Nutrients assessment of some lima bean varieties grown in southwest Nigeria

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Abstract

Four varieties of lima bean seeds with accession number NSWP100, NSWP98, NSWP47 and NSWP96 were subjected to standard analytical techniques to evaluate the physical, proximate, mineral and amino acids composition. Significant (p≤ 0.05) variations existed among the varieties with respect to their proximate composition, mineral constituent and amino acid profile. NSWP98 showed higher hydration indices (0.70) and percentage cotyledon (87.27 g/100 g). Proximate result revealed low moisture and high protein contents (3.71 to 7.45 g/100 g and 25.91 to 30.29 g/100 g) respectively. The most abundant mineral elements were potassium and sodium (7.53 to 360.80 mg/100 g) and (7.53 to 80.73 mg/100 g) respectively; calcium was in the range of 11.13 to 2014 mg/100 g and iron 11.30 to 18.17 mg/100 g. However, high content of amino acids were also detected, lysine (6.85 to 7.25 g/100 g protein), leucine (8.2 to 8.64 g/100 g protein) and phenyalanine (5.63 to 6.24 g/100 g protein). Highest concentration of total essential amino acids (52.65 g/100 g protein) was observed in NSWP98. Increase in utilisation of lima bean will improve livelihoods and value-added food products that can serve as important driver for economic development.

Introduction

The possible avenue of achieving nutrition security in third world countries is through exploitation of underutilised plant foods sources (Champ et al., 2003). In such countries, plant foods are the most important dietary sources to satisfy individuals’ nutrient requirements due to the availability and low cost. Legumes also known as pulses are important food source and play a significant role in traditional diets all over the world (Chung et al., 2008). In Africa especially and other developing countries, animal proteins are grossly inadequate and relatively expensive. Research effort has been intensified towards finding alternative sources of protein from underutilised grain legume seeds in the last decades (Adebowale et al., 2005). Plant proteins have been used extensively for many years in the food industry as food product ingredient due to the amino acid content (Horax et al., 2004). Grain legumes are an excellent source of protein, carbohydrates, dietary fiber, vitamins, minerals and phytochemicals (Tharanathan and Mahadevamma, 2003) which has led to the increase in consumption worldwide.

Researchers have demonstrated that legumes could prevent or manage chronic health challenges such as diabetes, cardiovascular disease, cancer, obesity and contribute to overall health and wellness of human body (Basset et al., 2010). Frequent consumption of legume (four or more times compared with less than once a week) has been associated with 22% and 11% lower risk of coronary heart disease (CHD) and cardiovascular disease (CVD) respectively (Flight and Clifton 2006). Considerable genetic variation has been reported in the chemical composition of legumes both between and within species. In addition, chemical composition is modified by environmental factors during plant development (Rochfort and Panozzo 2007).

Lima bean (Phaseolus lunatus) is a cheap source of protein to the Nigerians rural dwellers (Ezeagu and Ibegbu 2010). Despite the great potential of the crop, it is highly underutilised in Nigeria and is known as “kapala” (Yoruba), “ukpa” (Igbo) in South-western and South-eastern Nigeria respectively; where the seeds are commonly consumed (Ezeagu and Ibegbu 2010; Seidu et al., 2014). It has good potential as a cheap and alternate source of protein. The seeds contain 24% proteins, 61% carbohydrate and minerals elements. One of the constraints to the consumption of lima beans, like other beans, is that certain varieties require a longer time to cook or soak than others (Giami, 2001). There is earthy

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of information on the varietal differences on the physical and nutritional aspects of lima bean species. Hence this study aimed at the evaluation of physical, mineral and amino acids composition of four varieties of lima species (NSWP100, NSWP98, NSWP47 and NSWP96) grown in Southwest states of Nigeria.

Materials and Methods

Materials

Four varieties of lima bean seeds with accession number NSWP100, NSWP98, NSWP47 and NSWP96 were obtained from the Institute of Agricultural Research and Training (IAR&T), Ibadan, Nigeria. Chemicals used were of analytical grade. The cleaned lima beans were cracked with hammer mill, soaked in water for 3 h, dehulled, washed and dried at (60±2°C) for 24 h before milling and sieving to give 40 mm mesh size flour which was kept in an airtight plastic container at 4°C prior to use.

Physical analysis

The physical analysis was carried out as described below (Adebowale et al., 2005). Lima bean seeds (100 g) was weighed accurately and transferred into 100 ml measuring cylinder, where 100 ml deionised water was added. The seeds were poured into the water and the volume of the displaced water was measured.

Seeds weighing 100 g was counted and transferred into a measuring cylinder with water and left for 24 h at room temperature (30±2°C), after which the seeds were drained with filter paper. The hydration capacity was determined using the relation:

\[ \text{Hydration capacity} = \frac{\text{Weight of soaked seeds} - \text{Weight of seed before soaking}}{\text{Number of seeds}} \]

The hydration index was calculated as follows:

\[ \text{Hydration index} = \frac{\text{Hydration capacity per seed}}{\text{Weight of one seed}} \]

Seeds weighing 100 g was counted; the volume was noted and soaked overnight in water. Swelling capacity and swelling index per seed was calculated as follows:

\[ \text{Swelling capacity} = \frac{\text{Volume after soaking} - \text{Volume before soaking}}{\text{Number of seeds}} \]

\[ \text{Swelling index} = \frac{\text{Swelling capacity of seed}}{\text{Volume of one seed}} \]

Results and Discussion

Physical properties of lima bean seeds

The physical properties of lima bean seeds are presented in Table 1. The seed weight was in the range of 0.31 to 0.49 g which is higher than 0.09 g reported for Asparagus bean (Olawuni et al., 2013); but lower than 0.59 to 0.98 g/ml reported for mucuna species (Adebowale et al., 2005); 100-seed weight was 31.81 to 39.41 g; the percentage seed coat was in the range of 12.41 to 13.81% lower than 36.9% reported for new line lima bean (Giami, 2001) and percentage cotyledon 86.25 to 87.27%. The density of the different seeds ranges from 0.77 to 0.79 g/ml; hydration capacity 0.23 to 0.32 g/seed, hydration index 0.67 to 0.73; swelling capacity 0.19 to 0.25 ml/seed and swelling index 0.27 to 0.34.

Proximate composition

The proximate composition of lima bean species is presented in Table 2. The result revealed low moisture content which are in agreement with 6.45 g/100 g reported for bambara groundnut (Martin et
al., 2011), lower than the moisture content of cowpea 10.39 g/100 g; mungbean 8.30 g/100 g and peas 9.05 g/100 g (Mosood and Rizwana 2010). This could be an indication of good keeping quality of the seeds. The highest protein (30.29 g/100 g) content was recorded in NSWP96 with the least value (25.91 g/100 g) in NSWP47; all are higher than those recorded for similar seeds: Pigeon pea 24.03 g/100 g, cowpea 24.46 g/100 g (Arawande and Borokini 2010); peas 22.95 g/100 g (Mosood and Rizwana 2010); Castellano chickpea 23.70 g/100 g (Aguilera et al., 2011). Ezeagu and Ibegbu (2010) reported a lower value of 23.17 g/100 g for lima bean; indicating that protein content may be dependent on varieties. The crude fibre content was significantly (p≤ 0.05) higher in NSWP98 (2.80 g/100 g) and NSWP47 (2.74 g/100 g) compare to other varieties; but lower than 7.86 g/100 g reported for red kidney beans (Sai-Ut et al., 2009). Fibre, especially in grain legumes, has been reported to be of health benefit.

Mineral composition

Mineral composition in mg/100 g of the lima bean flours is shown in Table 3. The abundant minerals in the studied varieties were potassium and sodium which agrees with the observation of (Olaofe and Sanni, 1988) on the potassium predominance in Nigerian agricultural products. Similar observations have been reported for gingerbread plum (Amza et al., 2011) and lima bean seed coat (Seidu et al., 2014) but contrary to the report on mucuna beans (Adebowale et al., 2005). The samples are high in phosphorus, calcium and magnesim, the minerals which are necessary for teeth and bone development in children (David, 2006). Manganese, zinc and copper content were relatively low. Variation was observed in the quantitative composition of mineral elements in agreement to the report of Seidu et al. (2015) as a result of genetic variation and soil conditions. Sodium/potassium (Na/K) ratio observed in this study is within the recommended level (≤1.0) (Aremu et al., 2006) and very vital in the prevention and management of high blood pressure. The calcium/phosphorus ratio (Ca/P) ratio is high (high calcium, low phosphorus intake) only little amount of calcium will be lost through the urine, increasing the calcium level in bones. The Ca/P (0.64 to 1.31) ratio in the present study which is above 0.5 is an indication that the varieties evaluated are potential minerals sources

<table>
<thead>
<tr>
<th>Table 1. Physical properties of lima bean seeds</th>
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<tbody>
<tr>
<td>Parameters</td>
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<tr>
<td>------------</td>
</tr>
<tr>
<td>Colour</td>
</tr>
<tr>
<td>Grain’s weight (g)</td>
</tr>
<tr>
<td>100-seed weight (g)</td>
</tr>
<tr>
<td>Cotyledon (g/100 g)</td>
</tr>
<tr>
<td>Density (g/ml)</td>
</tr>
<tr>
<td>Hydration capacity (g/g)</td>
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<tr>
<td>Hydration index</td>
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<tr>
<td>Swelling capacity (mg/g)</td>
</tr>
<tr>
<td>Swelling index</td>
</tr>
</tbody>
</table>

Values are means of triplicate determinations ± Standard deviation. Means with different superscript in the same row are significantly different (p ≤ 0.05).

<table>
<thead>
<tr>
<th>Table 2. Proximate composition of lima bean varieties (g/100 g dry weight)</th>
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<tbody>
<tr>
<td>Parameters</td>
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<tr>
<td>----------</td>
</tr>
<tr>
<td>Moisture</td>
</tr>
<tr>
<td>Protein</td>
</tr>
<tr>
<td>Fat</td>
</tr>
<tr>
<td>Crude fibre</td>
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<tr>
<td>Ash</td>
</tr>
<tr>
<td>Carbohydrate</td>
</tr>
</tbody>
</table>

Values are means of triplicate determinations ± Standard deviation. Means with different superscript in the same row are significantly different (p ≤ 0.05).
for bone formation (Nieman et al., 1992).

### Amino Acid Composition

The result of amino acid profile is depicted in Table 4, for reference purpose the recommended mode of essential amino acid for children and adult is included in the table (WHO, 2007). The result shows acceptable amino acids composition in the four varieties of lima bean flours evaluated due to the high level of essential amino acids except methionine and cysteine. The low level of methionine/cysteine recorded in this study is a common phenomenon in legumes. However, this challenge can be overcome by complementing the diet with cereal proteins

<table>
<thead>
<tr>
<th>Amino Acid</th>
<th>NSWP100</th>
<th>NSWP98</th>
<th>NSWP47</th>
<th>NSWP96</th>
<th>WHO 2007</th>
</tr>
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<tbody>
<tr>
<td>ASX</td>
<td>4.36±0.05&lt;sup&gt;a&lt;/sup&gt;</td>
<td>4.22±0.02&lt;sup&gt;a&lt;/sup&gt;</td>
<td>4.38±0.01&lt;sup&gt;a&lt;/sup&gt;</td>
<td>4.36±0.01&lt;sup&gt;a&lt;/sup&gt;</td>
<td>-</td>
</tr>
<tr>
<td>GLX&lt;sup&gt;+&lt;/sup&gt;</td>
<td>14.20±0.12&lt;sup&gt;a&lt;/sup&gt;</td>
<td>14.26±0.11&lt;sup&gt;a&lt;/sup&gt;</td>
<td>14.18±0.05&lt;sup&gt;a&lt;/sup&gt;</td>
<td>14.10±0.30&lt;sup&gt;a&lt;/sup&gt;</td>
<td>-</td>
</tr>
<tr>
<td>PRO&lt;sup&gt;+&lt;/sup&gt;</td>
<td>4.21±0.05&lt;sup&gt;a&lt;/sup&gt;</td>
<td>4.50±0.10&lt;sup&gt;a&lt;/sup&gt;</td>
<td>4.42±0.10&lt;sup&gt;a&lt;/sup&gt;</td>
<td>4.22±0.10&lt;sup&gt;a&lt;/sup&gt;</td>
<td>-</td>
</tr>
<tr>
<td>ALA</td>
<td>0.24±0.00&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.24±0.00&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.54±0.01&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.64±0.01&lt;sup&gt;a&lt;/sup&gt;</td>
<td>-</td>
</tr>
<tr>
<td>VA&lt;sup&gt;+&lt;/sup&gt;</td>
<td>4.61±0.16&lt;sup&gt;a&lt;/sup&gt;</td>
<td>6.11±0.10&lt;sup&gt;a&lt;/sup&gt;</td>
<td>4.54±0.01&lt;sup&gt;a&lt;/sup&gt;</td>
<td>4.18±0.13&lt;sup&gt;a&lt;/sup&gt;</td>
<td>3.00</td>
</tr>
<tr>
<td>MET&lt;sup&gt;+&lt;/sup&gt;</td>
<td>1.16±0.01&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1.17±0.01&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1.22±0.02&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1.12±0.01&lt;sup&gt;a&lt;/sup&gt;</td>
<td>2.70</td>
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<td>LEU&lt;sup&gt;+&lt;/sup&gt;</td>
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<td>4.55±0.10&lt;sup&gt;a&lt;/sup&gt;</td>
<td>4.12±0.01&lt;sup&gt;a&lt;/sup&gt;</td>
<td>4.38±0.10&lt;sup&gt;a&lt;/sup&gt;</td>
<td>2.80</td>
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<tr>
<td>TYR&lt;sup&gt;+&lt;/sup&gt;</td>
<td>3.31±0.10&lt;sup&gt;a&lt;/sup&gt;</td>
<td>3.54±0.10&lt;sup&gt;a&lt;/sup&gt;</td>
<td>3.21±0.01&lt;sup&gt;a&lt;/sup&gt;</td>
<td>3.41±0.01&lt;sup&gt;a&lt;/sup&gt;</td>
<td>-</td>
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<tr>
<td>HIS&lt;sup&gt;+&lt;/sup&gt;</td>
<td>0.62±0.16&lt;sup&gt;a&lt;/sup&gt;</td>
<td>6.02±0.13&lt;sup&gt;a&lt;/sup&gt;</td>
<td>5.83±0.01&lt;sup&gt;a&lt;/sup&gt;</td>
<td>6.18±0.10&lt;sup&gt;a&lt;/sup&gt;</td>
<td>6.30</td>
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<tr>
<td>LYS&lt;sup&gt;+&lt;/sup&gt;</td>
<td>7.25±0.11&lt;sup&gt;a&lt;/sup&gt;</td>
<td>7.32±0.02&lt;sup&gt;a&lt;/sup&gt;</td>
<td>6.85±0.01&lt;sup&gt;a&lt;/sup&gt;</td>
<td>7.33±0.41&lt;sup&gt;a&lt;/sup&gt;</td>
<td>5.60</td>
</tr>
<tr>
<td>ARG&lt;sup&gt;+&lt;/sup&gt;</td>
<td>6.87±0.10&lt;sup&gt;a&lt;/sup&gt;</td>
<td>6.36±0.13&lt;sup&gt;a&lt;/sup&gt;</td>
<td>6.08±0.08&lt;sup&gt;a&lt;/sup&gt;</td>
<td>6.02±0.21&lt;sup&gt;a&lt;/sup&gt;</td>
<td>-</td>
</tr>
<tr>
<td>TRP&lt;sup&gt;+&lt;/sup&gt;</td>
<td>1.34±0.01&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1.38±0.01&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1.34±0.02&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1.02±0.01&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1.10</td>
</tr>
</tbody>
</table>

Values are means of triplicate determinations ± Standard deviation. Means with different superscript in the same row are significantly different (p ≤ 0.05).

ASX = aspartic acid+asparagine.

GLX = glutamic acid+glutamine

* = Essential amino acid
in which sulphur-amino acids are relatively high (Mortuza et al., 2009). Aspartic acid/asparagine and glutamic acid/glutamine were the most abundant amino acids found in all the varieties ranging from 12.69 to 13.20 g/100 g and 14.10 to 14.26 g/100 g protein respectively and have been reported as seed storage proteins (Tang and Ma, 2009); as well as important amino acids reservoirs for human body (Vasconcelos et al., 2010).

In terms of essential amino acids, all the varieties exhibited relatively higher amounts of valine, isoleucine, leucine, lysine, threonine and histidine compared to the standard. The contents of tryptophan and sulphur containing amino acids were slightly lower than the recommended mode for children (2-5 years). However, all the essential amino acids contained in samples were adequate for adults (WHO, 2007). Arginine (5.87 to 6.36 g/100 g protein) is an essential amino acid which has direct antioxidant activity (Boger et al., 1996) also necessary for growth in children (Robinson, 1987). Though not essential for adult, but infants may not be able to synthesis the amount required for growth as such some may be needed in infant diets (David, 2006).

Lysine is a major limiting amino acid in most cereals and was presented at 6.85 to 7.25 g/100 g protein in this study, is higher than value reported for *L. cylindrica* seed kernel (2.9 g/100 g protein) (Aremu et al., 2008). This value is higher than what is obtainable in most cereals and can serve as a good complement in diet formulation. NSWP98 had the highest amount of total essential amino acid (52.65 g/100 g protein) while lower value (51.39 g/100 g protein) was observed in NSWP47. The percentage of total essential amino acids is above 39% considered adequate for ideal protein food for infants, 26% for children and 11% for adults (WHO, 1985).

**Conclusion**

Lima bean varieties studied are good source of proteins, fibre and mineral elements. Besides, they contained high level of essential amino acids which suggest the potential application in infant’s food formulation. Therefore, it becomes important to focus on promoting maximal use of locally available inexpensive legume such as lima bean which is highly rich in essential nutrients required for body development.

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