



Nutrient and Phytochemical Compositions of Cowpea (*Vigna unguiculata*) Varieties in South-West Nigeria: Implication on Children's Health

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Abstract Background: Malnutrition in children is often associated with infections and diseases that may prevent them from reaching their full potential. Cowpea (*Vigna unguiculata*) seeds contain nutrients and phytochemicals which may vary depending on the variety. We compared the nutrient and phytochemical compositions of selected cowpea varieties consumed in Southwest Nigeria and explored their possible implication on children's health.

Methods: Six varieties of Cowpea seeds; *Olowewe*, *Peu*, *Oloyin*, *Drum*, *Sokoto White* and *Iron* were purchased from Sabo market, Sagamu, Southwest Nigeria. Foreign particles were removed and each variety boiled at 100 °C in 200mL distilled water for 45 minutes, oven-dried at 40°C for 12hrs, milled and kept in an airtight container at 4°C till analysis. Phytochemical content (tannin, saponin, alkaloid, polyphenol) and macronutrients (crude protein, lipids, carbohydrates, fibre) were determined using standard methods. Micronutrients: potassium and sodium were determined using flame photometer while calcium, magnesium, phosphorus, copper, manganese, zinc and iron were determined using AAS. Results were expressed as mean ± SD and compared using ANOVA and Duncan's post-Hoc test. $p < 0.05$ was significant.

Result: Phytochemicals (tannins, saponins, alkaloids and polyphenol), macronutrients (crude protein, fat, carbohydrates and fibre) and micronutrient (calcium, potassium, phosphorus, sodium, copper, zinc, iron except magnesium and manganese showed significant differences ($p < 0.05$).

Conclusion: Cowpea varieties commonly consumed in southwest Nigeria contained significant amounts of nutrients and phytochemicals in varying concentrations. These findings may provide insights and scientific basis for the promotion of consumption of cowpea as a major step in curbing malnutrition in children.

Keywords Cowpea, Malnutrition in children, Nutrient, Phytochemicals

Introduction

Children are at increased demand for nutrients necessary for cognition, development, growth and good health [1]. Malnutrition, which is more common particularly in children in developing countries [2,3], is often associated with infections and diseases that may prevent affected children from reaching their full potential [4]. However, indigenous legumes in these countries have been reported to be excellent sources of affordable nutrients and phytochemicals with health-promoting and protective properties [5]. Cowpea (*Vigna unguiculata*) is the most economically important indigenous legume in Nigeria where a lot of varieties exist [6]. In this country, cow pea is



mainly grown for its edible seeds, which could be boiled or processed into flour to make other food products which may be eaten in the form of pudding, cake, baked beans and soup [7]. These seeds therefore, serve as staple nutritious food that is widely available, acceptable and affordable particularly for the average Nigerian.

Cowpea seeds have been reported to provide essential macronutrients such as protein, carbohydrates, lipids and fibre involved in diverse physiological processes [1]. They also contain micronutrients which include macro-minerals such as calcium (Ca), phosphorus (P), potassium (K), sodium (Na) and magnesium (Mg) and micro-minerals such as iron (Fe), copper (Cu), zinc (Zn) and manganese (Mn). These micronutrients are key factors in metabolism; they act as cofactors in many reactions and also enable the body to produce enzymes, hormones and other substances that are essential for proper growth and development [8]. Cowpea seeds have also been reported to contain phytochemicals which are natural secondary plant metabolites that mainly participate in defence mechanism and provide protection against abiotic or biotic stress in the plant and include alkaloids, saponins, tannins and polyphenols [9,10]. Phytochemicals been reported to have some health-promoting properties and their consumption has been associated with decreased risk of several types of infections and chronic diseases [11].

The nutrient and phytochemical contents of varieties of cowpea seeds have been reported to differ based on climate, fertilization, season, agronomic practices, genetic, environmental and technologic factors [12]. However, there is paucity of data on nutrients and phytochemical concentrations from the cowpea varieties commonly consumed in southwest Nigeria. More so, considering the possible health-promoting benefits of these nutrients and phytochemicals, insufficient attention has been given to children who are the population at greatest risk of malnutrition and its associated infections and diseases. We therefore, determined and compared the nutrient and phytochemical compositions of selected cowpea varieties consumed in southwest Nigeria and explored their relevance to children's health.

Materials and Methods

Seed Collection and Preparation

Six varieties of Cowpea (*Vigna unguiculata*) seeds, [comprising four brown cowpea seeds (*Olowewe, Peu, Oloyin and Drum*) and two white cowpea seeds (*Sokoto White and Iron*)] that are commonly consumed by people living within and around Southwest Nigeria, were bought from Sabo market, Sagamu, Southwest, Nigeria. Each of the varieties of beans was carefully hand-picked to remove any foreign particle, boiled at 100 °C in 200mL distilled water for 45 minutes, oven-dried at 40°C for 12hrs, milled with a mechanical blender (until all the material passed through a 1mm metal sieve) and kept in an airtight container at 4 °C till analysis.

Nutrient Analysis

For macronutrients, the crude fibre was obtained by content by digesting the sample in sulphuric acid and sodium hydroxide solutions and the residue calcined. The difference in weight after calcination indicated the quantity of fibre present [13]. The micro-Kjeldahl method was employed to determine the total nitrogen which was multiplied by a factor of 5.95 [13]. Crude lipids were extracted with petroleum ether, using Soxhlet apparatus [13]. Total carbohydrate was calculated by the difference method [14]. The micronutrients were determined based on the method of Inobeme *et al* [8]. Potassium and sodium contents of samples were determined using flame photometer while the levels of calcium, magnesium, phosphorus, copper, manganese, zinc and iron in the samples were determined by atomic absorption spectrophotometry (Perkin-Elmer, Analysist A700) after digestion with concentrated nitric acid.

Phytochemical Analysis

Tannin content was evaluated using the modified vanillin-HCl methanol method of Okwu and Emenike [15]. Saponin content was evaluated using the method of Okwu and Emenike [15]. Alkaloid concentration was evaluated using the methanol of Onyilagha and Islam [16]. Polyphenol content was determined using the method of Singleton *et al* [17]. All the chemicals and reagents that were used were of analytical grade.



Statistical Analysis

Statistical analysis was carried out in triplicates for all determinations and the results expressed as mean \pm SD. The SPSS version 21.0 was used as the statistical tool. Analysis of Variance followed by Duncan post-hoc test [18], was used to compare the means for the different varieties of cowpea. Results were significant at $p < 0.05$.

Results and Discussion

Macronutrient Compositions of Selected Cowpea Varieties

There were significant differences in the selected cowpea varieties in terms of crude protein, crude fat, total carbohydrates and fibre ($p < 0.05$) (Table 1).

The crude protein content of the cowpea varieties ranged between 21.4 g/100g and 25.8 g/100g (Table 1), which was in consonance with the range reported by Alayande *et al.* [6]. The *drum* variety was observed to have the highest concentration (25.8 g/100g), followed by *oloyin* (24.5 g/100g), *peu* (23.7 g/100g), *sokoto white* (23.6 g/100g), *olowewe* (22.2 g/100g) and *iron* (21.3 g/100g) (Table 1). This result validates cowpea seeds as good sources of plant protein. However, the very high protein content of the *drum* variety makes it appear to be a good source of dietary protein for the synthesis of antibodies, enzymes, hormones, new cell, repair of worn out tissues and transporters of other nutrients [19]. This variety may serve as available and affordable source of plant protein particularly for children owing to their high demands for protein for the developing brain, immune system and general growth and development.

The crude carbohydrate content was found to be in the range of 55.6 g/100g to 63.6 g/100g and appeared to be in line with the report of Alayande *et al.* [6]. *Iron* had the highest carbohydrate content (63.6 g/100g), followed by *Olowewe* (62.8 g/100g), *Oloyin* (61.4 g/100g), *Sokoto white* (59.8 g/100g), *drum* (58.8 g/100g) and *Peu* (55.6 g/100g) ($p < 0.05$) (Table 1). Carbohydrates are good sources of energy. The *iron* variety had the highest carbohydrate content making them good source of higher energy compared to the other selected varieties. This cowpea variety may provide readily available glucose to meet children's glucose demand for brain in order to enhance brain work and sustain academic activities. It may also enhance the energy production for the high physical activity of children.

The crude lipid content of the cowpea varieties ranged between 2.1 g/100g to 3.3 g/100g which appeared to be in line with the reports of Ologhobo and Fetuga [20]. *Peu* had the highest lipid content (3.3 g/100g), followed by *Sokoto white* (2.9 g/100g), *Olowewe* (2.8 g/100g), *Oloyin* (2.58 g/100g), *drum* (2.4 g/100g) and *Iron* (2.1 g/100g) ($p < 0.05$) (Table 1). Lipids provides strong energy and transports fat soluble vitamins like vitamins A, D, E, K. Lipids is also the main source of fatty acids which have been associated with wound healing and immunity [21]. The *Peu* variety because of its high lipid content, may be pivotal in the health of children because of their vulnerability to infections and injuries. The high energy value may also control under-weight in children with increased physical activities [22].

The crude fibre content was found to range between 3.1 g/100g and 5.3 g/100g. This range was similar to the range of 3.9 g/100g to 5.2 g/100g reported by Gibney [23]. In this study, *Peu* had the highest crude fibre content (5.3 g/100g), followed by *Sokoto white* (4.5 g/100g), *iron* (4.3 g/100g), *Olowewe* (3.9 g/100g), *drum* (3.5 g/100g) and *Oloyin* (3.1 g/100g) ($p < 0.05$) (Table 1). Dietary fibre enhances intestinal motility and the activities of probiotics and decreases inter-colonic pressure, hence, reduces the risk of haemorrhoids which are very common in children [24,25]. *Peu* variety appeared to have the highest fibre content as such may to be more beneficial to children.

Table 1: Macronutrient Compositions of Selected Bean Varieties

Cowpea variety	Crude Protein (g/100g)	Crude Lipid (g/100g)	Total Carbohydrates (g/100g)	Crude Fiber (g/100g)
<i>S. white</i>	23.6 \pm 0.1 ^c	2.9 \pm 0.1 ^b	59.8 \pm 0.1 ^c	4.50 \pm 0.0 ^b
<i>Olowewe</i>	22.2 \pm 0.4 ^d	2.8 \pm 0.1 ^{bc}	62.8 \pm 0.8 ^a	3.9 \pm 0.1 ^c
<i>Oloyin</i>	24.5 \pm 0.1 ^b	2.6 \pm 0.1 ^{bcd}	61.4 \pm 0.1 ^b	3.1 \pm 0.1 ^e



<i>Iron</i>	21.3±0.2 ^e	2.1±0.1 ^d	63.6±0.2 ^a	4.25±0.1 ^b
<i>Peu</i>	23.7±0.1 ^c	3.3±0.1 ^a	55.6±0.3 ^d	5.3±0.1 ^a
<i>Drum</i>	25.8±0.0 ^a	2.4±0.2 ^{cd}	58.8±0.0 ^c	3.5±0.1 ^d
<i>F-value</i>	5.469	12.473	9.984	8.593
<i>p-value</i>	0.024	<0.001	0.006	0.010

Values in the same column with different superscripts are significantly different ($P < 0.05$)

S. White = Sokoto White

Micronutrient (Macro- and Micro mineral) Compositions of Selected Cowpea Varieties

There were significant differences in the micronutrient (macro and micro- minerals) concentrations in *Sokoto White*, *Olowewe*, *Oloyin*, *Iron*, *Peu* and *Drum* varieties ($p < 0.05$) (Tables 2 and 3). The micronutrients; Ca, P, Mg, K, Na, Cu, Zn, Fe and Mn were found in appreciable amounts validating the cowpea varieties as rich sources of these minerals. Highest concentrations of K, Ca, P, Na, Fe, Cu and Zn were observed in *Peu* (120.0 mg/100g), *Iron* (304.0 mg/100g), *Olowewe* (51.0 mg/100g), *Sokoto white* (50.4 mg/100g), *olowewe* (5.6mg/100g), *drum* (1.1mg/100g) and *drum* (5.6 mg/100g) respectively ($p < 0.05$) (Tables 2 and 3). However, no significant difference was observed in the concentrations of both Mg (Table 2) and Mn (Table 3) ($p > 0.05$).

Calcium and phosphorus regulate neuromuscular excitability and are involved in blood coagulation, membrane integrity, plasma membrane transport, neurotransmission, bone mineralization and maintenance of healthy teeth [26]. Sodium and potassium are involved in the proper functioning of muscles and nerves, controls blood volume and modulate glucose transport across cell membranes [27]. Copper, zinc, iron and manganese serve as antioxidants, cofactors of enzymes, help to make proteins, boost the immune system to fight infections and accelerate wound healing [28]. The micronutrients which occurred in varying concentrations in the different cowpea varieties are fundamental for the maintenance of undisturbed physiological functions in children owing to their increased metabolic functions, increased demand for nutrients and vulnerability to infections and diseases.

Table 2: Micronutrient (Macromineral) Compositions of Selected Bean Varieties

Cowpea variety	K(mg/100g)	Mg(mg/100g)	Ca(mg/100g)	P(mg/100g)	Na(mg/100g)
<i>S. white</i>	108.0±4.0 ^{ab}	180.0±5.0 ^a	174.0±5.0 ^{acd}	46.0±5.0 ^{acd}	50.0±4.0 ^b
<i>Olowewe</i>	105.0±5.0 ^{ab}	180.0±7.0 ^a	157.0±9.0 ^a	51.0±7.0 ^d	40.0±2.0 ^a
<i>Oloyin</i>	96.0±6.0 ^a	170.0±8.0 ^a	225.0±11.0 ^b	31.0±3.0 ^b	50.0±3.0 ^b
<i>Iron</i>	105.0±6.0 ^{ab}	180.0±10.0 ^a	304.0±4.0 ^d	36.0±3.0 ^{bc}	40.0±2.0 ^a
<i>Peu</i>	120.0±8.0 ^b	193.3±17.0 ^a	245.0±8.0 ^c	33.0±6.0 ^{bc}	50.0±3.0 ^b
<i>Drum</i>	109.0±9.0 ^{ab}	190.0±9.0 ^a	160±6.0 ^a	16.0±2.0	40.0±6.0 ^b
<i>F-value</i>	4.226	1.034	17.903	15.855	6.154
<i>p-value</i>	0.019	0.146	<0.001	<0.001	0.005

Values in the same column with different superscripts are significantly different ($P < 0.05$)

S. White = Sokoto White, K = potassium, Mg = magnesium, Ca = calcium, P = phosphorus, Na = sodium,

Table 3: Micronutrient (Micromineral) Compositions of Selected Bean Varieties

Cowpea Variety	Mn (mg/100g)	Fe (mg/100g)	Cu (mg/100g)	Zn (mg/100g)
<i>S. white</i>	2.9±0.4 ^a	2.4±0.3 ^d	1.0±0.2 ^a	1.1±0.2 ^e
<i>Olowewe</i>	2.1±0.3 ^c	5.6±0.7 ^a	0.5±0.1 ^{cd}	4.9±0.4 ^c
<i>Oloyin</i>	2.4±0.3 ^b	4.7±0.4 ^b	0.6±0.1 ^c	5.2±0.6 ^b
<i>Iron</i>	2.3±0.3 ^b	4.5±0.5 ^b	0.4±0.1 ^d	3.6±0.7 ^d
<i>Peu</i>	2.3±0.2 ^b	3.6±0.4 ^c	0.8±0.2 ^b	5.0±0.8 ^c
<i>Drum</i>	2.4±0.3 ^b	3.3±0.5 ^c	1.1±0.3 ^a	5.6±1.7 ^a
<i>F-value</i>	2.541	16.736	7.080	25.253
<i>p-value</i>	0.086	<0.001	0.003	<0.001

Values in the same column with different superscripts are significantly different ($P < 0.05$)

S. White = Sokoto White, Mn = manganese, Fe = iron, Cu = copper, Zn = zinc



Phytochemical Composition of Selected Cowpea Varieties

The selected cowpea varieties were observed to be rich in saponins, tannin, alkaloids and polyphenol validating them as valuable sources of these phytochemicals which showed significant differences in their concentrations ($p < 0.05$) (Table 4). *Peu* had the highest Saponin content (2.1 mg/100g). Saponins have been reported to lower serum cholesterol and the incidence of cardiovascular disorders [29]. *Peu* variety may be useful in controlling the incidence of obesity and hypertension in children. *Olowewe* had the highest alkaloid (0.4 mg/100g), highest tannin (4.3 mg/100g) and polyphenol (4.4 mg/100g) contents. Alkaloids and tannins are basic medicinal agents for their analgesic, antispasmodic and bactericidal effects [30,31]. Polyphenols also have been reported to offer some protection against development of infections and chronic diseases such as cancer, cardiovascular and cerebrovascular diseases through its strong antioxidant activity that suppresses the generation of free radicals in the body [11]. *Olowewe* variety may protect children against infections and non-communicable diseases even when they advance in age.

Table 4: Phytochemical Composition of Selected Cowpea Varieties

Cowpea variety	Saponin (mg/100g)	Alkaloid (mg/100g)	Tannin (mg/100g)	Polyphenol (mg/100g)
<i>S. white</i>	1.8±0.0 ^c	0.2±0.0 ^d	2.9±0.0 ^c	3.4±0.6 ^b
<i>Olowewe</i>	1.1±0.0 ^d	0.4±0.0 ^a	4.3±0.2 ^a	4.4±0.3 ^a
<i>Oloyin</i>	1.9±0.1 ^b	0.4±0.0 ^{ab}	3.7±0.1 ^b	4.4±0.1 ^a
<i>Iron</i>	1.0±0.1 ^d	0.3±0.0 ^b	2.9±0.2 ^c	3.4±0.1 ^b
<i>Peu</i>	2.1±0.0 ^a	0.3±0.0 ^c	1.9±0.1 ^d	3.1±0.1 ^{bc}
<i>Drum</i>	1.8±0.0 ^c	0.2±0.0 ^d	1.6±0.2 ^d	2.4±0.0 ^c
<i>F-value</i>	4.185	8.328	12.985	9.344
<i>p-value</i>	0.020	0.009	<0.001	0.004

Values in the same column with different superscripts are significantly different ($P < 0.05$)

S. White = *Sokoto White*

Conclusion

The findings from this study validate the cowpea varieties (*Sokoto White*, *Olowewe*, *Oloyin*, *Iron*, *Peu* and *Drum*) commonly consumed in southwest Nigeria, as rich sources of nutrients and phytochemicals which appeared to be in different concentrations. These nutrient and phytochemical compositions may curb malnutrition and confer protection against infections and diseases particularly in children even as they advance in age. The findings from this study may provide insights and scientific basis that may instigate the promotion of consumption of cowpea seeds as a major step in curbing malnutrition and infections which are prevalent in children in developing countries. The data from the study may also provide a basis for policy formulation by the food and health sectors.

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