Research/Review Article

FEDPOLEL JOURNAL OF APPLIED SCIENCES
https://fedpoleljournalofappliedsciences.com/

Evaluation of Proximate and Anti-nutritional Composition of Six Different Accessions of *Vigna subterranea* (L.) Verdc.

Yekeen M.O.[1*], Shaib-Rahim H.O.[2] and Omogbehin, S.A.[1]

[1]*Department of Science Laboratory Technology, Federal Polytechnic, Ile-Oluji, Nigeria*
[2]*Federal College of Forestry, Ibadan, Nigeria*

[*]yekeenolaidem@gmail.com

Article Info

Received: 08/04/2021
Accepted: 17/09/2021

Keywords

Vigna subterranea; Seeds; Proximate analysis; Anti-nutritional factors; Accessions

Abstract

Vigna subterranea L. Verdc is an annual seed crop widely favoured by resource-limited rural farmers. The fresh seeds can be consumed raw, cooked or utilized to make different delicacies. This study evaluates nutritional and antinutritional contents of seeds of different accessions of *V. subterranea* in order to obtain information on their potential suitability as an alternative source of protein for humans and livestock. The result of showed that the accessions are rich in protein (19.43±0.07%), crude fiber (4.38±0.23 %) and carbohydrate (55.59±2.52%) but also contained substantial amount of anti-nutritional factors such as oxalate (4.63±0.14 mg/g) and phytic acid (4.51±0.03 mg /g). TVSu 325, an accession originating from USA, had the highest protein (20.11%), high nitrogen-free extract (53.24%) and lowest fat (4.60%) content making it the most nutritious among the accessions studied, though it also contained the highest tannin (4.60 mg/g) level. TVSu 277 exhibited lowest crude protein (18.91 %), lowest crude fiber (3.28 %), highest carbohydrate (57.43 %) and highest nitrogen free extract (54.15 %). These showed that the accessions are quite rich, and exhibited diversity, in both proximate and antinutritional characteristics. It can be concluded that TVSu 352 is the most-nutritious among the accessions studied and can therefore be recommended for consumption or industrial utilization and widespread cultivation but further study is required to unravel its yield stability and resistance status. It can also be inferred that with adequate processing, the seeds of *V. subterranea* will be a good substitute for cowpea as an alternative source of protein in both humans and livestock because they are very rich in nutritional compounds.

1. INTRODUCTION

Bambara groundnut (*Vigna subterranea* L. Verdc) is an annual seed crop belonging to the family Fabaceae. It is a self-pollinating legume widely favoured by resource-limited rural farmers [1]. It is an indigenous African crop widely cultivated for its highly nutritious seeds and its ability to grow and produce on marginal lands which are unsuitable for the cultivation of other favoured species [2]. The seeds are consumed in diverse forms. The fresh seeds are sometimes consumed raw, boiled or grilled [3]. The dry seeds may also be roasted and ground into powder to make bean cakes and different delicacies [4]. In spite of its high nutritional contents and ability to grow in highly degraded soil it remains underutilized and neglected. This is probably due to its storage-induced defects, hard-to-cook phenomenon or the presence of anti-nutritional factors presence in the testa [5]. It has been reported that these antinutritional factors may not only reduce the bioavailability of nutrients present in food but may also be harmful to human health [6]. Although some antinutritional factors (e.g. phytic acid and phenol) may be beneficial to humans by helping to reduce the risk of coronary heart diseases and diabetes [7]. Hence, this study aims at determining nutritional and antinutritional content of the seeds of different varieties of *V.*

subterranea with a view to obtain information and subsequently exploiting them as alternative sources of protein, not only for human consumption but also its potential as source of nutrient supplement in the formulation of animal feeds.

2. MATERIALS AND METHOD

2.1 Sources of *V. subterranea* Germplasms

The seeds of six (6) accessions of *V. subterranea* utilized in this study were sourced from the Genetic Resources Centre, International Institute of Tropical Agriculture (IITA), Ibadan, Nigeria (Table 1).

Table 1: Passport data of the accessions studied

Varieties	Accession	Seed Colour	Geographical Region	Cultivar Name
V1	TVSu 277	Cream	USA (North America)	188-2/HILLx
V2	TVSu 733	Cream	Tanzania (East Africa)	Kumashi
V3	TVSu 178	Cream	USA (North America)	211-18-M-M
V4	TVSu 352	Cream	USA (North America)	D66-8666X
V5	TVSu 11	Purple	Nigeria	FA78-194
V6	TVSu 254	Dark Brown	Plateau, Nigeria	3H/9-2

2.2 Sample preparation

Seeds of each accession were ground to fine powder, sieved and labelled separately. Three replicates of each were then used for both proximate and anti-nutritional analyses.

2.3 Proximate Analysis

The moisture content of the seeds was determined at 105^{o}C while the percentage ash was evaluated at 550^{o}C. The total nitrogen and crude protein value was determined using micro-Kjeldahl method according to AOAC [8]. Crude fat was determined by extraction with petroleum ether using Soxhlet apparatus. Crude fiber was determined according to Chinedu and Nwinyi [9]. Total carbohydrate was determined by subtracting the value of moisture content, ash, crude protein, crude fiber and crude fat (ether extract) from 100 according to AOAC [10].
Nitrogen Free Extract (NFE) was determined as: NFE = Total Carbohydrate – Crude Fiber
Gross energy per 100g dry matter was calculated using method of Eknayake et al., [11]:
Gross Energy (kJ) = (crude protein x 16.7) + (crude lipid x 37.7) + (crude carbohydrates x 16.7).

2.4 Anti-nutritional Analysis

Total oxalate was determined, using the method of Umar *et al.,* (2007) and expressed as g/ 100g of dry seed weight. Total alkaloid in the sample was determined using the method of Shamsa *et al.,* [12] and expressed as g/ 100g of seed dry weight. Total flavonoid content was determined, using the method of Mistrello *et al.,* [13] and expressed as mg of Catechin equivalents per 100g of seed dry weight. Phytic acid level was evaluated using an indirect colorimetric method of Wheeler
and Ferrel [14] and expressed as mg/ g of dry seed weight. Tannin content was determined using method of Makkar and Goodchild [15] and expressed as mg/ g of dry seed weight.

2.5 Data Analysis

The proximate composition and anti-nutritional analysis was carried out in triplicates and the results obtained was analysed using one way analysis of variance (ANOVA) with Statistical Tool for Agricultural Research (STAR) and the results were expressed as mean ± standard deviation. Significant differences within treatments were determined at 5% significance level.

3. RESULTS AND DISCUSSIONS

The result of proximate analysis is presented in table 2. Crude protein value was high, like most legumes, and ranged from 18.91% to 20.11%. Statistical analysis showed significant difference

in crude protein values among the accessions. This value was lower than the 32.40% crude protein observed in white black eyed Bambara groundnut by Chinedu and Nwinyi [9]. It was also lower than the 28.63-30.43% observed in African yam bean seeds by Abioye *et al.,* [16]. This high level of protein would therefore make it an ideal food for supplementing carbohydrate-rich diet consumed by both adults and children in developing countries. It also meant it could be used as an ingredient in compounding animal feed. Fiber ranged from 3.28% to 5.61%. Statistical analysis showed significant difference in Fiber among the accessions. These values were lower than the 9.29% fiber observed in raw *V. subterranea* seeds by Ndidi *et al.,* [17]. High fiber in this seed is advantageous because fiber not only aid peristaltic movement in the intestinal tract in order to ease the passage of waste, it also help to reduce risk of intestinal cancer and lower the level of cholesterol in the blood [18]. Fat ranged from 4.60% to 6.67%. Statistical analysis showed significant difference in fat among the accessions. These values were higher than the 2.84% crude lipids observed in *S. stenocarpa* by Ndidi *et al.,* [17], but was significantly lower than the 22.25% crude lipids observed in whole seeds of *G. max* by El-Shemy *et al.,* [19]. The low fat content of the seed is advantageous because it can be utilized as an integral part of a weight-reducing diet. Ash ranged from 4.16% to 6.97%. Statistical analysis showed significant difference in ashg among the accessions. These values were slightly higher than the 3.6% ash observed in *V. subterranea* by Mahala and Mohammed [20]. This shows that appreciable level of minerals exists in the seeds hence their consumption would help to enhance growth and development in children. The fact that the ash is above 1.5-3.5% range, proposed as suitable for formulation of animal feeds by Pomeranz and Clifto [21], meant they could serve as potential source of animal feeds. MOC ranged from 8.88% to 9.55%. Statistical analysis showed significant difference in MOC among the accessions. This level was higher than the 6.51% observed in *G. max* but lower than the 10.44% observed in *Vicia faba* by El-Shemy *et al.,* [19]. This high level of moisture in the seeds would make them more susceptible to microbial attack thus reducing their shelf-life. CHO content ranged from 53.70% to 57.43%. Statistical analysis showed no significant difference in CHO values among the accessions. These values were slightly lower than the 60.8% CHO observed in *V. unguiculata* by Olaleye *et al.,* [22], as well as the 64.9g/ 100g observed in *V. subterranea* by Enwere and Hung [23]. This high level of CHO meant the seeds could be considered as good source of energy since carbohydrates are energy giving food.

Table 2: Proximate composition of seeds of six accessions of *V. subterranea*

Varieties	Accession	PROTEIN (%)	FIBER (%)	FAT (%)	ASH (%)	MOC (%)	CHO (%)	NFE	GE (kJ)
V1	TVSu 277	18.91^{d}	3.28^{d}	4.74^{e}	6.48^{c}	9.16^{b}	57.43^{a}	54.15^{a}	1453.58^{d}
V2	TVSu 733	19.27^{c}	4.00^{c}	5.35^{d}	6.79^{b}	9.36^{ab}	55.23^{a}	51.23^{a}	1445.68^{e}
V3	TVSu 178	19.45^{b}	4.39^{b}	6.36^{b}	6.97^{a}	9.13^{b}	53.70^{a}	49.31^{a}	1461.39^{c}
V4	TVSu 352	20.11^{a}	3.68^{cd}	4.60^{e}	5.81^{d}	8.88^{c}	56.92^{a}	53.24^{a}	1459.82^{c}
V5	TVSu 11	19.39^{bc}	5.32^{a}	5.87^{c}	4.28^{e}	9.55^{a}	55.59^{a}	50.27^{a}	1473.46^{b}
V6	TVSu 254	19.44^{b}	5.61^{a}	6.67^{a}	4.16^{e}	9.43^{a}	54.69^{a}	49.08^{a}	1489.43^{a}
Mean±SD		19.43±0.07	4.38±0.23	6.00±0.12	5.75±0.07	9.25±0.13	55.59±2.52	51.21±2.58	1463.89±1.76
LSD		0.13	0.41	0.20	0.12	0.23	4.48	4.58	3.25
CV (%)		0.38	5.20	2.07	1.18	1.38	4.53	5.03	0.12
Sig. (*p*)		**	**	**	**	**	ns	*ns*	**

Values are expressed as mean of three replicates; Values with different superscripts within the same column are significantly different from each other at p<0.05. Protein: Crude protein; Fiber: Crude Fiber; Fat: Crude Fat; Ash: Ash Content; MOC: Moisture Content; CHO: Total Carbohydrate; NFE: Nitrogen Free Extract; GE: Gross Energy.

NFE ranged from 49.08% to 54.15%. Statistical analysis showed significant difference in NFE among the accessions. The NFE was similar to the 54.22% observed in *S. stenocarpa* by Ndidi *et al.,* [17]. GE value ranged from 1445.68 kJ to 1489.43 kJ. Statistical analysis showed significant difference in GE values among the accessions. These levels were much higher than those observed in *V. subterranea* by Olaleye *et al.,* [22]. This high GE value indicates that the seeds can

contribute about 20% of the 6691 kJ recommended daily intake. The generally low CV (%) observed among the accessions revealed there is little variation among the results observed.
The result of antinutritional analysis is presented in table 3. Oxalate value ranged from 3.29 mg/g to 6.23 mg/g. Statistical analysis showed significant difference in oxalate among the accessions. This value was comparable to the 5.02 mg/g oxalate observed in raw *V. subterranea* seeds by Olaleye *et al.*, [22]. Alkaloids value ranged from 0.12 to 0.43 g/100g. Statistical analysis showed significant difference in alkaloid among the accessions. This value was comparable to the 0.14-0.39 g/100g alkaloid content observed in raw *V. subterranea* seeds by Olaleye *et al.,* [22].

Table 3: Antinutritional content of seeds of six accessions of *V. subterranea*

Varieties	ACCESSION	OXALATE (mg/g)	ALKALOIDS (g/100g)	FLAVONOID (g/100g)	PHYTIC ACID (mg/g)	TANNIN (mg/g)
V1	TVSu 277	4.21^{c}	0.40^{b}	0.29^{de}	5.54^{a}	0.74^{e}
V2	TVSu 733	3.35^{d}	0.33^{c}	0.32^{cd}	4.60^{c}	1.45^{c}
V3	TVSu 178	5.35^{b}	0.43^{a}	0.36^{b}	4.33^{d}	1.15^{d}
V4	TVSu 352	3.29^{d}	0.40^{b}	0.28^{e}	4.95^{b}	4.60^{b}
V5	TVSu 11	6.23^{a}	0.14^{d}	0.34^{bc}	3.29^{e}	5.26^{a}
V6	TVSu 254	5.35^{b}	0.12^{d}	0.40^{a}	4.37^{d}	0.20^{f}
Mean±SD		4.63±0.14	0.30±0.02	0.33±0.02	4.51±0.03	2.23±0.11
LSD		0.25	2.81	3.11	6.11	0.19
CV (%)		3.03	5.21	5.28	0.76	4.78
Sig. (*p*)		**	**	**	**	**

Values are expressed as mean of three replicates; Values with different superscripts within the same column are significantly different from each other at p<0.05.

Flavonoids value ranged from 0.28 g/100g to 0.40 g/100g. Statistical analysis showed significant difference in flavonoid among the accessions. This value contrasts with the 2.21-2.24 g/100g flavonoid values observed in seeds of six species of *S. stenocarpa* by Onuoha *et al.* [24]. The presence of flavonoids in the seeds, albeit at low level, indicates that its consumption may result in decrease in the absorption of non-heme iron in the intestine and may also inhibit cellular uptake of vitamin C. Phytic acid content ranged from 3.29 mg/g to 5.54 mg/g. Statistical analysis showed significant difference in Phytic acid among the accessions. This value was similar to 1.35-4.93 mg/g observed in seeds of 30 accessions of *V. subterranea* by Unigwe *et al.,* [25]. The presence of phytic acid in the seeds, albeit at very low level, may reduce the nutritional quality of the accessions by making the nutrients unavailable through inhibition of activities of gastrointestinal enzymes such as tyrosinase, pepsin, trypsin, lipase, and amylase. Tannin content ranged from 0.20 mg/g to 5.26 mg/g. Statistical analysis showed significant difference in tannin among the accessions. This value contrasts with the 0.10-0.14 mg/g tannin observed in seeds of six species of *S. stenocarpa* by Onuoha *et al.* [24]. The high tannin content may result in reduction in nutritional quality of the accessions by making the protein unavailable through inhibition of the activities of digestive enzymes (chymotrypsin, trypsin, amylase, and lipase) present in the seeds while also interfering with dietary iron absorption [26].
It can be observed from these results that the accessions exhibited diversity, in both proximate and antinutritional characteristics. They are quite rich in nutritional characteristics, though they also contained appreciable quantities of antinutritional factors but these could be reduced or eliminated through adequate processing.

4. CONCLUSIONS

From the results presented above, it can be concluded that the seeds of *V. subterranea* are quite rich in nutritional and anti-nutritional compounds. They also exhibited diversity in these characteristics. It can also be concluded that TVSu 352 is the most-nutritious among the accessions studied and can therefore be recommended for human consumption, though with adequate processing, or industrial utilization in the formulation of animal feed and ultimately widespread cultivation and possible development as a cultivar but further study is required to unravel its yield stability and pest/ disease resistance status.

ACKNOWLEDGEMENT

The authors are grateful to the Genetic Resources Centre (GRC), International Institute of Tropical Agriculture (IITA), Ibadan for the provision of the accessions utilized in this study.

CONFLICTS OF INTEREST

No conflict of interest was declared by the authors.

REFERENCES

[1]. Azam-Ali, S. N., Sesay, A., Karikari, S. K., Massawe, F. J., Aguilar-Manjarrez, J., Bannayan & Hampson, K. J. (2001). Assessing the potential of an underutilized crop: A case study using Bambara groundnut. *J. of Experimental Agriculture.* 37: 433-472.

[2]. Anchirinah, V. M., Yiridoe, E. K. and Benneh-Lartey, S. O. (2001). Enhancing Sustainable Production and Genetic Resources Conservation of Bambara Groundnut: A Survey of Indigenous Agricultural Knowledge System. *Outlook on Agric.* 30: 281-288.

[3]. Adebowale, K.O., and Lawal, O. S. (2002). Effect of Annealing and Heat Moisture Conditioning on the Physicochemical Characteristics of Bambara Groundnut (*Voandzeia subterranea*) starch. *Die Nahrung,* 46(5): 311-316.

[4]. Goli, A. E. (1995). Bibliographical Review of Bambara groundnut. In: *proceedings of the workshop on conservation and improvement of Bambara groundnut*, 14-16 November, 1995, Harare, Zimbabwe. 4-10.

[5]. Fadahunsi, I. F. and Sanni, A. I. (2010). Chemical and Biochemical Changes in Bambara Nut (*Voandzeia subterranea* (L) (Thours) During Fermentation to Tempeh. *Elect. J. Environ. Agric. Food. Chem.*, 9(2): 275-283.

[6]. Silvestrini, V. C., Goncalves, D.B., Granjeiro, P. A. and da Silva, J. A. (2017). Anti-nutritional factors and digestibility of protein in *Cayocar brasiliense* seeds. *Food Sci. Technol, Campinas,* 37(4): 632-639.

[7]. Holloway, W. and Bradbury, J. H. (1999). Anti-Nutritional Factors in Root Crops. *Chemistry of Tropical Root Crops,* 201:11–15.

[8]. Association of Official Analytical Chemists, AOAC (2000). *Official Methods of Analysis.* 17th Edition. The Association of Official Analytical Chemists, Gaithersburg, MD, USA.

[9]. Chinedu, S. N., and Nwinyi, C. O. (2012). Proximate analysis of *Sphenostylis stenocarpa* and *Voadzeia subterranea* consumed in South –Eastern Nigeria. *J. Agric. Ext. Rural Dev.* 4(3): 57 – 62.

[10]. Association of Official Analytical Chemists, AOAC (2005). *Official Methods of Analysis.* 18th Edition. The Association of Official Analytical Chemists,, *Alington,* Washington D.C., USA.

[11]. Eknayake, S., Jansz, E. R. and Nair, B. M. (1999). Proximate composition, mineral and amino acid content of mature *Canavalia gladiata* seeds. *Food Chem.* 66(1):115–119.

[12]. Shamsa, F., Monsef, H., Ghamooshi, R., and Verdian-rizi, M. (2008). Spectrophotometric Determination of total alkaloids in some Iranian Medicinal Plants. *Thai J. Pharm. Sci.* 32: 17-20.

[13]. Mistrello, J. Sirisena, S. D., Ghavami, A., Marshall, R. J., and Krishnamoorthy, S. (2014). Determination of the antioxidant capacity, total phenolic and flavonoid contents of seeds from three commercial varieties of culinary dates. *IJFS.* 3:34-44.

[14]. Wheeler, & Ferrel (1971) In: Okon, E. U. and Akpanyung, E. O. (2005). Nutrients and Antinutrients in selected Brands of Malt Drinks Produced in Nigeria. *Pakistan Journal of Nutrition* 4(5); 352-355.

[15]. Makkar, A. O. S., and Goodchild, A. V. (1996), *Quantification of tannins. A laboratory manual,* ICARDA, Aleppo, Syria.

[16]. Abioye, V. F., Olanipekun, B. F. and Omotosho, O. T. (2015). Effect of Varieties on the Proximate, Nutritional and Anti-nutritional Composition of Nine Variants of African Yam Bean Seeds (*Sphenostylis stenocarpa*). *Donn. J. Food. Sci. Tech.* 1(2): 017-021.

[17]. Ndidi, U. S., Ndidi, C. U., Olagunju, A., Muhammad, A., Billy, F. G. and Okpe, O. (2014). Proximate, Antinutrients and Mineral Composition of Raw and Processed (Boiled and Roasted) *Sphenostylis stenocarpa* Seeds from Southern Kaduna, Northwest Nigeria. *ISRN Nutrition:* 1-9.

[18]. Bello, M. O., Farade, O. S., Adewusi, S. R. A and Olawore, N. O. (2008).Studies of Some Lesser Known Nigerian Fruits. *Afr. Journal of Biotechnology*.7 (1): 3972-3979.

[19]. El-Shemy, H., Abdel-Rahim, E., Shaban, O., Ragab, A., Carnovale, E. and Fujita, K. (2000). Comparison of Nutritional and Antinutritional Factors in Soybean and Fababean Seeds with or without Cortex. *Soil Sci. Plant Nutr.* 46 (2): 515-524.

[20]. Mahala, A. G. and Mohammed, A. A. A. (2010). Nutritive Evaluation of Bambara Groundnut (*Vigna subterranea*) Pods, Seeds and Hull as Animal Feeds. *J. Appl. Sci. Res.,* 6(5): 383-386.

[21]. Pomeranz, Y. and Clifto, D. (1981). Food Analysis Theory and Practices. In: Melon, E. E. (ed) *Chemical Food Analysis Practical Manual – Chemistry*. Avi Publishing Company, Westport, C.T.

[22]. Olaleye, A. A., Adeyeye, E. I. and Adesina, A. J. (2013). Chemical Composition of Bambara Groundnut (*V. subterranea* L. Verdc) Seed Parts. *Bangladesh J. Sci. Ind. Res.* 48(3), 167-178.

[23]. Enwere, N. J. and Hung, Y. C. (1996). Some Chemical and Physical Properties of Bambara Groundnut (*Voandzeia subterranea* Thouars) Seed and Products. *Int. J. Food Sci. Nutri.* 47(6): 469-475.

[24]. Onuoha, C. H., Harry, B. J. and Eze, S. O. (2017). Evaluation of Nutrients and Anti-Nutritional Factors of Different Species of African Yam Bean (*Sphenostylis Stenocarpa*). *European Journal of Basic and Applied Sciences,* 4(1): 1-8.

[25]. Unigwe, A. E., Doria, E., Adebola, P., Gerrano, A. S. and Pillay, M. (2018). Anti-nutrient analysis of 30 Bambara groundnut (*Vigna subterranea*) accessions in South Africa, *Journal of Crop Improvement*, 32:2, 208-224.

[26]. Felix, J. P., and Mello, D. (2000). *Farm Animal Metabolism and Nutrition.* Wallingford, Oxfordshire, United Kingdom: CABI Publishers.