NUTRITIONAL QUALITY OF DRIED FERMENTED LOCUST BEAN (*PARKIA BIGLOBOSA*) AND SORREL SEEDS (*HIBISCUS SABDARIFFA L*) CONDIMENTS

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Abstract: The study was conducted to determine the nutritional quality of dried fermented locust bean (*Parkia biglobosa*) and sorrel seed (*Hibiscus sabdariffa* L) condiments. *Hibiscus sabdariffa* (sorrel) is one of the most important and popular medicinal plant with high nutritional potential. In this work, the seeds were used in producing a food condiment to evaluate its acceptability and further usage as a substitute to replace popular locust bean which is almost going extinct. Proximate compositions, mineral, anti-nutrient and sensory analysis were determined using standard methods The values for carbohydrates was (67.30%), fibre (11.75%), moisture (8.41%), and ash (4.18%) than those from fermented sorrel seed condiments (19.32%, 2.14%, 6.25%, and 3.27% respectively). While fat (38.4%), protein (30.58%), and values from the fermented sorrel seed were higher than that of locust bean (1.8% and 21.35% respectively). Also the minerals values in the fermented locust bean seed recorded higher values from calcium, phosphorus, and (sodium (2.31mg/100g, 0.175mg/100mg, 0.34mg/100g) than sorrel seed. While sorrel seed samples were higher in iron (2.19mg/100g) and zinc (1.65mg/100g).The samples for fermented locust bean condiment were significantly ($p<0.05$) higher than the sorrel seed. The anti-nutrient content of the samples were higher in the locust bean than sorrel seed. The values from locust bean were (18.00mg/100g, 4.86mg/100g, 60.00mg/100g, and 17.80mg/100g) for tannin, oxalate, phytate and saponin respectively. While the sorrel seed recorded the following; tannin (21.42mg/100g) oxalate (0.091mg/100g), phytate (3.62mg/100g), and saponin (1.04mg/100g). The values from Locust bean condiment was preferred over sorrel seed condiment in all the parameters evaluated. There were significant differences in all the parameters ($p<0.05$). The significant difference in overall acceptability can be attributed to the consumers being accustomed to the conventional fermented locust bean found in the market.

Keywords: Fermented, locust bean, sorrel seed, fermented food condiment, anti-nutrient.

Introduction

Fermented foods are palatable products, which are prepared from raw or heated materials and acquire their characteristic properties by a process that involves microorganisms (Osuntokun *et al.,* 2020). The foods fermented represent 10 to 40% of the global diet, and represent a cultural and gastronomic heritage of high value and constitute a significant components in Africa (Talon and Zagorec, 2017; Olasupo and Okorie, (2019). Studies have revealed that microorganisms such as various beneficial fungi and probiotic bacterial species present in these fermented foods significantly enhance numerous health conditions (Abrar and Jaffri, 2023). Fermentation being it indigenous or after addition of starter cultures has been proven to be beneficial. Food stability, storage and food losses; which could have emanated if left unprocessed. Fermentation also improved nutritional value and flavour of the food product, improved sensory properties and digestibility (Dosumu, 2012).

African locust bean *(Parkia biglobosa*) is a legume tree that belongs to the family MIMOSOIDEAE. It has been recognized widely long ago as an important indigenous multipurpose fruit tree with numerous uses ranging from food, medicine, manure, tannin, shade, windbreaks, bee food, livestock feeds, fuel, fibre, condiment and several other domestic uses (Aremu *et al.,* 2015). African locust bean, as it is commonly known, are the mature seeds that come from the parkia pods. The pods are harvested and processed into the fermented condiment product known as 'Iru', 'Daddawa' 'nune' and 'ogiri' in Yoruba, Hausa, Tiv and Igbo Languages respectively in Nigeria (Aremu, *et al.*, 2015). The tree is grown predominantly in the Northern states of Nigeria. The seed is very important for food security particularly during food shortage and drought periods.

Sorrel (*Hibiscus sabdariffa* L) is an annual plant which is grown widely in the northern part of Nigeria, with promising nutritional potential (Ilyas *et al.*, 2021). It is one of the under-utilized food crops of Nigeria. The different parts of the plant appear to have potentials exploitation by the food processing industry (Ashaolu, & Adeyeye, 2022). Sorrel is one of the most important and popular medicinal plant which has several properties and uses including calyces, seeds, leaves and roots. The leaves are used for making soup and the calyxes for making the popular non-alcoholic beverage "Zoborodo".The products from the seeds can be used as food condiments, coffee, essential oil, porridge, animal feed, oily soups, and sauces. It is one of the most important and popular medicinal plant which has several properties. The seed is a valuable food resource on account of its protein, calorie, fat and also substantial amount of fibre and valuable micro-nutrients and medicinal uses (Omenna *et al.*, 2023; Atta *et al*., 2013). However, in Nigeria larger quantities of the seeds of this crop are wasted on the farm annually and just a small quantity is being collected and stored for planting (Idoko, *et al.,* 2020). The seeds are subjected to a solid-state fermentation process for the production of food condiment called "Furudu" in Sudanbikalga (Burkina Faso), daddawabotso (Niger and Nigeria), datou (Mali), and mbuja (Cameroon) (Bell, Guina

& Fernandes,2023). However, only few published studies have been done on the fermented seeds.

Food condiments are products usually derived from the fermentation activities of microorganism on vegetables prophet of legumes oil seeds origin. They are substances that are added in small quantities to add flavour or as a seasoning to soups, stews to give it a better taste (Ajayi, 2014). Food condiments are widely consumed in African setting most especially Nigeria which is commonly made from fermented locust bean and soybean which has been proven to be rich in protein and minerals (Tersoo-Abiem *et al.*, 2021).

Much has not been documented about the fermented sorrel seed condiments in most part of Nigeria. Therefore, this research work was aimed at producing 'daddawa from sorrel seeds to assess its quality to see how it can complement the popularly locust beans which is at verge of going extinct. Therefore, this study is aimed to evaluate the nutritional quality of dried fermented locust bean (*Parkia biglobosa*) and sorrel (*Hibiscus sabdariffa L*) seeds condiments.

Materials and Methods

Source of Materials

Dry white sorrel seed and locust beans seed were purchased from Wurukum market a local market in Makurdi Benue State.

Sample Preparation

About 4kg of the locust beans seeds were cleaned of debris, washed and put in a metallic pot. The pot was placed on a tripod stand having firewood as a source of heat. The timing of the cooking started at the point of boiling which lasted for two hours, and the pot was brought down from the fire, and was drained immediately after cooking and was allowed to cool for 30 minutes and after, the seeds were dehulled. The dehulled seeds were washed and cooked for another 1hour. The water was drained immediately after cooking and the seeds were packed in sterile nylons and were allowed natural fermentation to take place. The fermentation process lasted for 120 hours (5 days). The fermented locust bean seeds were sundried and pound with mortar and pestle to produce fermented flour. The same preparation method was carried out for the sorrel seeds.

Chemical Analysis

Proximate Composition (moisture, crude protein, crude fat, ash, crude fibre and carbohydrate contents) of the dried fermented locust bean and sorrel seed condiments were determined according to the methods described by (Association of Official Analytical Chemists, (AOAC, 2012).

Minerals (Iron, Sodium Calcium, Magnesium, Phosphorus and Potassium contents) were analyzed using atomic absorption spectrophotometer as described by (AOAC, 2012).While Zinc was determined by the method described by (Pearson, 1997). The anti-nutrients were determined employing the method describe by (Latta and Eskin, 1980) in determining phytates, AOAC, (2012) methods were used in determining oxalates and saponin, while tannins was analyzed using the method described by (Kirk and Sawyer,1998).

Sensory Evaluation

The condiments were used and prepared a common soup" Okoho" which was prepared traditionally and was served to a 20-member semi-trained panel that were familiar with the soups so as to evaluate such attributes as colour, taste, flavor, texture and overall acceptability based on a 5-point hedonic scale (Umoh and Iwe,2022).

Statistical Analysis

Data obtained was analyzed using Statistical Package for Social Sciences (SPSS) version 20.0 and result presented as means and standard deviation. T-test was used to compare the means between the two samples. Significant difference was accepted at $p < 0.05$.

Results and Discussion

Proximate composition of fermented locust bean and sorrel seed condiments

Table1 presented result for the proximate composition of fermented locust bean and sorrel seed condiments. The samples for fermented locust bean condiment for carbohydrates (67.30%), fibre (11.75%), moisture (8.41%), and ash (4.18%) were higher than those from the fermented sorrel seed condiments (19.32%, 2.14%, 6.25%, and 3.27% respectively). While (fat (38.4%), protein (30.58%), and values from the fermented sorrel seed were higher than that of locust bean (1.8% and 21.35% respectively). The carbohydrates contents as presented in the current study (67.30% and 19.32%) of both fermented locust bean and sorrel seed were higher than the values reported by (Osuntokun *et al.,* 2020) (24.2%), (Tersoo-Abiem *et al.,* 2021), (20.62%) and Owusu-Kwarteng *et al.,* 2022) (13.7%), (Makanjuola and Ajayi, 2012) (17.00%) respectively which indicates that the seed are high in carbohydrate. A high carbohydrate food is desirable while deficiency of it causes depletion of body tissues (Akpi *et al.,* 2023). Carbohydrate is a source of fuel to the body and consumption of these seed will yield more energy to the body. The fibre content obtained from the study for both condiments were higher compared to the values reported (Omodara and Olowomofe, 2015) (6.49%) and (Ari *et al.,* 2015) (6.16%) and (Hafeez, 2023) (17.33%) for sorrel seed. Fibre helps in binding saturate fats, low density, lipoprotein, cholesterol and triglycerides thereby regulate serum and fibre in food stimulates bowel movement and prevents constipation (Khalid *et al.,* 2022).

The moisture level of the condiments from locust bean were (8.41%) and sorrel seed (6.25%) which were below 18.435 and 8.24% as reported by (Akinoso and El-alawa,2013; Owusu-Kwarteng *et al.,* 2022; Ibrahim, Sani and Shinkafi, 2011) (15.00%). The low moisture content may be due to environmental and genetic factors and also the method employed during the processing. It also shows indication of improved shelf stability at ambient temperature (Onyeke, 2015). Earlier studies have shown that moisture content increased in fermented seeds probably due to the cooking period (Owusu-Kwarteng *et al.,* 2022). There was slight decrease in ash content of both fermented locust bean and sorrel seed condiment (Tersoo-Abiem, 2021) (6.21%) and (Osuntokun *et al.,* 2020) (4.55%). This may be due to processing method and period of fermentation and also loss of dry matter due to increased activity of the protease, lipase and pectinase enzymes

which may led to the reduction (Yang *et al.*, 2022; Dwivedi *et al.*, 2022).

The result obtained in the current research for fat from the fermented locust bean is contrary to what was reported by Makanjuola and Ajayi, (2012) and (Tersoo-Abiem,2021). The values obtained for sorrel seed were higher (38.4%) compared to (Ibrahim, Sani and Shinkafi, 2011). (17.17%). The sorrel seed is an oil seed and this might be the reason for the high fat value. Fermentation caused increase in fat content of the food. To confirm this increase, other researchers also reported increase in the lipid content of H. *sabdariffa* seed during fermentation for the production of 'Bikalga' (Ouangraoua *et al.*, 2022) and for furundu production (Afeez, 2023). The protein content obtained in the fermented locust bean is lower compared to what has been reported by (Umoh and Iwe, 2022) (37.34%) while a higher value was obtained from sorrel seed against the value (Ari *et al.*, 2015) (23.20%). These variations maybe as a result of species used and environmental factors. Protein in food generally helps in fighting protein malnutrition in communities where is prevalent. It is also a quality to measure the usefulness of a food for the growth and maintenance of tissue. Sorrel seed contains the highest amount of protein which is a little higher than locust bean seed indicating that both seeds are rich in protein.

TABLE 1: Proximate Compostion of Fermented Locust Bean and Sorrl Seed Condiments

Samples	Moisture (%)	Ash (%)	Protein (%)	Fibre (%)	Fat (%)	Carbohydrate (%)
Samples A	8.41±0.01[a]	4.18±0.12[a]	21.35±0.07[a]	11.75±0.20[c]	1.80±0.01[a]	67.30±0.23[a]
Samples B	6.25±0.01[a]	3.27±0.00[b]	30.58±0.11[a]	2.14±0.00[c]	38.4±0.01s[a]	19.32±0.12[d]

Table 2: Mineral Composition of Fermented Locust Bean and Sorrel Seed Condiments

Sample	Sodium	Iron	Calcium	Phosphorus	Magnesium	Zinc
Sample A	0.34±1.22[a]	0.14±0.07[a]	2.31±8.96[a]	0.18±0.25[a]	0.17±0.14[a]	0.20±0.6[a]
Sample B	0.29±0.01[a]	2.19±0.00[b]	0.44±0.00[a]	0.66±0.00[c]	0.24±0.04[a]	1.65±0.00[a]

Values are means ± standard deviation of triplicate determinations. Means in same column with p-value less than 0.05 are significantly different ($p<0.05$). Sample A = Dried Fermented Locust bean Condiment, Sample B = Dried Fermented sorrel seed Condiment

Mineral composition of fermented locust bean and sorrel seed condiments

The minerals values in the fermented locust bean seed had higher values of (2.31 mg/100g) for calcium, (0.175 mg/100mg) phosphorus, (0.34 mg/100g) sodium, than sorrel seed. While sorrel seed were higher in iron (2.19 mg/100g) and zinc (1.65 mg/100g). Researchers like Makanjuola and Ajayi, (2012) and Owusu-Kwarteng *et al.*, 2022 reported high mineral in both the samples. 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 (Tounkara and Fane, 2022). It has been documented that, food fermentation increases mineral and trace elements bioavailability by reducing non-digestible material in plants such as glucuronic and polygalacturonic acids, cellulose, and hemicelluloses (Gupta, Gangoliya & Singh, 2015). In facts, 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 (Ahmed *et al.*, 2023) . Minerals provide the medium essential for normal cellular activity, determine the osmotic properties of body fluids, and import hardness to bones and teeth (Dash, Mohanty, & Nayak, 2023).

Anti-nutrient composition of fermented locust bean and sorrel seed condiment

The anti-nutrient composition of fermented locust bean and sorrel seed condiment is presented in Table 3. The anti-nutrient content of the samples seems to be higher in the locust bean than sorrel seed. Tannin content in fermented sorrel seed and locust bean differed significantly ($p < 0.05$) (21.42 mg/100g and 18.00 mg/100g) respectively. There were also significant differences in oxalate content ($p < 0.05$) in fermented locust bean and sorrel seed condiment (4.86 mg/100g and 0.095 mg/100g) respectively. It was also recorded that the phytate content of locust bean seed significantly differed ($p < 0.05$) (60.00 mg/100g and 3.62 mg/100mg) respectively. The saponin content of the sample recorded higher value in locust bean against sorrel seed condiment (17.80 mg/100g and 1.04 mg/100g) respectively. The anti-nutrients contents in the locust bean sample are higher than the value obtained (Ndukwe and Solomon, 2017), (6.05 mg/100g) for tannins, and lower than the values (Adanlawo, Malomo & Adeniran, 2023) (38.77 mg/100g) for sorrel seed. The differences may be due to variation in calcium distribution in plant parts, taxonomy and genetic (Adanlawo, Malomo & Adeniran, 2023).

Tannin has been reported to have anticancer and antimicrobial activities (Shaik, Hamdi & Sarbon, 2023). It contributes to the astringent taste of some fruits and also forms an insoluble complex with protein, thereby reducing protein digestibility. Moreover, the reducing effect of tannin on protein digestibility can be eliminated during processing as a result of solubility and heat sensitive nature of tannin (Pricop *et al*., 2023). Fermentation is one of the processes that can be used to reduce the negative effects of tannins.

The Oxalate values obtained in this current study were lower than the values recorded by (Ndukwe and Solomon, 2017) (84.99 mg/100g) for locust bean seed. Oxalate is of concern because of its negative effect on mineral bioavailability and can increase the risk of renal calcium absorption (Pricop *et al.,* 2023). Values obtained for locust bean and sorrel seed for phytate and saponin were higher than those reported for both condiments. However, there are reports that conventionally food-processing techniques reduce phytate content in plant foods to the lowest level (Tonukari *et al*., 2023).

TABLE 3 Anti-Nutrient Component of Fermented Loucust Bean and Sorrel Seed Condiments

Samples	Tannin	Oxalate	Phytate	Saponin
Samples A	18.00 ± 0.08^{b}	4.86 ± 0.30^{a}	60.00 ± 0.09^{a}	17.80 ± 0.12^{b}
Samples B	21.42 ± 0.12^{a}	0.091 ± 0.0^{b}	3.62 ± 0.01^{b}	1.04 ± 0.00^{c}

Values are means ± standard deviation of triplicate determinations. Means in same column with p-value less than 0.05 are significantly different ($p<0.05$). Sample A = Dried Fermented Locust bean Condiment, Sample B = Dried Fermented sorrel seed Condiment.

Sensory properties of fermented locust bean and sorrel seed condiments

The Table 4 presents the scores for sensory properties of fermented locust bean and sorrel seed condiments. Locust bean condiment was preferred over sorrel seed in all the parameters evaluated. There were significant differences in all the parameters ($p< 0.05$). The significant difference in overall acceptability can be attributed to the consumers being accustomed to the conventional fermented locust bean found in the market.

TABLE 4: Sensory Properties of Fermented Locust Bean and Sorrel Seed Condiments

Samples	Colour	Taste	Texture	Aroma	General acceptability
Sample A	3.90 ± 1.07^{b}	3.60 ± 1.35^{a}	3.55 ± 1.39^{a}	3.40 ± 1.31^{b}	3.30 ± 1.42^{b}
Sample B	2.55 ± 1.28^{c}	2.85 ± 1.09^{b}	2.43 ± 139^{b}	2.15 ± 1.18^{a}	2.05 ± 1.09^{a}

Values are means ± standard deviation of triplicate determinations. Means in same column with p-value less than 0.05 are significantly different ($p<0.05$). Sample A = Dried Fermented Locust bean Condiment, Sample B = Dried Fermented sorrel seed Condiment.

Conclusion

Seeds are good sources of nutrients to humans and their functions are numerous to man. Fermented locust bean and sorrel seed condiments are good and cheap sources of protein for human nutrition. It could be considered as an affordable fish or meat substitute particularly for low income earners in developing countries such as Nigeria. Also being that locust bean tree are going extinct, sorrel seed condiments can be considered as an option in place of locust bean since they have comparable nutrient content.

This study found that sorrel seed contains the highest amount of protein which is a little higher than locust bean seed which means that both seeds are rich in protein. However, the anti-nutrient content of the samples seems to be higher in the locust bean than sorrel seed. Locust bean condiment was preferred over sorrel seed in all the parameters evaluated. This study concludes that given the nutritional value of fermented locust beans and sorrel seed condiments, families should prioritize their preparation and consumption.

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