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

*Soetan, K. O. and Atanda, T. N.

Department of Veterinary Physiology and Biochemistry
University of Ibadan, Ibadan, Nigeria

*Corresponding Author Email: kehinde.soetan@gmail.com; 08074437629.

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 ($25.70 \pm 0.06\%$), crude fat ($3.10 \pm 0.05\%$) and crude fibre ($3.20 \pm 0.06\%$) and moisture content ($9.3 \pm 0.16\%$), LB 015 recorded the highest value for ash ($3.90 \pm 0.04\%$), nitrogen free extract ($60.35 \pm 0.20\%$) while LB001 gave the highest value for dry matter ($92.30 \pm 2.50\%$). 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 nutrient

contents and medicinal benefits (Gepts *et al.*, 2005; Adebawale *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

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

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*)

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

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*)

Phytochemicals	LB 001	LB 011	LB 015
Anthraquinone	-	-	-
Saponin	++	++	++
Tannin	-	-	-
Flavonoid	+	+	+
Cardiac glycoside			
i. Keller-Killani	-	-	-
ii. Kedde	-	-	-
Alkaloid			
Drageduff	++	+++	++
Wagner	++	+++	++
Meyer	++	+++	++

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*)

Antinutritional Factors (mg/g)	LB001	LB011	LB015
Alkaloids	56.67±5.78	40.0±5.00	50.0±5.00
Tannins	80.00±5.00	58.33±2.89	93.33±2.89
Saponins	55.00±0.00	43.33±2.89	61.67±2.89
Oxalates	21.67±2.89	30.00±5.00	23.33±2.89

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 (Obboh 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). Dietary ash to some extent gives an indication of the mineral content of foods (Musa *et al.*, 2010) and ash helps to maintain acid-base balance of the body system (Hawkins, 1979) and in the control of hyperglycemic condition in humans (Gokani *et al.*, 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.

Acknowledgement

The authors appreciate the Genetic Resources Centre (GRC) of International

Institute of Tropical Agriculture (IITA) for providing the lima beans.

References

- Adebowale, Y. A., Henle, T. and Schwarzenbolz, U. 2009.** Acetylated and Succinylated Derivatives of African Yam Bean (*Sphenostylis stenocarpa* Hochst. Ex A. Rich. Harms) protein isolates. *Journal of Mobile Communication*, 3(2): 34-36.
- Adeparusi, E. O. 1994.** Evaluation of the nutritive potential of cooked pigeon pea (*Cajanus cajan*) meal as a protein source for *Clarias gariepinus* fingerlings. *Journal of Agricultural Techechnology*, 1: 48-57.
- Akande, K. E., Doma, U. D., Agu, H. O. and Adamu, H. M. 2010.** Major Antinutrients Found in Plant Protein Sources: Their Effect on Nutrition. *Pakistan Journal of Nutrition* 9 (8): 827-832, 2010, ISSN 1680-5194.
- Aletor, V. A. and Aladetimi, O. O. 1989.** Compositional evaluation of some cowpea varieties and some under-utilized edible legumes in Nigeria. *Food/Nahrung*, 33: 999-1007.
- Alozie, Y. E., Iyam, M. A., Lawal, O., Udofia, U. and Ani, I. F. 2009.** Utilization of bambara groundnut flour blends in bread production. *Journal of Food Technology* 7:111-114.
- AOAC (Association of Official Analytical Chemists) 2000.** "Official Method of Analysis" 4th Edition (129-135), Washington D.C. U.S.A.
- Asante, I. K., Offei, S. K., Addy, R. and Carson, A. G. 2008.** Phenotypic and seed protein analysis in 31 lima bean (*Phaseolus lunatus*) accessions in Ghana. *West African J. Appl. Ecol.* 12:1-10.
- Awojolu, O. V. 2018.** Comparative nutritional analysis and phytochemical screening of eight improved cowpea genotypes. Master of Science (M.Sc.) Dissertation, Department of Biochemistry, College of Medicine, University of Ibadan, Ibadan.
- Bathaie, S. Z., Faridi, N., Nasimian, A., Heidarzadeh, H. and Tamanai, F. 2015.** How phytochemicals prevent chemical carcinogens and/or suppress tumour growth? *The Enzymes* 37: 1-42.
- Brunner, J. H. 1984.** Direct spectrophotometric determination of saponin. *Analytical Chemistry* 42:1752-1754.
- Chai, W. and Liebman, M. 2004.** Assessment of oxalate absorption from almonds and black beans with and without the use of an extrinsic label. *Journal of Urology*, 172: 953-957.
- Dawra, R. K., Makkar, H. S. P. and Singh, B. 1988.** Protein binding capacity of microquantities of Tannins. *Analytical Biochemistry* 170:50-53.
- Doughari, J. H. 2012.** Phytochemicals and extraction methods, Basic structures and mode of action as potential chemotherapeutic agents, phytochemicals: A global perspective of their role in Nutrition and Health, DrVenketeshwer Rao (Ed.) ISBN 978-953-51-0296-0.
- Dutta, A. C. 1981.** Botany for Degree Students, (Sixth Edn.). Oxford University Press, New Delhi. 708

- pp.
- Ene-Obong, H. N. and Carnovale, E. 1992.** A comparison of the proximate, mineral and amino acid composition of some known and lesser-known legumes in Nigeria. *Food Chemistry* 43:169-175.
- Fagbenro, O. A. 1999.** Use of fullfat winged bean (*Psophocarpustetragonolobus*) seed meal as a protein feedstuff in fishmeal-free diets for African catfish (*Clariasgariepinus*). *Aquaculture Nutrition*, 5(3): 99-204.
- Fasset, D. W. 1996.** Oxalates. In: Toxicants occurring naturally in foods. National Academy of Science Research Council, Washington D.C, U.S.A.
- Gepts, P., Beavis, W. D., Brummer, E. C., Shoemaker, R. C., Stalker, H. T., Weeden, N. F. and Young, N. D. 2005.** Legumes as a model plant family. Genomics for food and feed report of the cross-legume advances through genomics conference. *Plant Physiology*, 137: 1228-1235.
- Gokani, A., Ibrahim, G. and Shah, H. 1992.** Alkaline-ash foods in the dietary management of diabetes mellitus. *International Journal of Diabetes in Developing Countries*, 12: 85-89.
- Habtamu, F. and Negussie, R. 2014.** Antinutritional factors in plant foods: Potential health benefits and adverse effects. *International Journal of Nutrition and Food Sciences*, 2014; 3(4): 284-289. Published online July 20, 2014 (<http://www.sciencepublishinggroup.com/j/ijnfs>) doi: 10.11648/j.ijnfs.20140304.18 . ISSN: 2327-2694 (Print); ISSN: 2327-2716 (Online).
- Hawkins, H. E. 1979.** Applied Nutrition, (2nd Edn), Lee Foundation for Research, Milwaukee, Wisconsin. 217 pp.
- Harborne, J. B. 1973.** Textbook of phytochemical methods, 1st Edn, Chapman and Hall Ltd. London. Pp. 110-113.
- Henry, T. A. 1973.** Organic Analysis of Alkaloids. 6:163-187.
- Kyeremateng, D. O. 2015.** Determination of compositional characteristics, functional properties and cluster analysis of lima bean accessions (*Phaseolus lunatus*). M.Sc Food Science and Technology Thesis, Department of Food Science and Technology, College of Science, Kwame Nkrumah University of Science and Technology, Kumasi, Ghana.
- Liener, I. E. 1976.** Legume toxins in relation to protein digestibility A review. *Journal of Food Science*, 41: 1076-1081.
- Madziga, H. A. Sanni, S. And Sandabe, U. K. 2010.** Phytochemical and elemental analysis of *Acalypha wilkesiana* leaf. *Journal of American Science* 6:510-514.
- Musa, A. K., Kalejaiye, D. M., Ismail, L. E. and Oyerinde, A. A. 2010.** Proximate composition of selected groundnut varieties and their susceptibility to *Trogoderma granarium* Everts attack. *Journal of Stored Products and Post Harvest Research*. 1(2): 13-17.
- Obboh, H. A. and Omofoma, C. O. 2008.** The effect of heat treated lima bean on plasma lipids in

- hypercholesterolaemia rats. *Pakistan Journal of Nutrition* 7: 636-639.
- Ojo, M. A. 2013.** Effect of trona on the nutritional status of *Vignaracemosa* during cooking. Proceedings of the 37th Annual Conference, Nigerian Institute of Food Science and Technology, Abuja 178-179.
- Okeke, C. U. and Adaku, C. N. 2009.** Phytochemical and Proximate Analyses of *Euphorbia heterophylla* Linn. (Euphorbiaceae). *Nigerian Journal of Botany*, 22(1): 215-222.
- Okeke, C. U. and Elekwa, I. 2006.** Proximate and Preliminary Phytochemical analyses of *Avocado pear*, *Perseagratisima* Gaertn. F. (Family Lauraceae). *Nigerian Journal of Botany*. 19(1): 156-162.
- Okeke, C. U., Izundu, A. I. and Uzoechina, E. 2008.** Phytochemical and Proximate study of female pawpaw (*Carica papaya* Linn.) Caricaceae. *Journal of Science, Engineering and Technology*. 15(2): 8207-8216.
- Okigbo, R. N., Anugasi, C. L. and Amadi, J. E. 2009.** Advances in selected medicinal and aromatic plants indigenous to Africa. *Journal of Medicinal Plants Research* 3(2): 86-95.
- Okwu, D. E. and Morah, F. N. 2007.** Isolation and Characterization of flavone glycoside 4,5,7 Trihydroxide flavone Rhamnoglucose from *Garcinia kola* seed. *Journal of Applied Sciences* 7(2): 155-164.
- Osagie, A. U., Murguiz, M., Cuadsado, C., Ayet, G. A. and Castano, A. 1996.** Some anti-nutritional constituents in ten staple food items in Nigeria. *Tropical Science* 36: 109-115.
- Osuigwe, D. I. 1999.** Growth responses and nutrient utilization of *Oreochromis niloticus* (L) fed on diets containing *Mucuna* seed meal. *Journal of Agriculture, Biotechnology and Environment*, 1(2):47-52.
- Pamela, C. C., Richard, A. H., Denise and R. F. 2005.** Lippincotts illustrated reviews in biochemistry. 3rd edition, Lippincott Williams and Wilkins, Philadelphia, pp. 335-388. ISBN-13: 978-1451175622.
- Patra, A. K. and Saxena, J. 2010.** Exploitation of dietary tannins to improve rumen metabolism and ruminant nutrition. *Journal of the Science of Food and Agriculture*. <http://doi.org/10.1002/jsfa.4152>.
- Price, K. R., Johnson, I. T. and Fenwick, G. R. 2001.** The chemistry and biological significance of saponins in food and feeding stuffs. *CRC Critical Reviews in Food Science and Nutrition*, 26:27-135.
- Ramachandran, H. D. 2014.** Role of phytochemicals in combating obesity. *International Journal of Innovative Pharmaceutical Sciences and Research* 2(7): 1606-1624.
- Sarker, S. D. and Nahar, L. 2007.** Chemistry for Pharmacy Students General, Organic and Natural Product Chemistry. John Wiley and Sons, England. pp. 283-359.
- Serrano-Serrano, M. L., Hernandez-Torres, J., Castillo-Villamizar,**

- G., Debouck, D.G. and Chacon, M. I. 2010.** Gene pools in wild lima bean (*Phaseolus lunatus* L.) from the Americas: Evidences for an Andean origin and past migrations. *Molecular Physiology and Evolution*, 54: 76-87.
- Soetan, K. O. 2012.** Comparative evaluation of phytochemicals in the raw and aqueous crude extracts from seeds of three *Lablab purpureus* varieties. *African Journal of Plant Science*, 6(15): 410-415.
- Tadele, Y. 2015.** Important Anti-Nutritional Substances and Inherent Toxicants of Feeds. *Food Science and Quality Management*, 36: 40-47.
- Trease, G. E. and Evans, W. C. 1989.** Pharmacognosy. 2nd Ed., BaillierTindell and Macmillan publishers.
- Umaru, H. A., Adamu, R., Dahiru, D. and Nadro, M. S. 2010.** Levels of anti-nutritional factors in some wild edible fruits of Northern Nigeria. *African Journal of Biotechnology* 6(16): 1935-1938.

Received: 10th January, 2018

Accepted: 12th May, 2018