ABSTRACT

Condiments produced from some underutilized legumes in Nigeria were evaluated for their nutritional and sensory qualities. Soybeans (Glycine max), locust beans (Parkia filicoidea L.), pigeon pea (Cajanus cajan) and melon seed (Citrullus lunatus) were subjected to solid substrate fermentation and their proximate composition, mineral, antinutrient and the organoleptic properties were subsequently determined. The result of the study revealed that the condiments had high protein (17.8 [pigeon pea] to 44.6% [soybean]), fat (11.8 [pigeon pea] to 21.0% [soybean]), ash (1.9 [melon] to 4. 7% [pigeon pea]) and crude fiber (5.9 [soybean] to 11.2% [pigeon pea]). The macroelements (K, Ca, Mg and Na) were generally high while the microelements (Fe and Zn) content was low. The phytate content of the condiments ranged from 187.8 (pigeon pea) to 921.2 mg/100 g (soybeans), while the tannin content ranged from 1.8 (pigeon pea) to 2.9 mg/g (melon seed). The calculated [phytate]/[Zn] (0.3–1.3), [Ca]/[phytate] (3.6–66.6) and [Ca]/[phytate]/[Zn] (0.02–0.06) molar ratios revealed that the phytate content did not reduce the estimated Zn bioavailability in the condiments to a critical level. However, the condiments had lower general acceptability when compared with monosodium glutamate-based seasoning salt. In view of the high nutrient content these condiments produced from underutilized legumes, they could be a good alternative to the monosodium glutamate-based seasoning salts presently in use. The condiments produced from soybean and locust beans appear to be more promising than those from pigeon pea and melon seed based on nutrition and sensory acceptability.
INTRODUCTION

A condiment is a substance applied to food in the form of a sauce, powder, spread or anything similar, to enhance or improve the flavor. Fermentation is one of the oldest methods of food preservation known to man. In Nigeria and most African countries, condiments such as fermented locust bean (Iru), fermented melon seed (Ogiri), fermented soybeans (Dadawa), fermented cotton seed (Ogiri) and fermented pigeon pea were widely used to season food. The production of condiments is largely on a traditional small-scale, household basis under highly variable conditions (Odunfa 1981).

Fermentation is usually carried out in a moist solid state, involving contact with appropriate microorganisms at the ambient temperature of the tropics. The completion of fermentation is indicated by the formation of mucilage and overtones of ammonia produced as a result of the breakdown of amino acids during the fermentation (Omafuvbe et al. 2000). The characteristic ammoniacal odor and flavor of condiments enhance the taste of traditional soups and sauces especially the various soups used as accompaniment to the starchy root and tuber diets (Omafuvbe et al. 2002).

Condiments are also known to contribute to the calorie and protein intake and are generously added to soups as low-cost meat substitute by low-income families in parts of Nigeria (Eka 1980; Odunfa 1981). Condiments produced from fermented pigeon pea are a good source of vitamin B. There are reports on the production of fermented condiments from African locust bean “Iru” (Eka 1980), melon seed fermented Ogi (Odunfa 1981, 1986; Barber and Achinewhu 1992) and soybean produced Daddawa (Omafuvbe et al. 2000, 2002).

The proximate composition indicates these condiments could contribute to the protein, lipid and mineral daily intake when used liberally, as done in several homes, where expensive animal products are a luxury (Odunfa 1981, 1985; Omafuvbe et al. 2000, 2002). In view of the controversy surrounding the use of monosodium-based seasoning salt (Walker and Lupien 2000), many homes in Nigeria are now using condiments produced from legumes as a flavorant in traditional soup preparation. However, there is limited information on the antinutrient and sensory quality of these locally produced condiments. This study therefore sought to determine the nutrient, antinutrient (phytate and tannin) and the effect of the phytate content on the estimated Zn bioavailability of condiments produced from some conventionally used legume condiments in tropical Africa and to assess their acceptability when compared to monosodium glutamate-based seasoning salt.
MATERIALS AND METHODS

Materials

The four legumes (African locust bean [Parkia biglolosa], soybean [Glycine max], melon seed [Citrullus vulgaris] and pigeon pea [Cajanus cajan]) used for the study were obtained from a local market in Akure, Ondo State, Nigeria. The chemical used was analytical grade, while the water was glass distilled.

Sample Preparation

Raw seeds were boiled for 12 h. Excess water was drained and the seeds were dehulled by mashing the seeds in a large wooden mortar, and further removal of the seed coat was achieved by rubbing the cotyledons between the palms of the hand and washing with water. The cotyledons were again cooked for another 2 h; the boiling hot water was drained and the cotyledons were then spread on calabash trays, covered with wooden trays, wrapped with jute sacks and fermented for 3 to 4 days. This procedure was followed for all the legumes except melon seeds that were wrapped with Thaumaloccus demoelli leaves (Eweran in Yoruba language), after which the cotyledons were boiled for another 2 h and fermented for 3 to 4 days at ambient temperature.

Sample Analysis

The nutrient composition (ash, fat and crude fiber) of the condiments was determined using the standard AOAC (1990) method and the protein content was determined using the micro-Kjeldahl method. The phytate content was determined by the method of Wheeler and Ferrel (1974) based on the ability of standard ferric chloride to precipitate phytate in dilute HCl extracts of the condiments, while the tannin content was determined using the method of Makkar et al. (1993). The Zn, Ca, Mg and Fe contents were determined on aliquots of the solutions of the ash by established flame atomic absorption spectrophotometry procedures using a Perkin-Elmer atomic absorption spectrophotometer (Model 372) (Perkin-Elmer 1982), while the Na and K were determined with flame photometer. Calculation of [phytate]/[Zn], [Ca]/[phytate] and [Ca][phytate]/[Zn] molar ratios was used in the prediction of Zn bioavailability in the condiments (Fergusson et al. 1988).

Sensory Analysis

The organoleptic properties of the condiments produced using the various kinds of coagulants were carried out using the method of Potter (1968). The products were assessed (aroma, taste, texture, color and general acceptability)
on a 7-point Hedonic scale (7 = excellent, 6 = very good, 5 = good, 4 = average, 3 = fair, 2 = poor and 1 = very poor) as described by Potter (1968) and the attribute mean score was calculated.

**Statistical Analysis**

The result of the replicates was pooled and expressed as mean ± standard error. A one-way analysis of variance and the least significance difference were carried out (Zar 1984). Significance was accepted at $P \leq 0.05$.

**RESULTS AND DISCUSSION**

The proximate composition of the condiments produced from some selected legumes is shown in Table 1. Condiments produced from fermented soybeans (*Glycine max*) had the highest protein content (44.6%), followed by that of locust beans (35.2%), while fermented pigeon pea (17.8%) had the lowest protein content. However, all the condiments could be generally considered to be very rich in protein (17.8–44.6%). The high amount of protein in the soybeans could be a result of more and active nitrogen-fixing bacteria giving rise to high amount of protein content (Oboh 2005; Oboh *et al.* 2005).

The protein contents were within the same range as that produced from melon and locust beans (Omafuvbe *et al.* 2004); however, the values were generally higher than that of other commonly consumed plant foods in Nigeria such as cassava products (Oboh *et al.* 2002; Oboh and Akindahunsi 2003), yam tubers (Akindahunsi and Oboh 1998) and leafy vegetables (Oboh 2005; Oboh *et al.* 2005). This high protein content in these condiments could be a good and cheap source of dietary protein, where animal proteins are presently highly unaffordable to many of the populace. Furthermore, the condiments also had high fat (11.8 [pigeon pea] to 21.0% [soybean]), crude fiber (5.9 [soybean] to 11.2% [pigeon pea]) and ash (1.9 [melon] to 3.3% [pigeon pea]) content.

**TABLE 1.**

<table>
<thead>
<tr>
<th>Sample</th>
<th>Protein (%)</th>
<th>Fat (%)</th>
<th>Ash (%)</th>
<th>Crude fiber (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Locust beans</td>
<td>35.2±3.4$^b$</td>
<td>19.3±2.1$^a$</td>
<td>2.4±0.5$^{ab}$</td>
<td>9.8±1.2$^{ab}$</td>
</tr>
<tr>
<td>Soybeans</td>
<td>44.6±2.5$^a$</td>
<td>21.0±1.8$^a$</td>
<td>3.0±1.0$^a$</td>
<td>5.9±1.4$^b$</td>
</tr>
<tr>
<td>Melon</td>
<td>23.6±3.0$^c$</td>
<td>12.7±1.4$^b$</td>
<td>1.9±0.5$^b$</td>
<td>7.8±2.0$^{ab}$</td>
</tr>
<tr>
<td>Pigeon pea</td>
<td>17.8±2.7$^d$</td>
<td>11.8±1.1$^b$</td>
<td>3.3±0.9$^a$</td>
<td>11.2±1.0$^d$</td>
</tr>
</tbody>
</table>

Values represent means of triplicate readings.

Values with the same letter along the same column are not significantly different ($P > 0.05$).
The results of the mineral composition are shown in Table 2. The macro-elements (K, Ca, Na and Mg) were generally high, while the microelements (Fe [1.9–39.1 ppm] and Zn [3.6–78.7 ppm]) were low. Condiment produced from pigeon pea had the highest Fe (37.1), K (297.2), Ca (79.3), Mg (367.8), Na (238.0) and Zn (23.1), while that of melon seed had the lowest amount of iron (1.9), sodium (45.9), potassium (35.3), calcium (11.6), magnesium (78.4) and zinc (3.6). However, Mg was generally high in all the condiments. These values were within the same range when compared with other food crops such as fruit (Oboh and Igbakin 2002), mushroom (Ola and Oboh 2001), yam tubers (Akindahunsi and Oboh 1998) and vegetables (Akindahunsi and Oboh 1999). However, they are far above the mineral composition of some commonly consumed cassava products in Nigeria (Akindahunsi et al. 1999; Oboh et al. 2002; Oboh and Akindahunsi 2003; Oboh et al. 2003). This high mineral content in the condiments most especially that in pigeon pea, will go a long way to help in the management/prevention of macroelements and microelements deficiency.

The levels of antinutrients (phytate and tannin) are shown in Table 3. The tannin content of the condiments ranged from 1.8 mg/g for condiment produced from pigeon pea to 2.9 mg/g for condiment produced from melon seed. These values compared well with the tannin content for cassava products (Oboh and Akindahunsi 2003), green leafy vegetables (Akindahunsi and Oboh 1999) and fruits (Oboh and Igbakin 2002). The products could also be considered to be safe with regard to tannin poisoning because the levels reported in this study are far below the critical value of 7.3–9.0 mg/g (Aletor 1993).

Phytic acid, though considered an antinutritional factor, is a common storage form of phosphorus in seeds and in a few tubers and fruits. The phytate content of the condiments ranged from 187.8 mg/100 g for that of pigeon pea to 921.2 mg/100 g for that of soybeans. The phytate content was higher than that of Solanum macrocarpon leaf (Oboh et al. 2005), but lower
than that of some commonly and underutilized legumes in Nigeria (Oboh, unpublished data) and that of *Tralinum triangulare* leaf (2341.1 mg/100 g), *Vernonia amygdalina* leaf (1466.7 mg/100 g) and *Baselia alba* leaf (2030.8 mg/100 g) that have exceptionally high phytate content (Akindahunsi and Oboh 1999). The lower phytate content when compared to raw legumes could be attributed to the ability of the microorganism to break down phytate during the fermentation process (Oboh *et al.* 2002, 2003).

However, there are reports that conventionally food-processing techniques reduce phytate content in plant foods (Akindahunsi and Oboh 1998, 1999; Oboh *et al.* 2002).

The potential of phytate in condiments on reducing the availability of the Zn was subsequently calculated (Table 4). The calculated [phytate]/[Zn] molar ratio for the condiments was very low (0.1 [pigeon beans] to 1.3 [melon seed]); their values were far below 15.0, which is considered to be the critical value (Fergusson *et al.* 1988). This indicates that the phytate content will not reduce the bioavailability of zinc to a critical level in both the processed and unprocessed samples (Turnland *et al.* 1984). The calculated [Ca]/[phytate] molar ratios revealed that the values obtained for all the samples tested were above

<table>
<thead>
<tr>
<th>Sample</th>
<th>Phytate (mg/100 g)</th>
<th>Tannin (mg/g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Locust beans</td>
<td>601.9 ± 5.0ab</td>
<td>2.0 ± 0.4ab</td>
</tr>
<tr>
<td>Soybeans</td>
<td>921.2 ± 13.2a</td>
<td>2.1 ± 0.3ab</td>
</tr>
<tr>
<td>Melon</td>
<td>545.2 ± 7.7c</td>
<td>2.9 ± 0.5a</td>
</tr>
<tr>
<td>Pigeon pea</td>
<td>187.8 ± 3.0d</td>
<td>1.8 ± 0.6b</td>
</tr>
</tbody>
</table>

Values represent means of triplicate readings. Values with the same letter along the same column are not significantly different (*P* > 0.05).
6.0, except that of melon seed (3.6). Wise (1983) suggested that the solubility of phytate and proportion of zinc bound to the complex depend on the dietary Ca levels. In his model, phytate precipitation is not complete until dietary Ca:phytate molar ratios attain a value of approximately 6.0. At lower ratios, phytate precipitation is incomplete, causing some dietary zinc to remain in solution.

Thus, the calculated [Ca][phytate]/[Zn] molar ratio is a better index for predicting Zn bioavailability because of a kinetic synergism that exists between [Ca] and [Zn] ions resulting in a Ca:Zn:phytate complex, which is less soluble than the phytate complex formed by either ion alone (Oberleas 1973). The calculated [Ca][phytate]/[Zn] molar ratios for the condiments (0.02 [pigeon pea] to 0.06 [soybeans]) were below the critical level of 0.5 M/kg. The calculated [Ca][phytate]/[Zn] ratios for these condiments were far below what Akindahunsi and Oboh (1999) obtained for water leaf (5.2) and Indian spinach (2.1), whose calculated [Ca][phytate]/[Zn] molar ratio is above 0.5 M/kg. However, the result of the calculated [Ca][phytate]/[Zn] molar ratios was below that of eggplant leaf (Oboh et al. 2005) and was within the same range with that of edible mushrooms in Nigeria (0.01–0.20 M/kg) (Ola and Oboh 2001). This clearly indicates the phytate content of the condiments will not reduce the estimated Zn bioavailability to a critical level.

The results of the sensory evaluation are shown in Table 5. All the condiments had a lower overall acceptability when compared to the monosodium glutamate-based salt. However, among the condiments produced, locust bean condiments had the highest acceptability (aroma, taste, color, texture and structure) and they are closely followed with the condiments produced from soybean and melon seed, while pigeon pea-based condiment had the least acceptability.

<table>
<thead>
<tr>
<th>Sample</th>
<th>Aroma</th>
<th>Color</th>
<th>Taste</th>
<th>Texture</th>
<th>Structure</th>
<th>General acceptability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Locust beans</td>
<td>6.2 ± 0.5bc</td>
<td>5.8 ± 0.3bc</td>
<td>5.5 ± 0.2bc</td>
<td>5.4 ± 0.2bc</td>
<td>5.6 ± 0.3bc</td>
<td>5.7 ± 0.5bc</td>
</tr>
<tr>
<td>Melon</td>
<td>4.5 ± 0.8bc</td>
<td>4.7 ± 0.2bc</td>
<td>5.6 ± 0.4bc</td>
<td>6.1 ± 0.3bc</td>
<td>5.5 ± 0.4bc</td>
<td>5.3 ± 0.3bc</td>
</tr>
<tr>
<td>Pigeon pea</td>
<td>3.2 ± 0.4c</td>
<td>5.2 ± 0.5bc</td>
<td>4.4 ± 0.2c</td>
<td>5.7 ± 0.5bc</td>
<td>4.9 ± 0.4bc</td>
<td>4.7 ± 0.3bc</td>
</tr>
<tr>
<td>Soybean</td>
<td>5.7 ± 0.7bc</td>
<td>5.2 ± 0.4bc</td>
<td>5.4 ± 0.2bc</td>
<td>4.9 ± 0.3bc</td>
<td>5.6 ± 0.5bc</td>
<td>5.4 ± 0.4bc</td>
</tr>
<tr>
<td>Control 1</td>
<td>6.8 ± 0.2a</td>
<td>6.5 ± 0.1a</td>
<td>6.9 ± 0.1a</td>
<td>6.5 ± 0.2a</td>
<td>6.7 ± 0.3a</td>
<td>6.7 ± 0.2a</td>
</tr>
<tr>
<td>Control 2</td>
<td>6.7 ± 0.1a</td>
<td>6.7 ± 0.1a</td>
<td>6.8 ± 0.1a</td>
<td>6.6 ± 0.3a</td>
<td>6.5 ± 0.4a</td>
<td>6.7 ± 0.2a</td>
</tr>
</tbody>
</table>

Values represent means of 24 replicates.
Values with the same letter along the same column are not significantly different (P > 0.05).
CONCLUSION

In view of the high nutrient content and low antinutrient content of those condiments produced from underutilized legumes, they could be a good alternative to the monosodium glutamate-based seasoning salts presently in use; however, the condiment produced from soybean appears to be more promising nutritionally, while that of locust beans had the highest acceptability. However, further study on how to improve the sensory quality of the condiments is needed.

REFERENCES


