crude fat content may be attributed to the increase activities of lipolytic enzymes which hydrolyse fat to glycerol and fatty acid. In the studies of Eka [14] on the effect of fermentation on the nutrient content of locust beans, it was reported that protein and fat increased when fermented which is nearly similar to our present study, as increased crude fat content was observed in African locust bean.

Studies have shown that dietary fibre has a number of beneficial effects such as maintenance of internal distention in the intestine tract, help in protection against colon cancer and also help to prevent constipation [15].

The decreased crude fibre contents observed in fermented dawadawan Botso, African locust bean and okpehe as well as decreased carbohydrate contents observed in all the food condiments in their fermented form could be due to the ultilisation of some of the sugars by the fermenting organisms for growth and metabolic activities. These observations are consistent with the report of [16] during oil seeds fermentation.

Ash content increased significantly in the fermented dawadawan botso may indicate that the fungi had peculiar role they play via biosynthetic or hydrolytic mechanisms to increase the inorganic mineral elements in the fermented form of this condiment (dawadawa botso). The lower amounts of ash content present in the fermented African locust bean, soya bean dawadawa, okpehe and oil bean seed may be attributed to the loss of minerals during fermentation processes which result from the stimulator effects of cooking and leaching [17].

The calcium concentration decreases in African locust beans and oil bean seed. This decrease may be due to leaching during fermentation or because of the utilisation of the compound by the fermenting organisms. Calcium concentration was higher in processed dawadawa botso, okpehe and oil bean seed, and calcium in conjunction with other mineral is involved in the formation of bone. Calcium is also very vital in blood clothing, muscle contraction and in certain enzymes in metabolic processes.

Nitrogen free extract (NFE) which represents the total carbohydrate contents is higher in the raw samples when compared with the fermented samples in this study except dawadawa botso, however with no significant difference. This may be attributed to amylase and sucrose by the fermenting microorganisms which hydrolyse carbohydrates into sugars. This concurs with the studies of [18].

4.2 Antinutrient Composition

Anti-nutrients contents which include tannins, oxalate and phytic acid reduced in all the fermented samples in this study. The decrease in anti-nutrient content may be attributed to leaching into the cooking water [19]. This reduction may also be due to the activities of the indigenous microbes as well as processing, and the activities of some indigenous enzymes that degrade these anti-nutrients. The general significant reductions observed in the anti-nutrient contents after fermentation had been observed by many investigators in other substrates [20,21]. The decrease in the phytic acid content of the processed samples could be due to secretion of phytase by fungi thereby hydrolyzing the phytic acid [22]. Tannins bind to proteins, carbohydrates and minerals.

Table 1. Mean proximate composition (g/100 g) of raw and fermented soybean Dawadawa, African locust bean Dawadawa and Okpehe

Parameters	Soybean dawadawa		African Locust bean		Okpehe *(Parkia biglobosa)*	
	Raw	Fermented	Raw	Fermented	Raw	Fermented
Moisture	6.28±0.10	22.83±0.76[a]	7.85±0.05	24.66±0.06[a]	10.17±0.08	30.92±0.36
Crude Protein	39.05±0.50	34.65±0.58[a]	32.76±0.21	31.38±0.06[a]	28.28±0.60	54.50±0.06[a]
Crude Fibre	13.13±0.28	20.96±0.51[a]	17.37±0.32	15.17±0.15[a]	9.20±0.06	2.66±0.06[a]
Crude Fat	10.97±0.18	17.64±0.38[a]	13.90±0.50	26.28±0.05[a]	38.93±0.03	4.90±0.05[a]
Ash	5.70±0.27	3.53±0.08[a]	5.60±0.10	2.42±0.06[a]	4.20±0.05	4.73±0.04[a]
NFE	24.26±0.30	0.03±0.01[a]	22.48±0.08	0.03±0.02[a]	14.26±0.05	2.21±0.06[a]
Calcium	0.35±0.05	0.38±0.15[a]	0.38±0.05	0.30±0.05[a]	0.38±0.05	0.45±0.06[a]
Phosphorus	0.12±0.02	0.13±0.01[a]	0.09±0.05	0.20±0.10[a]	0.004±0.002	0.27±0.04[a]
Carbohydrate	24.87±0.10	0.39±0.02[a]	22.52±0.27	0.09±0.12[a]	9.22±0.03	2.29±0.31[a]
Energy (Kcal)	354.41	298.92[a]	346.22	362.40[a]	500.37	271.26[a]

Values (mean ± standard deviation of triplicate determinations) with same superscripts in a row (Raw and Fermented samples) are significantly (p<0.05) different. Where a = significantly different when compared to the values of Raw.

Table 2. Mean proximate composition (g/100 g) of raw and fermented Dawadawan Botso and oil bean seed (Ugba)

Parameter	Dawadawan Botso (*Cassia sieberiana*)		Oil bean seed (Ugba)	
	Raw	Fermented	Raw	Fermented
Moisture	6.19±0.20	7.39±0.09[a]	20.26±0.06	46.16±0.58[a]
Crude Protein	25.48±0.47	19.47±0.05[a]	3.78±0.55	14.1±0.20[a]
Crude Fibre	23.41±0.25	18.59±0.07[a]	22.87±0.32	27.63±0.35[a]
Crude Fat	38.56±0.06	46.83±0.03[a]	9.44±0.36	11.13±0.02[a]
Ash	6.20±0.05	7.69±0.04[a]	2.81±0.08	0.73±0.03[a]
NFE	0.03±0.01	0.03±0.02[a]	12.35±0.13	0.02±0.02[a]
Calcium	0.28±0.05	0.87±0.35[a]	0.28±0.03	0.22±0.03[a]
Phosphorus	0.14±0.05	0.33±0.15[a]	0.07±0.02	0.027±0.002[a]
Carbohydrate	0.16±0.03	0.04±0.21[a]	40.84±0.001	0.25±0.25[a]
	449.60	499.51[a]	263.44	157.57[a]

Values (mean ± standard deviation of triplicate determinations) with same superscripts in a row (Raw and fermented samples) are significantly (p<0.05) different. Where a = significantly different when compared to the values of Raw

Table 3. Mean anti-nutrient composition (mg/100 g) of raw and fermented soybean Dawadawa, African locust bean Dawadawa and Okpehe

Parameters	Soyabean dawadawa		African Locust bean		Okpehe*(Parkia biglobosa)*	
	Raw	Processed	Raw	Processed	Raw	Processed
Tannins	5.36±0.06	2.18±0.07[a]	8.51±0.04	6.05±0.05[a]	10.45±0.52	2.44±0.04[a]
Oxalate	114.99±0.52	50.00±0.50[a]	164.99±0.06	84.99±0.07[a]	125.00±0.50	60.00±0.50[a]
Phytic Acid	21.46±0.04	16.44±0.05[a]	44.51±0.06	15.28±0.05[a]	13.71±0.05	12.55±0.05[a]

Values (mean ± standard deviation of triplicate determinations) with same superscripts in a row (Raw and Fermented) are significantly (p<0.05) different. Where a = significantly different when compared to the values of Raw

Table 4. Mean anti-nutrient composition (mg/100g) of raw and fermented Dawadawan Botso and oil bean seed (Ugba)

Parameters	Dawadawan Botso (*Cassia sieberiana)*		Oil Bean Seed (Ugba)	
	Raw	Processed	Raw	Processed
Tannins	3.51±0.05	3.24±0.05[a]	6.25±0.05	3.23±0.05[a]
Oxalate	80.06±0.05	35.00±0.50[a]	90.23±0.25	84.99±0.01[a]
Phytic Acid	17.80±0.05	10.04±0.05[a]	13.92±0.04	20.10±0.05[a]

Values (mean ± standard deviation of triplicate determinations) with same superscripts in a row (Raw and Fermented) are significantly (p<0.05) different. Where a = significantly different when compared to the values of Raw

Tannins concentration decrease generally in the processed samples in this study. Fermentation is one of the processes that can be used to reduce the negative effects of tannins [23].

In general, the reduction in anti-nutrient is due to the fact that fermentation is usually preceded with soaking, hydration and cooking of the raw seeds; and these processes have reduction effects on the level of anti-nutritional factors in fermented food products. These findings concur with the report of other investigators [24-26].

5. CONCLUSION

The results obtained from the present study showed that soybean dawadawa, African locust bean, okpehe, dawadawan botso and oil bean seed have good nutritional profile levels. Fermentation as a way of food processing improves nutritional quality, shelf life of food and enhances sensory qualities of food. Fermentation reduced the level of anti-nutrients in the local food condiments in this study. However; some quantity of the nutrients could still not be available due to the presence of the anti-nutrients. For example, oxalate, tannin and hydrogen cyanide will negatively affect the mineral level (ash), carbohydrate and nitrogen free extract. This can be attributed to the unavailability of these nutrients. Phytic acid negatively affects protein content, lipid and fibre. This is likely to explain why processing/fermentation seems not, in some cases, to increase the level of nutrients. Notwithstanding, in view of the nutrient availability, low antinutrient content and high level of proteins present in these samples after fermentation could be used as alternative source of protein in the diet/protein supplement especially in okpehe and oil bean seed.

The values for each parameter checked may be lower or higher than other values reported in other studies. These variations may be due to different species of these local food condiments seeds used, the climate and environmental conditions which plant grow.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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