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Chemical Composition, Antioxidant Capacity and Total Phenolic Content of the Flours Obtained from Cow Pea (*Vigna ungualata)* Varieties Commonly Consumed in Nigeria

Ibiyinka Ogunlade[1], Roseline Taiwo Ogunleye[1] and Ilesanmi Osasona[2*]

[1]Department of chemistry, Ekiti State University, Ado -Ekiti, Nigeria.
[2]Deparment of Chemical Sciences, Afe Babalola University, Ado-Ekiti, Nigeria.

Authors' contributions

This work was carried out in collaboration between all authors. Author IO designed the study, wrote the protocol and wrote the first draft of the manuscript. Authors RTO and IO managed the analyses of the study. Author IO managed the literature searches. All authors read and approved the final manuscript.

Original Research Article

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ABSTRACT

Aim: To determine the proximate, mineral composition, antioxidant capacity and total phenolic content of the flours of four varieties of cow pea commonly consumed in Nigeria and to examine the influence of the colour of the beans' hull on the antioxidant capacity of the bean varieties.
Place and Duration of Study: The experiments on proximate and mineral composition were performed in Chemistry Laboratory of Ekiti State University, Ado-Ekiti while those on antioxidant capacity and total phenolic content were conducted in Chemistry Laboratory, Afe Babalola University, Ado-Ekiti, Nigeria.
Methodology: Standard analytical methods were employed to determine the proximate and mineral composition of the flours obtained from four varieties of cow pea *Vigna unguiculata* subsp. dekindtiana, the wild relative of the cultivated subspecies; *Vigna unguiculata* subsp. *cylindrica*, cultivated, catjang; *Vigna unguiculata* subsp. *sesquipedalis*, cultivated, yardlong beans and *Vigna unguiculata* subsp. *unguiculata*, cultivated, black-eyed pea. The antioxidant capacity and total phenolic content of the aqueous extracts were determined using Ferric ion Reducing Antioxidant potential (FRAP assay) and Folin-

**Corresponding author: E-mail: oosasona@yahoo.com;*

Colcalteau method respectively.
Results: The moisture content, crude fibre, ash and fat were generally low in the four varieties with significantly high protein (24.19%-25.74%). Calcium and phosphorous were found to be high in all the varieties. Antioxidant Activity ranged from 44.52-150.05 mgGAE/100g DW while the total phenolic content varied from 88.15-100.02 mgGAE/100 g DW. A linear positive relationship existed between the antioxidant activity and total phenolic content of the cow pea varieties (R^2=0.3333).
Conclusion: This study shows that the four cow pea varieties could serve as good sources of protein, calcium and phosphorous with valuable antioxidant properties. All the varieties could however be utilized in food preparations and formulations for both adults and children.

Keywords: Cow pea; biodiversity; nutritional composition; antioxidant capacity.

1. INTRODUCTION

The role of biodiversity in sustaining food, nutrition and health security with the growing world population and its resultant effect on the environment cannot be over emphasized. Hence the issue of double burden malnutrition and health especially in developing countries calls for nutrient profiles of local functional plant food species and varieties that can bring about the achievement of the Millenium Development Goals (MDGs) [1], concerning eradication of extreme poverty and hunger; reduction of child mortality, improvement of maternal health, combating HIV/AIDS, malaria and other diseases and ensuring environmental sustainability. The concern for health status of the populace has served as impetus for food producers and plant breeders (agriculturists) to develop plant foods and products comprising of high phytochemicals [2].

Many of these phytochemicals possess significant antioxidant capacities that may be associated with lower incidence of chronic diseases e.g. cancer, diabetes and cardiovascular disesaes [3]. The antioxidant capacity of most plant foods have been attributed to the presence of phenolic compounds [4]. The antioxidant activity of phenolic compounds is mainly due to their redox properties which can play an important role in absorbing and neutralizing free radicals [5]. These free radicals are generated in the body metabolic process and environmental pollution.

In Nigeria, legume based foods especially bean seeds cultivars (*Vigna unguiculata* subspecies) form a major component of the diet processed in various forms either as sauces, pudding, soup, cakes additive and/ adjuncts for both adults and children. Currently the food industries are experiencing an increasing demand from the general populace for new ingredients and food packages in response to the growing awareness of natural antioxidants and their potential health benefits. This study, therefore, was aimed at investigating some bean varieties- *Vigna unguiculata* subsp. *dekindtiana*, the wild relative of the cultivated subspecies;*Vigna unguiculata* subsp. *cylindrica*, cultivated, catjang; *Vigna unguiculata* subsp. *sesquipedalis*, cultivated, yardlong beans and *Vigna unguiculata* subsp. *unguiculata*, cultivated, black-eyed pea.commonly consumed in Nigeria as potential sources of dietary antioxidants. The proximate composition and the mineral content of the bean varieties were evaluated. Our study also demonstrates a possible relationship between total phenolic content and antioxidant activity.

2. MATERIALS AND METHODS

Four bean varieties commonly consumed in Nigeria were obtained from Oba Market, Ado-Ekiti, Ekiti State, Nigeria. Twenty grams (20 g) of each variety was weighed, homogenized with 100ml distilled water and centrifuged. The supernatant was used for phytochemical analyses.

Moisture, crude protein, crude fat and ash of the dry and powdered bean seeds were determined according to AOAC [6]. Sodium and potassium were determined using a flame photometer (Corning, UK model 405). Phosphorous was determined colourimetrically using spectronic 20 (Gallenkamp, UK) as in Ogunlade et al. [7]. All other minerals were determined using Atomic absorption spectrophotometer. Antioxidant activity was determined by Ferric ion Reducing Antioxidant Potential (FRAP assay) according to the method of Chan et al (2007) [8] and is presented as milligram gallic acid equivalent (mgGAE/100 g). Total phenolic content was done by Folin-Coicalteau method [9]. The matabolisable energy was estimated from the equation below:

Metabolisable energy = (% protein x 17 + % fat x 37 + % carbohydrate x 17) KJ/100g.

3. RESULTS AND DISCUSSION

Table 1 presents the results on moisture, protein, fat, ash, fibre and carbohydrate contents of the four varieties of *Vigna unguiculata* (bean seeds) while Table 2 presents the mineral composition. Fig. 1a and 1b present the antioxidant capacity and total phenolic content of the aqueous extract of the bean flours. The results of the proximate composition are reported in percentages dry sample. Mineral contents are reported in mg/100g dry sample. The samples contained low moisture content which varied from 8.3% (*Vigna unguiculata*subsp. *dekindtiana*, to 8.93% *Vigna unguiculata subsp. cylindrical*. The low value is due to preservation before sale for consumption. The crude protein varied from 24.19% in *Vigna unguiculat*a subsp. *sesquipedalis* to 26.59% in *Vigna unguiculata*sub sp. *dekindtiana*. These are comparable with the results of crude protein in protein-rich foods such as soy beans (24.9%), pigeon pea (22.4%) [10]. The crude fat and crude fibre contents are low when compared with other leguminous seeds [7]. However, the ash content which varied from 3.66-3.85% is comparable with that of calabash seed's kernel [11]. The carbohydrate content of the cow pea varieties ranged from 57.07 -58.68.

Table 1. Proximate composition of bean seeds varieties

Sample	Crude protein (%)	Fat (%)	Fibre (%)	Moisture (%)	Ash (%)	CHO (%)	Energy KJ/100g
A	26.59±0.57	2.65±0.02	1.74±0.01	8.30±0.49	3.66±0.01	57.07±0.08	1521.97
B	25.74±0.57	3.11±0.01	1.01±0.01	8.93±0.04	3.83±0.01	57.38±0.62	1528.11
C	24.19±0.58	2.24±0.01	2.33±0.01	8.72±0.02	3.85±0.07	58.68±0.65	1491.67
D	25.21±0.04	2.49±0.01	1.84±0.01	8.55±0.07	3.75±0.04	58.16±0.60	1509.42

A=Vigna unguiculata subsp. dekindtiana, B=Vigna unguiculata subsp. Cylindrical, C=Vigna unguiculata subsp. sesquipedalis, D=Vigna unguiculata subsp. unguiculata, cultivated, black-eyed pea CHO= carbohydrate

The bean seeds have an estimated energy ranging from 1491.67-1528.11 KJ/100g. These values are higher than those reported for some pepper varieties (196.33-255.51KJ/100g) [12] and cereals 1,300-1600KJ/100g [13]. This suggests that the seeds are good sources of energy dietary allowance for children [14].

Table 2 presents the mineral composition of bean varieties. The most abundant mineral is phosphorous 421.56-468.43 mg/100g dry weight followed by sodium. The present results show the bean seeds varieties are good sources of phosphorous. Phosphorous is always found with calcium in the body both contributing to the bone formation and supportive structure of the body. Table 2 further shows that the values for other minerals are low but comparable to values reported for some pepper varieties [12]. Sodium/potassium ratio is less than 1 which suggests that the seeds will be very suitable for hypertensive patients [7]. Although Ca/P ratio is low indicating that bean seeds would be a good source of minerals for bone formation. The ratio of Na/K in the body is of great concern for prevention of high blood pressure; Na/K ratio less than 1 is recommended [15]. The Na/K for the bean seeds varieties under consideration is less than 1 hence most of the samples would probably reduce high blood pressure disease when included in the diet. Copper was not detected while Zn and Mn are the minerals with the lowest values.

Table 2. Mineral Composition of bean seeds varieties (mg/100g)

Mineral	A	B	C	D
K	9.75	10.12	8.53	11.18
Ca	17.77	17.95	22.46	22.63
Na	98.51	95.66	90.58	96.40
Zn	4.59	5.24	5.21	9.50
Fe	3.92	4.51	4.83	4.47
Cu	8.22	8.65	7.58	9.31
Mn	ND	ND	ND	ND
Pb	2.01	2.30	2.08	2.24
P	467.65	468.43	423.24	421.58

Antioxidant capacity and total phenolic content of the aqueous extracts of the bean varieties are shown in Figs. 1a and 1b respectively. The antioxidant capacity ranged from 44.5 (in *subsp. sesquipedalis*) to 150.05 mgGAE/100g dry weight (in *subsp. cylindrica*). It was observed that the brown coated beans showed higher antioxidant capacity than the white varieties Fig. 1a. This could make one suggest that the hull of the brown bean varieties may likely contain β-carotene. Total phenolic content of the bean varieties ranged from 88.19 in *Vigna unguiculata subsp*. *sesquipedalis* to100.2 mgGAE/g DW in *Vigna unguiculata subsp. cylindrica* with *Vigna unguiculata subsp. cylindrica* showing significantly higher TPC.

Table 3. The colour of the different bean varieties

Bean variety	Colour
subsp. dekindtiana	Brown
subsp. cylindrical	Brown
subsp. *sesquipedalis*	White
subsp. *unguiculata*, cultivated, black-eyed pea	White

Fig. 2 shows the relationship between antioxidant capacity and total phenolic content of the bean varieties. The figure reveals that less than 35% (correlation coefficient of 0.3333) of the antioxidant capacity of the cowpea varieties are contributed by phenolic compounds. Other phytochemicals might be responsible for greater percentage of the antioxidant activity of the bean varieties.

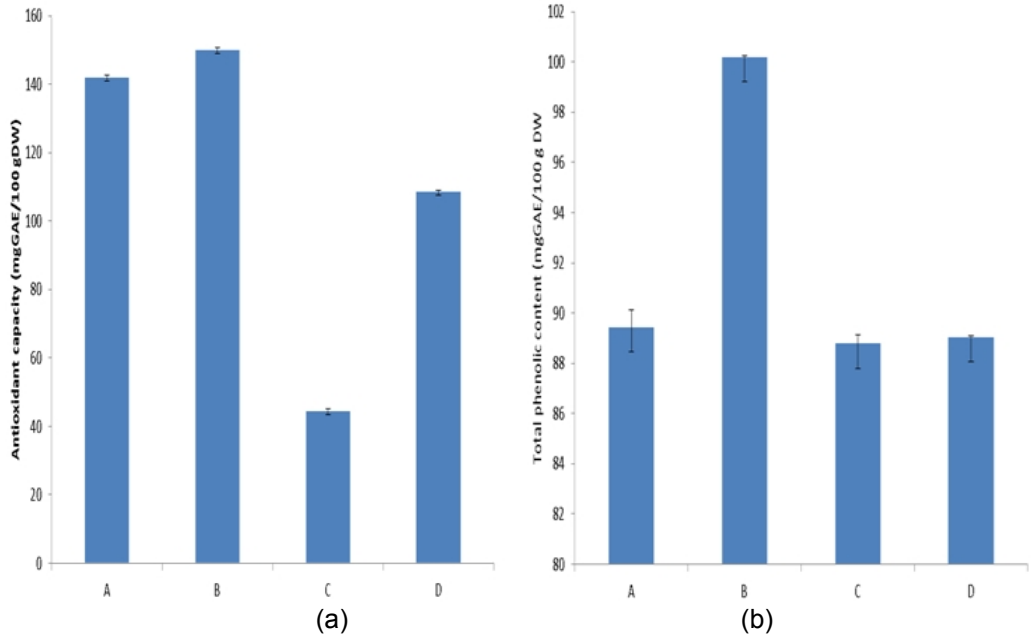

Fig. 1. Antioxidant capacity and Total phenolic content in some commonly utilized bean varieties

A=Vigna unguiculata subsp. dekindtiana, B=Vigna unguiculata subsp. Cylindrical, C=Vigna unguiculata subsp. sesquipedalis, D=Vigna unguiculata subsp. unguiculata, cultivated, black-eyed pea

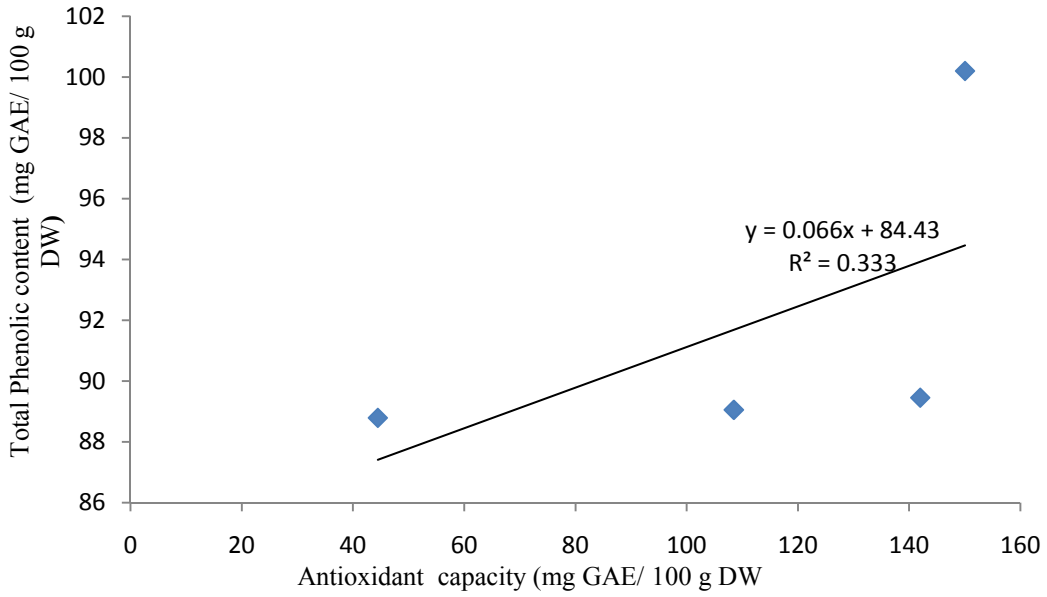

Fig. 2. Relationship between Antioxidant capacity and Total phenolic content in some commonly utilized bean varieties

4. CONCLUSION

The present study showed that bean varieties commonly used in various food preparations and formulations for both adults and children as weaning/complimentary foods in Nigerian diet can be considered as good sources of nutritionally valuable minerals and natural dietary antioxidants and therefore could be utilized as potent scavengers/mopping agents of free radicals which can be utilized to alleviate symptoms associated with chronic, degenerative and age related diseases.

COMPETING INTERESTS

Authors have declared that there are no competing interest exits.

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