Proximate composition, phytochemical screening and some antinutritional factors of three accessions of lima beans (Phaseolus lunatus) an underutilized legume

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Abstract

Lima bean (LB) (Phaseolus lunatus) is an underutilized legume in Nigeria and West Africa despite its numerous nutritional benefits. This study evaluated the proximate composition, phytochemical screening and antinutritional factors (ANFs) of three accessions of Lima beans; LB 001, LB 011 and LB 015 from the International Institute of Tropical Agriculture (IITA), Ibadan, Oyo State. All analyses were done using standard protocols. Statistical analysis was done using descriptive statistics. Result of proximate analysis revealed that LB 011 recorded the highest value for crude protein (25.70±0.06%), crude fat (3.10±0.05%) and crude fibre (3.20±0.06%) and moisture content (9.3±0.16%), LB 015 recorded the highest value for ash (3.90±0.04%), nitrogen free extract (60.35±0.20%) while LB 001 gave the highest value for dry matter (92.30±2.50%). Phytochemical screening revealed presence of saponin, flavonoid and alkaloid in the three accessions of LB while anthraquinone and cardiac glycoside were absent in all the LB accessions. Results of ANFs showed that LB 001 recorded the highest value for alkaloid (56.67±5.78 mg/g), LB 015 gave the highest value for tannin (93.33±2.89 mg/g) and saponin (61.67±2.89 mg/g) while LB 011 had the highest oxalate content (30±5.00 mg/g). The study concluded that the three accessions of lima beans have high levels of crude protein, crude fat and ash and phytochemicals, which compared favourably with that of cowpea (Vigna unguiculata), a conventional legume. However, the ANFs present in LB need adequate processing for their reduction and optimal utilization as a protein source for human and animals.

Keywords: Lima beans, proximate, phytochemicals, antinutritional factors

Introduction

Lima beans (Phaseolus lunatus), sometimes called “butter beans” or sieva beans because of their starchy yet buttery texture is a legume grown for its edible seeds or beans (Serrano-Serrano et al. 2010). Lima beans are classified as one of the under-utilized legumes in Nigeria (Aletor and Aladetimi, 1989) and West Africa (Asante et al., 2008). Alternative sources of proteins from underutilized grain legume seeds are now used to meet the protein demand in developing countries where animal protein intake is inadequate and relatively expensive (Adaparusi, 1994; Fagbenro, 1999; Osuigwe, 1999). Legume seeds are utilized as a source of human food and animal feeds due to their high nutritious contents and medicinal benefits (Gepts et al., 2005; Adebowale et al., 2009; Ojo, 2013). There is therefore the need to intensify research efforts aimed at identifying new legume utilization since a reappraisal of beneficial effects of legume seed dietary intake is the basis for various health claims. However, legumes generally contain antinutritional factors which limit their utilization as human food and animal feeds (Liener, 1976; Akande et al., 2010). The need to quantify the levels of antinutrients in the different accessions of lima bean was reported by (Kyeremateng, 2015). The aim of this work is to obtain some basic nutritional information and the potential use of lima beans as a phytomedicinal plant through information
on its proximate composition, phytochemical screening and antinutritional factors in three accessions of lima beans (*Phaseolus lunatus*).

**Materials and methods**

**Source of the Lima beans**

The three accessions of lima beans (*Phaseolus lunatus*); (LB001, LB011 and LB015) were supplied by the Genetic Resources Unit, International Institute of Tropical Agriculture (I.I.T.A.), Ibadan, Oyo State, Nigeria.

**Proximate analysis**

% Crude Protein, % Crude Fat, % Crude Fibre, % Ash, % Nitrogen free extract, % Dry Matter and % Moisture were analysed by the method of (AOAC, 2000).

**Phytochemical screening**

Phytochemical analyses on the aqueous extracts of the powdered samples of the Lima beans (*Phaseolus lunatus*) were done according to Harborne (1973) and Trease and Evans (1989).

**Antinutritional factors**

The alkaloids contents of the lima beans accessions were carried out by the method of Henry (1973), tannins (Dawra *et al.*, 1988), saponins (Brunner, 1984) and the total oxalates were quantified according to the method of Fasset (1996). The detailed methodologies for the quantification of the antinutritional factors have been reported (Soetan, 2012).

**Statistical analysis**

Data were subjected to students' t-test, mean±standard error of mean.

**Results and discussions**

### Table 1: Proximate analysis of the three accessions of Lima beans (*Phaseolus lunatus*)

<table>
<thead>
<tr>
<th>Proximate Analysis (%)</th>
<th>LB001</th>
<th>LB011</th>
<th>LB015</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crude protein</td>
<td>22.40±0.95</td>
<td>25.70±0.06</td>
<td>22.75±0.38</td>
</tr>
<tr>
<td>Crude fat</td>
<td>2.60±0.06</td>
<td>3.10±0.05</td>
<td>2.80±0.05</td>
</tr>
<tr>
<td>Crude fibre</td>
<td>3.10±0.04</td>
<td>3.20±0.06</td>
<td>2.40±0.02</td>
</tr>
<tr>
<td>Ash</td>
<td>3.30±0.04</td>
<td>2.90±0.02</td>
<td>3.90±0.04</td>
</tr>
<tr>
<td>Nitrogen free extract</td>
<td>60.9±0.24</td>
<td>55.80±0.16</td>
<td>60.35±0.20</td>
</tr>
<tr>
<td>Moisture content</td>
<td>7.7±0.14</td>
<td>9.3±0.16</td>
<td>7.8±0.15</td>
</tr>
<tr>
<td>Dry matter</td>
<td>92.30±2.50</td>
<td>90.70±3.60</td>
<td>92.20±2.70</td>
</tr>
</tbody>
</table>

**Key:** LB 001 (Lima bean 001), LB 011 (Lima bean 011), LB 015 (Lima bean 015)

### Table 2: Phytochemical screening of the three accessions of Lima beans (*Phaseolus lunatus*)

<table>
<thead>
<tr>
<th>Phytochemicals</th>
<th>LB 001</th>
<th>LB 011</th>
<th>LB 015</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anthraquinone</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Saponin</td>
<td>++</td>
<td>++</td>
<td>++</td>
</tr>
<tr>
<td>Tannin</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Flavonoid</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Cardiac glycoside</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>i. Keller-Killani</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>ii. Kedde</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Alkaloid</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Drageduff</td>
<td>++</td>
<td>+++</td>
<td>++</td>
</tr>
<tr>
<td>Wagner</td>
<td>++</td>
<td>+++</td>
<td>++</td>
</tr>
<tr>
<td>Meyer</td>
<td>++</td>
<td>+++</td>
<td>++</td>
</tr>
</tbody>
</table>

**Key:** LB 001 (Lima bean 001), LB 011 (Lima bean 011), LB 015 (Lima bean 015)

+= Present ++ = Moderately present +++ = Strongly present - = Absent
Table 3: Some antinutritional factors in the three Accessions of Lima beans (*Phaseolus lunatus*)

<table>
<thead>
<tr>
<th>Antinutritional Factors</th>
<th>LB001</th>
<th>LB011</th>
<th>LB015</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alkaloids</td>
<td>56.67±5.78</td>
<td>40.0±5.00</td>
<td>50.0±5.00</td>
</tr>
<tr>
<td>Tannins</td>
<td>80.00±5.00</td>
<td>58.33±2.89</td>
<td>93.33±2.89</td>
</tr>
<tr>
<td>Saponins</td>
<td>55.00±0.00</td>
<td>43.33±2.89</td>
<td>61.67±2.89</td>
</tr>
<tr>
<td>Oxalates</td>
<td>21.67±2.89</td>
<td>30.00±5.00</td>
<td>23.33±2.89</td>
</tr>
</tbody>
</table>

Key: LB 001 (Lima bean 001), LB 011 (Lima bean 011), LB 015 (Lima bean 015)

Table 1 shows the results of proximate composition of the three accessions of lima beans. Crude protein values ranged from 22.40±0.95% (LB001) to 25.70±0.06% (LB011). These values obtained for lima beans, an underutilized legume compared well with that of cowpea (*Vigna unguiculata*), a conventional legume, having a crude protein value of 24.4% for Agwa brown variety (Ene-Obong and Carnovale, 1992), thus indicating that lima bean with higher protein content can serve as inexpensive protein source for both humans and livestock (Kyeremateng, 2015). Proteins enhances the functions of the immune system and play an important role in cell division and growth (Okeke and Elekwa, 2006; Okeke et al., 2008). Crude fat of the LB ranged from 2.60±0.06% (LB001) to 3.10±0.05% (LB011). The crude fat obtained for these accessions of lima beans also compared well with that of Agwa brown variety of cowpea which is 2.0% (Ene-Obong and Carnovale, 1992). Fats play important functions in hormone production and in insulation and protection of body organs (Dutta, 1981; Pamela et al., 2005). Crude fibre ranged from 2.40±0.02% (LB015) to 3.20±0.06% (LB011). The crude fibre for LB is lower than that of Agwa brown variety of cowpea which is 11.4% (Ene-Obong and Carnovale, 1992). Dietary fibres slow down the rate of glucose absorption into bloodstream, reduces the risk of hyperglycemia and also reduces blood cholesterol (Oboh and Omofoma, 2008; Okeke and Adaku, 2009). Ash content of the LB ranged from 2.90±0.02% (LB011) to 3.90±0.04% (LB015). The ash content of LB is comparable to that of Agwa brown variety of cowpea which is 4.0% (Ene-Obong and Carnovale, 1992). Nitrogen free extract (NFE) ranged from 55.80±0.16% (LB011) to 60.9±0.24% (LB001). NFE consists mainly of soluble carbohydrates (sugars) and starch. The high-energy content of food samples can be attributable to their high levels of carbohydrate (Kyeremateng, 2015). Moisture contents of the LB ranged from 7.7±0.14% (LB001) to 9.3±0.16% (LB011). Low moisture content of food enhances the storage capacities of food products (Alozie et al., 2009). Dry matter ranged from 90.70±3.60% (LB011) to 92.30±2.50% (LB001). The dry matter of LB in this study is similar to that of Agwa brown variety of cowpea which is 90.7% (Ene-Obong and Carnovale, 1992). The results of the phytochemical screening (Table 2) revealed the presence of saponin, flavonoid and alkaloid in all the three accessions of LB while anthraquinone and cardiac glycoside were absent in all the LB accessions. Phytochemicals like saponin, flavonoid, and alkaloids were also detected in cowpea (Awojulu, 2018). Phytochemicals are natural chemical compounds produced during the normal
Antinutritional factors of three accessions of lima beans (Phaseolus lunatus)

metabolic processes of plants and they exhibit chemoprevention and chemotherapeutic effects in cell lines and animal models of cancer (Okigbo et al., 2009; Bathaie et al., 2015). The antioxidant properties of plants have been attributed to their rich phytochemical composition (Ramachandran, 2014). The presence of phytochemicals like flavonoids and saponins in lima beans suggest that it could be a good source of phytomedicines for the benefit of humans and animals. Saponins are important therapeutically because of its hypolipidaemic and anticancer activities (Sarker and Nahar, 2007). Flavonoids are antioxidants and free radical scavengers which prevent oxidative cell damage (Okwu and Morah, 2007). Alkaloids functions in the defense of plants against herbivores and pathogens and have been exploited as pharmaceuticals agents (Madziga et al., 2010; Doughari, 2012). The results of the antinutritional factors (Table 3) of the three accessions of LB revealed that alkaloids contents ranged from 40.0±5.00 mg/g (LB011) to 56.67±5.78 mg/g (LB001). Alkaloids exert adverse effects on the nervous system by disrupting or inappropriately augmenting electrochemical transmission (Habtamu and Nigusse, 2014). Consumption of high tropane alkaloids causes rapid heartbeat, paralysis and in fatal cases, lead to death.Tannins ranged from 58.33±2.89 mg/g (LB011) to 93.33±2.89 mg/g (LB015). Tannins can bind to protein and form insoluble complexes with proteins thereby reducing digestibility of food proteins (Chai and Liebman, 2004; Patra and Saxena, 2010). Saponins contents ranged from 43.33±2.89 mg/g (LB011) to 61.67±2.89 mg/g (LB015). Saponins decrease the uptake of some nutrients, including cholesterol and glucose in the gastrointestinal tract (Umaru et al., 2007) and also cause haemolysis of red blood cells (Price et al., 2001). Oxalates ranged from 21.67±2.89 mg/g (LB001) to 30±5.00 mg/g (LB011). The levels of ANFs analyzed in the three accessions of LB were higher than the values recorded for cowpea by (Osagie et al., 1996). The presence of certain antinutritional factors is the highest impediment to the utilization of underutilized legumes as human food and animal feeds, which could be toxic and also lethal in extreme situations. These ANFs when present in large quantities, results in loss of appetite, reduction in dry matter intake and reduce protein digestibility. However, ANFs in plants could be reduced by different processing techniques like boiling, soaking, heat treatment, microwave and autoclaving, roasting, simmering and blanching, fermentation, germination followed by dehulling (Tadele, 2015). There is the need to evaluate the various traditional and modern processing methods that can be used to reduce or eliminate the antinutritional constituents in the different accessions of lima bean (Kyeremateng, 2015).

Conclusion

The presence of nutrients like crude proteins and crude fibres and phytochemicals in the three accessions of lima beans (Phaseolus lunatus) indicates that lima beans could serve as a good source of protein in human food and animal feeds and can also serve as a basic ingredient in making drugs for use in the treatment of diseases. However, the antinutritional factors in lima beans should be adequately processed for maximal utilization in human and animals.

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References


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Antinutritional factors of three accessions of lima beans (Phaseolus lunatus)

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