



## Proximate, Mineral and Anti-nutrient Contents in *Psophocarpus tetragonolobus* (L) DC. (Winged Bean) Leaves

J. A. Alalade<sup>1\*</sup>, J. A. Akinlade<sup>2</sup>, O. A. Aderinola<sup>2</sup>, A. N. Fajemisin<sup>3</sup>,  
T. O. Muraina<sup>1</sup> and T. A. Amoo<sup>4</sup>

<sup>1</sup>Department of Animal Health and Production, Oyo State College of Agriculture and Technology,  
P.M.B. 10, Igbo Ora, Oyo State, Nigeria.

<sup>2</sup>Department of Animal Production and Health, Ladoke Akintola University of Technology,  
P.M.B. 4000, Ogbomoso, Oyo State, Nigeria.

<sup>3</sup>Department of Animal Production and Health, Federal University of Technology, P.M.B. 704,  
Akure, Nigeria.

<sup>4</sup>Department of Home Rural and Economics, Oyo State College of Agriculture and Technology,  
P.M.B.10, Igboora, Oyo State, Nigeria.

### Authors' contributions

This work was carried out in collaboration between all authors. All authors read and approved the final manuscript.

### Article Information

DOI: 10.9734/BJPR/2016/22087

#### Editor(s):

(1) Nawal Kishore Dubey, Centre for Advanced Studies in Botany, Banaras Hindu University, India.

#### Reviewers:

(1) Anthony Cemaluk C. Egbuonu, Michael Okpara University of Agriculture, Umudike, Nigeria.

(2) Carolina Baraldi Araujo Restini, University of Ribeirao Preto, Brazil.

(3) Ejeatuluchukwu Obi, Nnamdi Azikiwe University, Nigeria.

(4) Kpobari Nkpaa, University of Port Harcourt, Rivers State, Nigeria.

Complete Peer review History: <http://sciencedomain.org/review-history/13071>

Original Research Article

Received 17<sup>th</sup> September 2015

Accepted 30<sup>th</sup> October 2015

Published 25<sup>th</sup> January 2016

### ABSTRACT

The leaves of *Psophocarpus tetragonolobus* (L) DC. (Winged bean) was evaluated for the proximate, mineral and anti-nutritional composition. Atomic absorption spectrometry was used in determination of the leaves for Phosphorus, Potassium, Magnesium, Calcium, Iron and Zinc. Anti-nutritional factors (ANFs) including tannin, oxalate and phytate were also determined using appropriate technique. The results of proximate analysis indicate that the leaves had high crude

\*Corresponding author: Email: [alaladeja16@gmail.com](mailto:alaladeja16@gmail.com);

protein (26.29%), moisture (75.29%), dry matter (24.71%), ether extract (4.10%), crude fibre (10.04%), and ash (5.08%). Mineral analysis indicate the *Psophocarpus tetragonolobus* leaves contained some essential mineral such as K<sup>+</sup> (0.84%), Ca<sup>2+</sup> (0.30%), P (0.34%), Mg (0.40%), Fe<sup>2+</sup> (181.66 mg/kg) and Zn (61.27 mg/kg). The leaves of *P. tetragonolobus* have low concentration of anti-nutritive factor. Phytate (1.35%), Oxalate (1.12%) and Tannin (0.02%) respectively. The overall results suggest that *P. tetragonolobus* leaves is of high nutritional quality due to high Crude protein and mineral contents with low presence of anti-nutritional factors.

**Keywords:** *Psophocarpus tetragonolobus*; anti-nutritional factors; proximate and mineral.

## 1. INTRODUCTION

To improve livestock productivity in Nigeria, To improve livestock productivity in Nigeria, sustainable solutions to essential deficiencies in feed availability and quality are required. A number of pasture legumes such as *Centrosema*, *Desmodium*, *Canavalia* and *Glycine* have been tried in Nigeria, but the minor information is on *Psophocarpus tetragonolobus* compared with those legumes mentioned above.

The *P. tetragonolobus* also known as the Goa beans, Four-angled bean, Four-cornered bean and winged bean. It is tropical legume plant native to New Guinea and it grows abundantly in hot, humid equatorial countries [1]. *P. tetragonolobus* is well recognized by farmers and consumers in the Asia region for its varieties of uses and diseases tolerance. Wing beans is nutrient rich and all part of the plant are edible. Leaves can be eaten like spinach, flowers can be used in salads, tubers can be eaten raw or cooked, and seeds can be used in similar way as the *Glycine*. The wind bean is underutilized specie but has the potential to become a major multi use food crop in the tropics of Africa [1].

The wing beans plant grows as vine with climbing stems and leaves 3-4 m in height. It is an herbaceous perennial can be grown as an annual. It is generally taller and notably larger than the common bean. The bean pod is typically 15-22 cm (6-9 inch) long and has four wings with frilly edges running lengthwise. The skin is waxy and the flesh partially translucent in the young pod. When the pod is fully ripe, it turns an ash-brown colour and splits open to release the seeds. The large flower is a pale blue. The beans themselves are similar to soybeans in both use and nutritional content (29.8% to 39% Protein) [1]. The wing bean is rich in protein and tocopherol and anti-oxidant that increases vitamin A use in the body [2].

Creeping legume such as *Canavalia ensiformis* and *P. tetragonolobus* are high in crude protein

and are well adapted to varying weather and ecological soil condition apart from being relished by ruminant' farmer, often use these legume for soil reclamation [3]. Some plant possesses some useful proximate, minerals which are highly useful for ruminant animals [4]. There is no report on the proximate, mineral composition and anti-nutrient factor present in the *P. tetragonolobus* leaves to ensure that the leaves are safe for animals use, and do not contain some high level harmful element.

Hence, the effect of high protein forage could override the effect of toxin compound when use as supplement in ruminant diet [5]. The present study therefore examines the nutrient and anti-nutritional contents present in *P. tetragonolobus* plant leaves.

## 2. MATERIALS AND METHODS

### 2.1 Experimental Site

The experiment was carried out at Teaching and Research farm of Oyo State College of Agriculture and Technology, Igboora which is located within 7°15' North and 3°30' East of the equator with an average rainfall of 1278mm and average annual temperature 27° [6].

### 2.2 Sample Collection

Sample was taken from edible plant of *P. tetragonolobus* leaves within the college premises. The sample was oven dry at 70°C cooled in a desiccator and finely ground or used fresh for moisture analysis. The dry sample was used for the analysis except for moisture content determination in which fresh sample was used.

### 2.3 Proximate Composition Determination

The air-dried leaves were and ground into fine powder. About 10.0 g of the grounded leaves was exhaustively processed for various parameters according to the Association of Official Analytical Chemists methods; [7,8]. The

proximate analysis (fats, crude protein, moisture, crude fiber and ash) of the leaves were determined using AOAC methods. Using weight difference, moisture and ash were obtained. The fiber content was estimated from the loss in weight of crucible and its content on ignition. The nitrogen value, which is the precursor for protein of a substance, was determined by micro kjeldahi method, involving digestion, distillation and finally titration of the sample [8]. The nitrogen value was converted to protein by multiplying with a factor of 6.25. The determination of crude lipids content of the samples was done using soxhlet type of direct solvent extraction method. The solvent used was petroleum ether (boiling range 40-600c). The result of proximate value was all estimated as percentage [7,8].

## 2.4 Mineral Analysis

The mineral element was analyzed using [9] method; the elements in the sample were brought in to solution by wet digestion technique using a mixture of concentrated nitric, perchloric and sulphuric acid. In the ratio 9:2:1 respectively. K, Fe, Zn, Ca and Mg were determined by Atomic Absorption spectrometer and Phosphorus was determined using calorimetric method.

## 2.5 Anti-nutritional Factor

Oxalate was determined by the method of [10] while Phytate was determined by the [7] method. The tannin was determined by the procedure of [11].

## 2.6 Statistical Analysis

The experiment design was a completely randomized. Data was analyzed using one way analysis of variance with the use of statistical package to generate means and standard error.

## 3. RESULTS AND DISCUSSION

### 3.1 Proximate Composition

The proximate composition of *P. tetragonolobus* DC leaves was presented in Table 1. The leaves of the winged bean had higher moisture content (75.29%) which was above (74.51%) reported by [12] on moisture content of *Clitoria ternatea* leaves. Higher moisture content of *P. tetragonolobus* leaves in the month of January 2015 showed that high quantity and water reserved in plants will aid acceptability and digestion of the feed by ruminant animal. The

result in the present study is not in line with report of [13] who reported that low moisture content in feed stored for a long time without spoilage.

**Table 1. Proximate composition of *Psophocarpus tetragonolobus* leaves**

Parameter (%)	Concentration (%)
Moisture content	75.29
Dry matter	24.71
Crude protein	26.29
Ether extract	4.10
Crude fiber	10.04
Ash	5.08

*Values are means of triplicate determinants*

The percentage crude protein (26.29%) recorded for *P. tetragonolobus* was above (17.5%) recorded for *Stylosanthes hamata* [14]. The higher values of Crude protein recorded in *Psophocarpus* leaves in the present study above 7% CP requirement for ruminant animal which will provide ammonia requirement by the rumen micro-organism to support optimum microbial activity. The *P. tetragonolobus* leaves could serve as potential protein supplement and will enhance the intake and utilization of low quantity grass and fibrous crop residue by ruminants. The importance of protein to animal and human health cannot be over emphasized, therefore *P. tetragonolobus* leaves could be used both as feed and food protein supplement.

Ether extract content of *P. tetragonolobus* leaves (4.10%) which was higher than (1.89%) reported for *Canavalia ensiformis* leaves [14]. The ether extract content of *P. tetragonolobus* fell within the range of (4-10%) EE recommended [15]. The value of ether extract in *P. tetragonolobus* leaves is an indicator of higher energy level for the animal [3] and this is a major form of energy store in plant which is been utilized by the animal for body maintenance and production.

The Crude fiber content of *P. tetragonolobus* leaves (10.04%) was lower compared with (14.80%) of *Mucuna utilis* leaves reported by [16] and (23.8%) for *Stylosanthes hamata* [17]. But mostly preferable compared to (8.45%) Crude fiber for *Clitoria ternatea* leaves reported by [12]. The crude fiber content of the sample did not fall within the range of 15-20% recommended for improved intake and production in finishing ruminant [18]. The crude fiber content value of winged bean leaves reported will aid digestion and absorption of water from the body and bulk stool [19].

The Ash content value of *P. tetragonolobus* leaves (5.08%) was observed to be higher than value (0.11%) reported for *Mucuna utilis* leaves by [16] and also (3.70%) by [20]. The value obtained for the present study fell within the range of 3.0-9.65% [21]. Ash content useful is assessing the quality grading of leaves and also give an idea of amount of mineral element present in the *P. tetragonolobus* leaves [22]. This suggests that the sample could be a better source of essential valuable and useful minerals needed for good body development.

### 3.2 Mineral Composition

The results on mineral composition are indicated in Table 2. The mineral analysis of a plant gives the idea of possibility either the plant should be used for any feeding trial purpose. The Calcium ( $\text{Ca}^{2+}$ ) content of *P. tetragonolobus* leaves (0.30%) was higher than (0.09%) observed in *Canavalia ensiformis* leaves by [14]. The forage Ca values found in this study was considered adequate for the optimum performance of ruminants. The values of  $\% \text{Ca}^{2+}$  of the *P. tetragonolobus* would meet the theoretical Ca requirement of 0.30%  $\% \text{Ca}^{2+}$  diet needed for all forms of production in ruminants [23]. Calcium helps in the regulation of muscle contraction required by kid, weaner and fetuses for bone and teeth development [24]. Magnesium (Mg) content of *P. tetragonolobus* leaves (0.40%) was higher than value (0.20%) reported for *Canavalia ensiformis* leaves by [14]. The higher forage Mg level found in this study was above 0.12-0.20% of the requirement of ruminant's diet suggested by [25]. Magnesium is an important mineral element in connection with its role in circulatory diseases such as ischemic heart disease and calcium metabolism in above [26,27].

**Table 2. Mineral composition present in *Psophocarpus tetragonolobus* leaves**

Parameter	Concentration
$\% \text{K}^+$	0.84
$\% \text{Ca}^{2+}$	0.30
$\% \text{P}$	0.35
$\% \text{Mg}$	0.40
$\text{Fe}^{2+}$ (mg/kg)	181.66
Zn (mg/kg)	61.27

Values are means of triplicate determinants

The Phosphorus content of *P. tetragonolobus* leaves (0.34%) was higher compared to the NRC recommended of 0.15% for Phosphorus [25]. The level of Phosphorus in the winged beans

leaves was consistently above the 0.2% level which would satisfy livestock dietary maintenance requirement [2] during the dry season. *P. tetragonolobus* plays a vital role in normal kidney functioning and transfer of nerves impulse. Phosphorus play an important role in carbohydrate, lipid and amino and metabolism. Phosphorylatin play a key role in muscle contraction. Phosphorus is also required for blood coagulation (thromboplastin) satisfactory bone calcification optimum growth rate and optimum utilization of birth calcium and phosphorus [28]. The value of Potassium ( $\% \text{K}^+$ ) in *P. tetragonolobus* leaves (0.84%) is higher than (0.46%) K for *Canavalia ensiformis* leaves by [14]. In the present investigation the level of  $\% \text{K}^+$  in *P. tetragonolobus* leaves was over 0.18% recommended for grazing animals [29]. However it has been suggested that ruminants with high producing may require  $\% \text{K}^+$  level above (1.0%) under stress particularly heat stress [30,31]. Potassium is the most abundant element and this is in agreement with many reports that Potassium is the most abundant mineral in Nigeria Agricultural Product [32]. Potassium help to maintain body weight and regulate water and electrolyte balance in the blood and tissues [2].

The iron ( $\text{Fe}^{2+}$ ) content of *P. tetragonolobus* leaves (181.66 mg/kg) higher compared to (10.58 mg / 100 g) recorded for iron content of *Mucuna utilis*. Iron levels obtained for *P. tetragonolobus* leaves in the present study was above (50 mg/kg) sufficient for the requirement of ruminants for optimal performance and also above the critical levels of  $\text{Fe}^{2+}$  in animal tissues (30-50 mg/kg) [30]. This implied that the leaves are a good source of dietary iron. Iron is said to be an important element in the diets of pregnant animals, nursing animal, infant and other related disease [33] The concentration of zinc in the plant sample was determine to be (61.27 mg/kg) higher than (44.3 mg/kg) recorded for *Clitoria ternatea* leaves by [12]. It has been suggested that 30 kg/kg zinc is a critical dietary level; although it has been recommended that concentration of 12-20 mg/kg are adequate of growing ruminants [34]. Zinc is said to be essential trace element for protein and nucleic acid synthesis and normal body development during period of rapid growth such as infancy and recovery of illness [35].

### 3.3 Anti Nutrient Factor

Table 3 show the level of anti-nutrient factors in the *P. tetragonolobus* leaves. The tannin

obtained in the *Psophocarpus* leaves was (0.02%). This tannin level is much lower than the level of 5% at which goats may reject feed [36]. Tannin at this level protects liable plant proteins in the rumen and consequently increases the supply of high-quality protein into the duodenum [36]. However, when forage legume contains high levels of condensed tannins, intake and apparent digestion of protein and carbohydrate are depressed [37]. The phytic acid and oxalate contents were also low. The phytic value was lower than the range values of 3.47% and 3.24% reported for some browse legumes in Nigeria [38], while the oxalate content was higher than 0.52-0.82 mg/100 g reported for some herbaceous legumes consumed by goats in Nigeria. However, due to microbial fermentation in the rumen, ruminants, including goats, can consume considerable amounts of plant with high oxalate content without adverse effects. The levels of the ant nutrients investigated and found in *P. tetragonolobus* are unlikely to have any negative effect on ruminant livestock.

**Table 3. Anti-nutrient factor present in *Psophocarpus tetragonolobus* leaves**

Parameter	Concentration (%)
%Phytate	1.35
%Oxalate	1.12
%Tannin	0.02

Values are means of triplicate determinants

#### 4. CONCLUSIONS

It can be concluded from the results of this study that *P. tetragonolobus* leaves appear to have the potentials to offer better nutritional value. Higher content of protein and mineral combined with relative low levels of anti-nutrients would seem to that leaves with regards to their nutritional values.

#### CONSENT

It is not applicable.

#### ETHICAL APPROVAL

It is not applicable.

#### COMPETING INTERESTS

Authors have declared that no competing interests exist.

#### REFERENCES

1. Venketeswaran S, Dias MA, Weyer UV. The winged bean; a potential protein crop (eds) Janick J, Jimon JE. In: Advances in new crops. Timber Press, Portlam; 1990.
2. NRC. Nutrients requirements of beef cattle (17<sup>th</sup> edition) National Academy Press, Washington D.C. USA; 1985.
3. Babayemi OJ, Bamikole MA. Some productive and nutritive effects of *Tephrosia bracteolata*, *Tephrosia candida*, *Leucaena leucocephala* and *Gliricidia sepium* hay for West African Dwarf goats kept on range. Journal of Central European Agriculture. 2006;7(2):323.
4. Gislence GF, Nascimento JL, Pau Lo CF, Ghilian LS. Antibacterial activity plant extracts and phytochemicals on antibiotic resistant Bacteria. Brazilian J. Microbial. 2000;31:247-256.
5. Njidda AA. Chemical composition, Fibre fraction and anti-nutritional substances of semi-arid browse forages of North-Eastern Nigeria. Nigerian Journal of Basic and Applied Science. 2010;18(2):181-188. ISSN: 0794-569.
6. Sanusi WA. Effect of poverty on participation in non- farm activity in Ibarapa local Government Area of Oyo State, Nigeria. IJAART. 2011;182:86-95.
7. AOAC. Official methods of analysis (15<sup>th</sup> ed.). Washington D.C USA. Association of Official Analytical Chemists inch. 400 – 2200 Wilson Boalevard, Arlinton Virginia USA. 1990;2:910-928. Available:<http://dx.doi.org/10.3923/pjn.1990.1204.1208>
8. AOCS. Official Methods of Analysis (5<sup>th</sup> Ed). American Oil Chemist Society: Washington, DC, USA; 2000.
9. Walinga I, Van-Veak VW, Houba VIG, Van-der Lee. JJ. Plant analysis, procedures (Soil and plant analysis, part 7) Wageningen Nertherland. 1989;18.
10. Krishna G, Ranjhan SK. Laboratory Manual for nutrition research. Vikas Publishing House. PVK. Ltd, Ghaziabad, U.P (India). 1980;121-123.
11. Polshettiwar SA, Ganjiwale RO, Wadher SJ, Yeole PG. Spectrophotometric estimation of total tannins in some ayurvedic eye drops. Indian J. Pharmaceutical Sci. 2007;69(4):574-576.
12. Swati Deshmukh, Varsha Jadhav. Bromatological and mineral assessment of *Clitoria ternatea* leaves. International

- Journal of Pharmacy and Pharmaceutical Sciences. 2014;6:3.
13. Onwuka GI. Food analysis and instrumentation theory and practice. Naphthali Print, Nigeria. 2005;63-98:155-159, 524.
  14. Akinlade JA, Farinu GO, Taiwo AA, Aderinola OA, Adebayo TA, Ojebiyi OO, Olaniran OA. Agronomic and nutritive evaluation of Jack bean (*Canavalia ensiformis*) for fodder in the derived Savannah zone of Nigeria. International Journal of Agricultural Research. 2007; 2(12):1059-1063.
  15. Campbell KLI, Garforth C, Heffernan C, Morton J, Paterson R, Rymer C, Upton M. Small stock in development. Natural Resources International Ltd.: Aylesford, Kent, UK; 2006.
  16. Ujowundu CO, Kalu FN, Emejulu AA, Okafor OE, Nkwonta CG, Nwosunjoku EC. Evaluation of the chemical composition of *Mucuna utilis* leaves used in herbal medicine in Southeastern Nigeria. African Journal of Pharmacy and Pharmacology. 2010;4(11):811-816.
  17. Akinlade JA, Farinu GO, Aderinola OA, Ojeleye TY, Tona GO. Nutritive value of *Stylosanthes guianensis* and *hamata* in derived Savannah zone of Nigeria. Science Focus. 2004;9:145-149.
  18. Buxton DR. Quality related characteristics of forages as influenced by plant environment and agronomic factors. Anim. Feed Sci. Technol. 1996;59:37-49.
  19. Ayoola PB, Adeyeye A. Proximate analysis and nutrient evaluation of some Nigerian papaw seeds varieties. Science Focus. 200;14(4):554-558.
  20. Ravindran V, Ravindran G. Nutritional and anti-nutritional characteristics of *Mucuna (Mucuna utilis)* bean seeds. J. Sci. Food Agric. 1988;46:71-79.
  21. Okoli IC, Ebere CS, Emenalom OO, Uchegbu MC, Esonu BO. Indigenous livestock paradigms revisited 11: An assessment of the proximate value of most preferred indigenous browses of south eastern Nigeria. Tropical Animal Production Investigation. 2001;4(2): 99-107.
  22. Smart J. *Canavalia gladiata* (Jacq) D.C. (Sword bean). Tropical Pulses. Longman Group Ltd, London. 1996;58.
  23. ARC. The nutrients requirements of ruminant livestock. 4<sup>th</sup> ed. 73-310. CAB International, Wallingford; 1980.
  24. Margaret L, Vickery B. Plant products of tropical Africa. Macmillan in College Ed. London; 1997.
  25. NRC. Nutrients requirements of beef cattle (17<sup>th</sup> edition) National Academy Press, Washington D.C. USA; 1985.
  26. Ishida H, Suzuno H, Sugiyama N, Innami S, Todokoro T, Maekawa A. Nutritional evaluation of chemical component of leaves and stems of sweet potatoes (*Ipomoea batatas* poir). Food Chemistry. 2000;68:359-367.
  27. Hassan LG, Umar KJ. Nutritional value of Balsam apple (*Momordica balsamina* L.) leaves. Pakistan Journal of Nutrition. 2006;5:522-529.
  28. Underwood EJ. The mineral nutrition of livestock. Commonwealth Agricultural Bureaux, Slough, England. 1981;10.
  29. McDowell LR. Calcium, phosphorus and fluorine. In: Nutrition of Grazing Ruminants in Warm Climates (Ed.): McDowell LR. Academic Press, Orlando, Florida. 1985;189-212.
  30. Khan ZI, Ashraf M, Hussain A, McDowell LR. Seasonal variation of trace Elements in a semi arid yield pasture. Communications in Soil Science and Plant Analysis. 2005;37:1471-1484.
  31. Afolabi G, Oluwade A, Tunde O. Estimation of proximate and mineral composition of some tropical crops. African Agricultural Journal. 1995;21:103.
  32. Oluyemi EA, Akilua AA, Adenuya AA, Adebayo MB. Mineral contents of some commonly consumed Nigerian foods. Science Focus. 2006;11(1):153-157.
  33. Anonymous. Analytical methods for atomic-absorption spectrophotometry. Perkin-Elmer Corporation, Norwalk, Connecticut; 1980.
  34. Melaku U, Clive EW, Habtamon F. Content of zinc, Iron, calcium and their absorption inhibitors in Ethiopia. Journal of Food Composition Analysis. 2005;18: 803-817.  
Available:<http://dx.doi.org/10.1016/j.jfca.2004.09.008>
  35. Barry TN, Duncan SJ. The role of condensed tannins in the nutritional value of Lotus pedunculatus for sheep Voluntary intake. Journal of Association of Official Analytical Chemists. 1984;65:496-497.
  36. McLeod MN. Plant-tannins. Their role in forage quality. Nutrition Abstracts and Reviews. 1974;11:803-815.

37. Bamikole MA, Ikhatua UJ, Ajulo MT, Oseji AC. Feed utilization potential of West African dwarf goats fed different proportions of *Ficus thonningii* and *Panicum maximum*. Proceedings of the 29<sup>th</sup> Annual Conference of the Nigerian Society for Animal Production, Sokoto, Nigeria. 2004;29:336–340.
38. Oke OL. Oxalic acid in plants and innutrition. World Review of Nutrition and Dietetics. 1969;10:263-303.

---

© 2016 Alalade et al.; This is an Open Access article distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/4.0>), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

*Peer-review history:*  
The peer review history for this paper can be accessed here:  
<http://sciencedomain.org/review-history/13071>