

# Chemical Composition and Antioxidant Capacity of Some Selected Underutilised Bean Seeds Varieties

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**Abstract** – The effect of climate change on plant biodiversity, thereby affecting the number of such plant foods varieties for use in solving food insecurity cannot be overemphasized. Four varieties of cooked underutilised bean seeds (*Cajanus cajan*, *Sphenostylis stenocarpa*, *Phaseolus lunatus 1*, and *Phaseolus lunatus 2*) which are rarely consumed were evaluated for proximate and mineral compositions using standard analytical methods. Antioxidant activity and total phenolic content of the aqueous extracts of the seed flours were determined using Ferric-ion Reducing Antioxidant Potential (FRAP) assay and Folin Coicalteu method respectively. Percentage moisture of the samples ranged from 9.24 – 9.96; crude protein 20.79 – 22.72; fat 5.19 – 5.65; crude fibre 3.26 – 7.91; ash 3.37 – 5.94; with high metabolisable energy. Essential minerals such as K, Ca, and P were present at significantly high levels ( $p < 0.01$ ) while the Na-K and Ca-P ratios for the samples were less than 1 indicating their suitability as diets for diabetic patients and food formulation for bone formation in children. Antioxidant activity of the samples ranged from 424.0 – 1295.7 mgGAE/100g while the total phenolic content ranged from 2740 – 5400 micromole GAE/g suggesting that the consumption of the bean seeds can be utilized as scavengers of free radicals produced by environmental pollution and essential body metabolic reactions. It is hoped that the inclusion of these underutilized bean seeds varieties in the diet will be a relief to the burden placed by the adverse effect of seasonal climatic changes on agriculture, thereby increasing food security.

**Keywords** – Antioxidant, Climate Change, Diseases, Environmental Pollution, Free Radicals.

## I. INTRODUCTION

The impact of food security on the populace as a result of climate change on the quality and quantity of agricultural products is increasing in most countries of the world. About, 870million people remain hungry as the world is increasingly faced with a double burden of malnutrition which affect more than 1.4billion people [1].

The burden of feeding a growing global population is made heavier by this adverse effect of climate change on food production. Currently, the world population is projected to swell from 6.8billion to 9.1billion by 2050 [2] with most of the growth in the developing countries.

In order to avert this trend, urgent action needs to be taken in solving the effect of the food insecurity brought

by the drastic change of climate and the resultant incidence in diseases. To this end, plant foods reported to be major sources of nutrients and provision of optimum health [3] need an in-depth research.

As such some selected underutilised bean seeds (*Cajanus cajan*, *Sphenostylis stenocarpa*, *Phaseolus lunatus 1*, and *Phaseolus lunatus 2*) were evaluated for nutritional potentials and antioxidant capacity. These are legumes reported to have nutritive and medicinal values [4]. The four selected bean seeds are known to form part of nigerian diet in various forms. However, the limitation of long cooking hours due to hard shell is a major drawback. It is hoped that the results of this study will provide the much needed information as to the potentials of the underutilised seeds as vital sources of natural antioxidants which are reported as scavengers of free radicals thereby reducing the occurrence of chronic and degenerative disease [4].

## II. MATERIALS AND METHODS

**Collection of the samples:** The bean seeds were purchased from local markets located in Iworoko – Ekiti, in Ekiti State, Nigeria.

**Preparation of the samples:** Five hundred grams of the bean seeds were weighed and subjected to cooking. Pigeon pea and African yam bean seeds were soft and presumed suitable for consumption after 2hrs while that of Lima bean seed 1 and Lima bean seed 2 took about 3hrs. The samples were oven dried and powdered for subsequent analysis.

**Proximate analysis:** The samples were analysed for proximate compositions according to the method of AOAC [5]. The analysis of the samples was carried out in triplicates.

**Mineral analysis:** Potassium and sodium were determined using a flame photometer (FP, model 140) and KCl and NaCl were used to prepare the standards. Phosphorus was determined by spectrophotometer. All other minerals were determined by atomic absorption spectrophotometer (Perkin- Elmer Model 403, Norwalk CT). All determinations were done in triplicates and the minerals were reported in mg/100 g.

**Antioxidant Activity (AA):** Antioxidant activity was determined using Ferric-ion Reducing Antioxidant potential (FRAP) assay method. [6]. The results were expressed as mg Gallic acid equivalent (mg GAE/100g sample).

**Total phenolic content (TPC):** Total phenolic content (TPC) was determined using Folin-Coicalteu method [7]. Analyses for each sample were determined in triplicates and their results were expressed as Gallic acid equivalent (micromole GAE/g).

### III. STATISCAL ANALYSIS

Three replicates of each sample were used for statistical analysis correlation analysis of TPC(y) against AA(x) were carried out using the correlation and regression program in Microsoft Excel (2007)

### IV. RESULTS AND DISCUSSION

Table 1 presents the results of proximate composition of

Table 1: % proximate composition of some selected underutilized leguminous seeds

Components	Sample A	Sample B	Sample C	Sample D	Mean	(±) SD	% CV
Moisture Content	9.24(±0.04)	9.95(±0.11)	9.70(±0.02)	9.52(±0.02)	9.60	0.30	3.31
Protein	22.52(±0.50)	20.79(±0.25)	21.23(±0.5)	22.72(±0.49)	21.82	0.95	4.35
Fat	5.22(± 0.01)	5.19(± 0.02)	5.34(±0.01)	5.65(±0.01)	5.35	0.21	3.93
Ash	5.94(± 0.05)	3.37 (± 0.02)	4.37(±0.02)	4.00 (±0.14)	4.42	1.09	24.66
Fibre	7.91(± 0.01)	6.19 (± 0.08)	3.26 (±0.01)	5.14(± 0.01)	5.63	1.95	34.64
Cho	49.18(±0.51)	54.54(±0.54)	56.11(±0.5)	52.98(±0.41)	53.20	2.97	5.58
Metabolisable Energy (KJ/100g)	1412.08	1472.64	1512.36	1495.95	1473.26	43.92	2.98

#### Legend

± S.D = Standard deviation in parenthesis

CV = Co-efficient of Variance

Sample A – *Cajanus cajan* (Pigeon pea)

Sample B - *Sphenostylis stenocarpa* (African Yam bean)

Sample C – *Phaseolus lunatus* (Lima Bean 1)

Sample D – *Phaseolus lunatus* (Lima Bean 2)

The present results of mineral analysis of the bean seed varieties in table 2 showed that the bean seeds as consumed are good sources of minerals. Phosphorus is always found with Calcium in the body, contributing to the blood formation and supportive structure of the body is significantly higher than other minerals. Low Ca/P ratio facilitates decalcination of Calcium in the bone leading to low Calcium levels in the bones [12]. The ratio of Na/K in the body of great concern for prevention of high blood pressure. Na/K ratio less than 1 is recommended. The

the four bean seed varieties as consumed. The percentage moisture content of (9.24 – 9.95)% for the bean seed varieties is comparable to the value 9.80% obtained for African yam bean reported by [8]. It was sufficient low enough to enhance better shelf life of the seeds. The crude protein value of (20.79 – 22.72)% is considered high to be protein-rich sources and favourably compared with 20.6% reported for some edible leguminous seed flours [9]. The fibre content of (3.26 – 7.91)% is an added advantage at nutrition wise when compared with the value 16.8% reported for (*Caesalpinia pulcherima*) [10], the fat value of (5.19 – 5.34)% falls within the values of (5.84-10.20)% as reported for some edible leguminous seed flours [8]. Similar trend was observed for a low total ash of (3.37 – 5.94)% as reported for African yam bean flour and pigeon pea flour [11]. The metabolisable energy of the bean seed varieties (1412.08 – 1512.36)% is considerably high to serve as veritable source of energy. It is however low when compared with processed Bambara groundnut (pride of Barbados) [10].

Na/K ratio for the bean seeds under consideration is less than one; hence the bean seeds when consumed would probably reduced high blood pressure related diseases. It has been reported that foods with low Na and high values such as vegetables, fruits and low sodium-cereals can be consumed with animal proteins [13]. Cu has the lowest occurrence when compared to all the other elements, this is in agreement with the observation of [10]. The study reveals that bean seeds varieties can be good sources of mineral supplement in our diet.

Table 2: Mineral composition of some selected underutilised leguminous seeds

Minerals (mg/100g)	Sample A	Sample B	Sample C	Sample D	Mean	(±) SD	% CV
Na	4.77	5.03	4.50	4.76	4.77	0.22	4.61
K	10.54	2.13	11.35	13.87	11.97	1.42	11.86
Ca	46.52	45.64	44.95	37.88	43.75	3.96	9.05
M	32.58	30.74	28.76	33.81	31.47	0.20	6.99

Zn	2.30	2.68	3.02	3.06	2.77	0.35	12.64
Fe	2.40	2.58	2.57	2.53	2.52	0.08	3.17
Cu	1.13	1.00	1.05	1.30	1.12	0.13	11.61
Mn	0.65	0.64	0.69	0.71	0.67	0.03	4.48
Pb	N.D	N.D	N.D	N.D	N.D	N.D	N.D
P	385.61	432.33	378.76	465.32	415.51	40.86	9.83
Na/K	0.45	0.41	0.40	0.34	0.4	0.05	12.5
Ca/P	0.12	0.11	0.12	0.08	0.11	0.02	18.18

**Legend**

± S.D = Standard deviation in parenthesis

CV = Co-efficient of Variance

Sample A – *Cajanus cajan* (Pigeon pea)

Sample B – *Sphenostylis stenocarpa* (African Yam bean)

Sample C – *Phaseolus lunatus* (Lima Bean 1)

Sample D – *Phaseolus lunatus* (Lima Bean 2)

Table 3 presents the Antioxidant Activity (AA) of the samples. The results ranged from 424.0 mgGAE/100g in *Sphenostylis stenocarpa* (African yam bean) to 1298.7 mgGAE/100g in *Phaseolus lunatus* 1 (Lima bean 1). However, this present study revealed that cooked underutilised leguminous bean seeds such as *Cajanus*

*cajan*, *Sphenostylis stenocarpa*, *Phaseolus lunatus* 1, and *Phaseolus lunatus* 2 are good for consumption when compared with the antioxidant capacity of some selected fruits (0.93 – 4.61 ) Trolox equivalent ml as reported by [14].

**Table 3: Antioxidant Activity of some selected underutilised leguminous seeds (mgGAE/100g).**

Samples	C1	C2	C3	Mean	(±)S.D	CV%
A	928	956	944	942.7	14.05	1.490
B	412	436	424	424.0	12.00	2.830
C	1276	1320	1300	1298.7	22.03	1.696
D	1048	1064	1056	1056.0	8.00	0.758

**Legend**

± S.D = Standard deviation in parenthesis

CV = Co-efficient of Variance

Sample A – *Cajanus cajan* (Pigeon pea)

Sample B - *Sphenostylis stenocarpa* (African Yam bean)

Sample C – *Phaseolus lunatus* (Lima Bean 1)

Sample D – *Phaseolus lunatus* (Lima Bean 2)

Table 4 presents the Total phenolic content (TPC) of the samples. The results ranged from 2740 micromoles GAE/g in *Sphenostylis stenocarpa* (African yam bean) to 5400 micromole GAE/g in *Phaseolus lunatus* (Lima bean 1).

The values were found in lower concentration when compared with those reported in selected fruits, vegetables, and grain products. [15].

**Table 4: Total phenolic content of some selected underutilised leguminous seeds (micromoleGAE/g).**

Samples	A1	A2	A3	Mean	(±)S.D	CV%
A	3772	3800	3780	3784	14.42	0.38
B	2740	2728	2572	2740	12.00	0.44
C	5384	5428	5388	5400	24.33	0.45
D	4896	4868	4900	4888	17.44	0.36

**Legend**

± S.D = Standard deviation in parenthesis

CV = Co-efficient of Variance

Sample A – *Cajanus cajan* (Pigeon pea)

Sample B - *Sphenostylis stenocarpa* (African Yam bean)

Sample C – *Phaseolus lunatus* (Lima Bean 1)

Sample D – *Phaseolus lunatus* (Lima Bean 2)

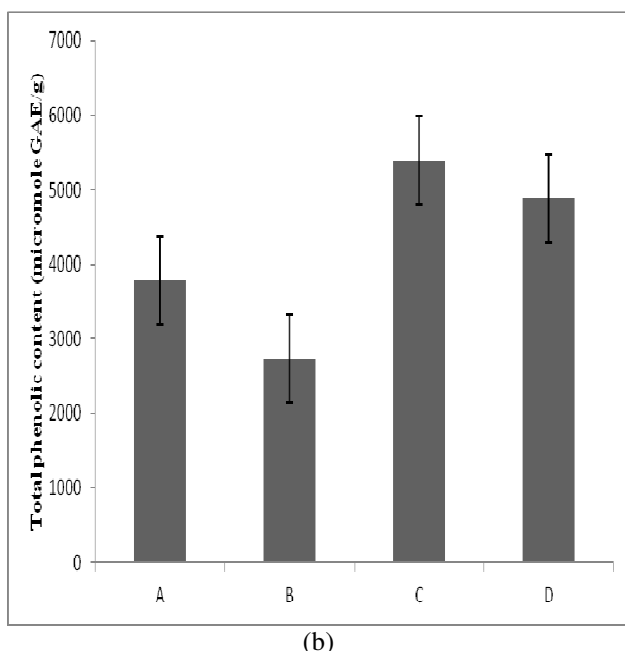
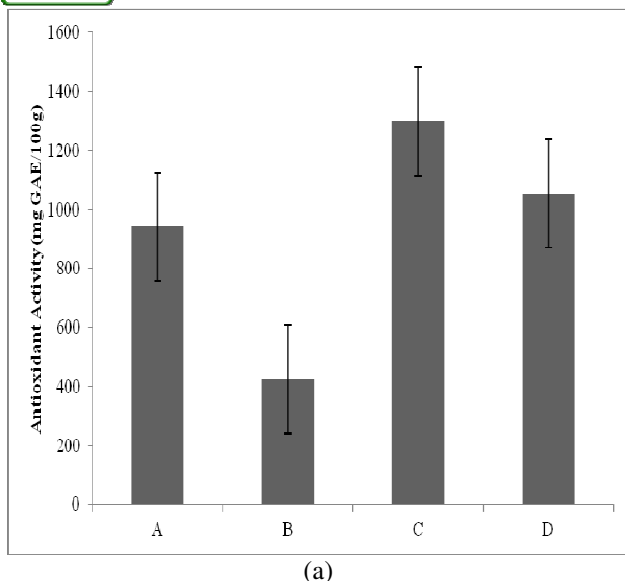


Fig.1. (a) (b) Free Radical Antioxidant Power (FRAP) and Total phenolic content of some selected underutilised leguminous seeds.

#### Legend

- Sample A – *Cajanus cajan* (Pigeon pea)  
 Sample B - *Sphenostylis stenocarpa* (African Yam bean)  
 Sample C – *Phaseolus lunatus* (Lima Bean 1)  
 Sample D – *Phaseolus lunatus* (Lima Bean 2)

Antioxidant activity of the aqueous extracts of the bean seeds varieties is as shown in Fig. 1a. the AA of the *Phaseolus lunatus* was found to be significantly higher ( $P < 0.001$ ) than other varieties. The general order of the AA in the seed varieties is *Phaseolus lunatus* 1 > *Phaseolus lunatus* 2 > *Cajanus cajan* > *Sphenostylis stenocarpa*. similar trend was observed with total phenolic content.

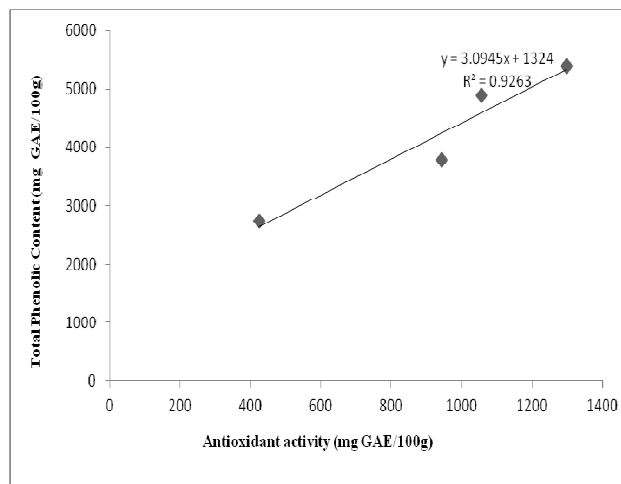


Figure 3: Relationship between the Antioxidant activity and total phenolic content of some selected underutilised leguminous bean seeds.

The relationship between antioxidant activity and total phenolic content (Figure 3) reveals coefficient of determination ( $R^2$ ) of 0.9263. This suggests that phenolic compounds contribute 92% to antioxidant activity from the underutilised bean seeds extract of the four underutilised bean seeds considered in this determination. This also implies that antioxidant activity of these bean seeds extracts is not limited to phenolic compounds alone, other metabolites like volatile oils, carotenoids, flavonoids and vitamins may contribute to the antioxidant activity of the extracts of these underutilised bean seeds [14].

#### Conclusion

Chemical compositions and high antioxidant capacity suggests that the consumption of these bean seeds needs to be encouraged as they are rich sources of nutrients, minerals and natural sources of dietary antioxidants that are capable of ensuring good health that can possibly alleviate symptoms associated with chronic and neurodegenerative disease.

It is hoped that the current estimated effect of climate change that could put more than 63 million people at risk of hunger by 2020 could be averted through agriculture by planting and utilization of these underutilised leguminous bean seeds in the diets.

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