Proximate, Mineral and Anti-nutrient Contents in \textit{Psophocarpus tetragonolobus} (L) DC. (Winged Bean) Leaves

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Authors’ contributions

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

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ABSTRACT

The leaves of \textit{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...
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+ (0.84%), Ca2+ (0.30%), P (0.34%), Mg (0.40%), Fe2+ (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, 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, prechloric 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>
<thead>
<tr>
<th>Table 1. Proximate composition of Psophocarpus tetragonolobus leaves</th>
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<tbody>
<tr>
<td>Parameter (%)</td>
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<tr>
<td>----------------</td>
</tr>
<tr>
<td>Moisture content</td>
</tr>
<tr>
<td>Dry matter</td>
</tr>
<tr>
<td>Crude protein</td>
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<tr>
<td>Ether extract</td>
</tr>
<tr>
<td>Crude fiber</td>
</tr>
<tr>
<td>Ash</td>
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</tbody>
</table>

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 (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 %Ca$^{2+}$ of the *P. tetragonolobus* would meet the theoretical Ca requirement of 0.30% %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

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Concentration</th>
</tr>
</thead>
<tbody>
<tr>
<td>%K$^{+}$</td>
<td>0.84</td>
</tr>
<tr>
<td>%Ca$^{2+}$</td>
<td>0.30</td>
</tr>
<tr>
<td>%P</td>
<td>0.35</td>
</tr>
<tr>
<td>%Mg</td>
<td>0.40</td>
</tr>
<tr>
<td>Fe$^{2+}$(mg/kg)</td>
<td>181.66</td>
</tr>
<tr>
<td>Zn(mg/kg)</td>
<td>61.27</td>
</tr>
</tbody>
</table>

*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 (%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 %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 %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 (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 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 *Climoria 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 ruminant [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

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Concentration (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>%Phytate</td>
<td>1.35</td>
</tr>
<tr>
<td>%Oxalate</td>
<td>1.12</td>
</tr>
<tr>
<td>%Tannin</td>
<td>0.02</td>
</tr>
</tbody>
</table>

*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.

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