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Physicochemical and Functional Properties of Some Nigerian Cowpea Varieties

C.E. Chinma[1], I.C. Alemede[2] and I.G. Emelife[1]
[1]Department of Food Science and Nutrition, Federal University of Technology, Minna, Nigeria
[2]Department of Animal Production, Federal University of Technology, Minna, Nigeria

Abstract: The physicochemical and functional properties of four local varieties of cowpea seeds (Achishiru, Akidi, Jokada and Odudu) in Nigeria were studied. Length, major and minor diameter of seeds were in the range 6.70-12.90 mm, 3.33-5.58 mm, 3.18-4.65 mm while grain weight of seeds varied between 8.40 to 34.90 g. Cooking time ranged from 28.00 to 40.00 min. Cooking yield were in the range of 55.43 to 59.77% and the dissolved solid ranged from 0.27 to 0.93%. Cowpea seeds contain high value of crude protein in the range of 25.79 to 29.25%. Moisture, dry matter, fat, ash and crude fibre value were in the range of 8.57 to 10.07%, 89.93 to 91.44%, 0.79 to 3.18%, 2.72 to 3.73% and 1.92 to 3.37% respectively. Carbohydrate content varied between 53.56 to 57.36%, while energy value ranged from 337.57 to 360.67 Kcal / 100g. Cowpea seed flours were good sources of calcium (424.00-582.00 mg /100g), iron (4.00-4.82 mg /100g), magnesium (128.54-145.12 mg /100g) and copper 5.55-6.13 mg /100g water absorption capacity varied between 1.60 and 1.94 g/g while oil absorption capacity ranged from 0.35 to 0.54 g/g. Bulk density and foam capacity were in the range 0.29 to 0.40 g /mL and 100.52 to 126.50 mL. Foam stability and Nitrogen solubility showed high value. The cowpea seed flours are functional foods for nutrition and utilization.

Key words: Cowpea seeds, physicochemical and functional properties

Introduction

Cowpea (*Vigna unguiculata* (L.) Walp), like other grain legume is an important foodstuff in tropical and subtropical countries. It is widely cultivated and distributed in Africa, Asia, West Indies, Latin America and India. The legume can be grown in marginal soils and in arid or semi arid regions. Its deep penetrating root system enables it to withstand very dry conditions. Cowpea provide essential nutrients and high level of protein (about 25%) making it extremely valuable where many people cannot afford protein foods such as meat and fish (Akpapunam and Sefa-Dedeh, 1997). The protein have a well recognized deficiency of the essential sulphur-bearing amino-acid, methionine and cystine but are comparatively rich in lysine; therefore a combination of cereal protein and legume protein such a s cowpea come very close to providing an ideal source of dietary proteins for human beings (Ihekoronye and Ngoddy, 1985). Cowpea are excellent sources of vitamins such as vitamin B and other trace elements in the diet of most rural populace (Bressani and Elias, 1984).

In Nigeria, cowpea are mainly prepared and eaten as a whole or part of a meal. The most common dishes being moi-moi (steamed bean cake), akara (fried bean balls), apapa (steamed cake with bitter pepper). In developed world, cowpea is technologically processed into flour and used in various preparation such as protein concentrate and isolates for the formulation of animal feed.

Cowpea production in Nigeria has more than double in the last 5 years and the production in 2003 alone was about 735,000 metric tones. There are several cowpea cultivars grown in Nigeria. Although many new cowpea cultivars are being developed in order to improve yield, crack resistance, quality of cowpea etc, there are still some wild cultivars that have potentials not harnessed or that its utilization have been neglected.

Therefore, information about the physicochemical and functional properties of these under utilized varieties are very important to the food processors and nutritionist. The food processors need to understand what they are working with and what happen to the quality of the grains when they are subjected under various conditions of food processing. The design of appropriate machinery for mechanizing the processing of any food product such as cowpea requires knowledge of the physical properties of the seeds. The identification of some functional properties of these local varieties of cowpea is essential in determining potential uses of such seeds in the formulation of foods.

The objective of this research work was to determine the physicochemical and functional characteristics of four local varieties of cowpea seeds, namely: Achishuru, Akidi, Jokada and Odudu.

Materials and Methods

Sources of raw material: Four local varieties of cowpea seeds namely: Achishiru, Akidi, Jokada and Odudu were purchased from paiko market, Minna modern market, Bida modern market in Niger State while latter was purchased from Bujju market in Southern Kaduna Nigeria.

Sample preparation: Extraneous matter such as unhealthy seed, insect infested seed, sand and chaff were removed from the samples before processing. Cowpea seeds were separately milled with an attrition mill (Model no ED-5) and sieved to a particle size of 1 mm. Flour samples were packaged in low density polyethylene bags and stored using covered plastic containers in a freezer at -18°C.

Determination of physical properties

Seed colour: The colour of seeds were determined according to the method of Gomez *et al*. (1997). The colour was effectively observed by placing 20 grain samples on a sheet of white paper. The difference in colour of the pericarp (outer coat of the grain) was recorded.

Major and minor diameter: The major diameter of seeds were determined by the measure of cowpea in its greatest dimension and the minor diameter was measured at the dorsal side as described by Dela and Khush (2000). The parameters were measured with micro-screw-meter-gauge. The results obtained were recorded as average values of three determinations in millimeter.

100 seed weight: The seed weight was determined by weighing 100 randomly selected raw seeds of each variety (AOAC, 2000).

Cooking time: Cooking time of each cowpea variety was determined according to the method of Akinyele *et al*. (1986) with slight modifications in terms of quantity of water and seeds used. Thirty grams of dry grains were added to hundred cowpea seeds were added and the flask was covered with wet filter paper. 500 mL of boiling water in stainless to reduce evaporation. Cooking time was recorded at the point when 50% of the cooking pot on an electric stove. Water was added intermittently as the level drops. Cooking time was determined by noting the time in minutes required for soft cooking as assessed by pressing the cooled seeds between two fingers until no hard material was found.

Solids in coking water: Solids in cooking water were determined as described by Okabe (1979). Ten milliliter of liquid obtained from the cooking time was placed in a tarred moisture can. It was dried to a constant weight in an oven at 130°C. The initial weight of the moisture can and final weight after oven drying was calculated and recorded in percentage.

Percentage solids in cooking water = (Final weight-can weight) × 100.

Cooking yield: Hundred grains of each cowpea variety were placed in a graduated beaker and the height noted in millimeter. They were separately cooked in 1000 mL of water until the optimum cooking time was reached. The cooked beans were separately transfer in a beaker and final height was recorded.

Determination of functional properties

Nitrogen solubility: Nitrogen solubility was determined in the pH range 2-12 at room temperature. The flour samples (1 g) was dispersion shaken for 2 h at room temperature (28°C). It was then centrifuged at 3120 × g for 30 min and nitrogen in the supernatant was estimated by the Kjeldahl method (AOAC, 2000). The nitrogen extracted was expressed as a percentage of the flour nitrogen.

Foam capacity and stability: One gram of sample was whipped with 100 mL distilled water for 5 min in a Kendwood blender (Philips, model HR 1702 England) at speed of 500. Min-1 poured into a 250 mL graduated cylinder. The volume of foam at 30 sec after whipping was expressed as the foam capacity and the volume of the foam over 0-120 min as the stability for the respective time periods.

Water and fat absorption: One gram of sample was mixed with 10 mL distilled water or refined palm oil (Solive oil, Nigeria; density 0.86 mL^{-1}) in a weighed 20 mL centrifuge tube. The slurry was agitated on a vortex mixer for 2 min, allowed to stand at 28°C for 30 min and then centrifuged at 500 x g for 20 min. The clear supernatant was decanted and discarded. The adhering drops of water or oil were removed and the tube was weighed, the weight of water or oil absorbed by 1 g of flour or protein was calculated and expressed as water or fat absorption capacity.

Bulk density: A calibrated centrifuge tube was weighed and samples were filled to 5 mL by constant tapping until there was no further change in volume. The contents were weighed and from difference in weight, the bulk density of the sample was calculated.

Determination of chemical properties: Local cowpea varieties were analyzed for moisture, protein, fat, ash, crude fibre, dry matter, mineral elements (calcium, phosphorus, iron, magnesium and copper). Carbohydrate was determined by difference. All determinations was carried out using standard procedures (AOAC, 2000). Energy value was calculated.

Results and Discussion

Physical characteristics: The results of the physical characteristics of local varieties of cowpea seeds are presented in Table length of cowpea seeds varied from 6.70 to 12.90 mm. Odudu and Jokada showed a significant difference ($P \leq 0.05$) when compared to other varieties. Major diameter of seeds ranged from 3.33 to

Table 1: Physical Characteristics of Local Varieties of Cowpea seeds

	Varieties			
Parameter	Achishiru	Akidi	Odudu	Jokada
Length (mm)	6.70±0.28^{c}	9.92±0.15^{b}	12.69±0.88^{a}	12.90±0.24^{a}
Major diameter (mm)	3.33±0.10^{c}	4.34±0.0^{b}	5.58±0.04^{a}	5.20±0.11^{a}
Minor diameter (mm)	3.18±0.22^{b}	3.48±0.10^{ab}	4.64±0.02^{a}	4.65±0.10^{a}
100 grain weight (g)	8.40±0.37^{d}	12.20±0.12^{c}	34.90±0.04^{a}	27.60±0.15^{b}
Cooking time (Minutes)	28.00±0.00^{c}	35.00±0.01^{b}	40.00±0.00^{a}	40.00±0.00^{a}
Cooking yield (%)	55.43±0.13^{c}	59.77±0.60^{a}	58.60±0.77^{b}	55.87±0.54^{c}
Dissolved solid (%)	0.27±0.11^{a}	0.70±0.01^{a}	0.63±0.02^{a}	0.93±0.01^{a}
Colour	Brown	Purple	Tan-brown	Cream mottled

Values not followed by the same superscript in the same row are significantly different ($p \leq 0.05$), Means±standard error mean from triplicate determinations

Table 2: Chemical Compositions of Local Varieties of Cowpea seeds (% wet basis)

	Varieties			
Parameter	Achishiru	Akidi	Odudu	Jokada
Moisture (%)	10.07±0.12^{a}	8.57±0.06^{b}	9.25±0.03^{ab}	9.50±0.01^{ab}
Dry matter (%)	89.93±1.38^{c}	91.44±0.87^{a}	90.77±1.10^{b}	90.51±1.64^{b}
Protein (%)	28.00±0.2 ^{b}	29.25±0.16^{a}	25.79±0.01^{c}	28.95±0.15^{a}
Fat (%)	2.40+0.05^{ab}	3.18+0.01^{a}	0.99+0.10^{c}	0.79+0.32^{c}
Ash (%)	2.72±0.01^{b}	3.24±0.28^{ab}	3.26±0.14^{ab}	3.73±0.02^{a}
Crude fibre (%)	3.25±0.5^{a}	1.92±0.04^{b}	3.37±0.10^{a}	3.36±0.20^{a}
Carbohydrate (%)	53.56±0.76^{b}	53.85±1.10^{b}	57.36±0.80^{a}	53.68±0.13^{b}
Energy (KCal/100g)	347.84±1.64^{b}	360.67±2.43^{a}	341.43±1.11^{b}	337.57±1.30^{c}
Calcium (mg/100g)	582.00±1.56^{a}	424.00±2.03^{d}	471.00±1.45^{c}	545.00±3.05^{b}
Phosphorus (mg/100g)	645.00±1.85^{a}	539.00±0.57^{b}	445.05±1.34^{d}	463.00±1.18^{c}
Iron (mg/100g)	4.60±0.04^{a}	4.82±0.01^{a}	4.00±0.01^{a}	4.45±0.01^{a}
Magnesium (mg/100g)	128.54±0.97^{d}	136.40±2.03^{c}	142.00±1.18^{b}	145.12±0.46^{a}
Copper (mg/100g)	6.13±0.10^{a}	6.00±0.05^{a}	5.93±0.23^{a}	5.55±0.02^{a}

Values not denoted by the same superscript in the same row are significantly different ($p \leq 0.05$), Means ± standard error of mean from triplicate determinations

5.58 mm. There were significant differences ($P \leq 0.05$) in major diameter between Odudu and Jokada when compared to other varieties. Minor diameter of cowpea seeds varied from 3.18 to 4.65 mm. There was significant difference ($P \leq 0.05$) in minor diameter between Achishiru and other varieties. Grain weight ranged between 8.40 and 34.90. There were significant differences ($P \leq 0.05$) among the samples. These differences in length, diameter grain weight among cowpea varieties may be attributed to difference in genetic traits. Cooking time varied between 28.00 to 40.00 min, Achishiru had the lowest cooking time value (28.00 min). There was significant difference ($P \leq 0.05$) between Odudu and Jokada when compared to other samples. These varieties had short cooking time, hence consumers especially the urban working time, hence consumers especially the urban working class will accept there varieties because of their long cooking time.

There was no significant difference ($P \leq 0.05$) between Achishiru and Jokada when compared to other varieties. Dissolved solid values varied from 0.27 to 0.93%. There were significant differences ($P \leq 0.05$) among the cultivars. The loss of solid from cowpea during cooking varies with, variety and cooking method.

Colour of seeds include brown (Achishiru) purple (Akidi), tan-brown (Odudu) and cream mottled (Jokada). The variation in cowpea colour agrees with the findings of Bergmann *et al*. (1994), who reported variability in cowpea colour among different varieties. The colour differences also have implication in the characteristics of the product produced from cowpea. Difference in colour also might have quality implication where used as a composite flour.

The chemical composition of cowpea seeds are presented in Table 2. Moisture content ranged from 8.57 to 10.07%. The Moisture content of Achishiru was significantly different ($p \leq 0.05$) from other samples.

Dry matter value of the seeds varieties varied from 89.93 to 91.44%. There was no significant difference ($p \geq 0.05$) between Odudu and Jokada when compared to other samples. The protein content of the cowpea range from 25.79 to 29.25%; There was no significant difference ($P \leq 0.05$) between Akidi and Jokada when compared to other varieties. Fat content varied between 0.79 to 3.18%, Akidi had the highest fat content of (3.18%). There was significant difference ($P \leq 0.05$) between Odudu and Jokada when compared to other varieties. Ash content of the cowpea varieties ranged from 2.72 to 3.73%. There was no significant difference ($P \geq 0.05$) in fat content between Akidi and Odudu. However, there was a significant difference ($P \leq 0.05$) when Achishiru was compared to other samples. Crude fibre content varied from 1.92 to 3.37%. There was significant

Table 3: Functional Properties of some local varieties of cowpea seeds

	Varieties			
Parameter	Achishiru	Akidi	Odudu	Jokada
Water absorption capacity (%)	1.85±0.10[a]	1.94±0.05[a]	1.60±0.10[a]	1.82±0.28[a]
Oil absorption capacity (g/g)	0.39±0.01[a]	0.35±0.16[a]	0.54±0.01[a]	0.43±0.12[a]
Bulk density (g mL)	0.33±0.01[a]	0.29±1.77[a]	126.50±2.10[a]	0.32±0.06[a]
Foam capacity (mL)	116.10±1.42[b]	114.38±1.77[c]	126.50±2.10[a]	100.52±1.40[d]
30 min	70.00±2.83[c]	88.50±1.05[b]	97.00±1.87[a]	60.00±1.40[d]
60min	52.50±0.76[c]	63.00±0.94[b]	74.00±0.67[a]	46.00±0.92[d]
120 min	37.00±0.63[c]	48.00±1.11[b]	60.00±1.05[a]	32.00±0.57[d]
Nitrogen solubility (%)				
pH 2	66.30±1.44[c]	75.05±2.15[a]	59.42±1.63[d]	68.00±1.01[b]
PH 4	15.15±0.23[d]	18.70±0.45[c]	24.06±0.92[a]	20.48±0.68[b]
pH 4..5	15.00±0.87[d]	18.67±1.32[c]	24.00±0.45[a]	20.40±0.70[b]
pH 5	28.00±0.14[c]	23.11±0.67[d]	36.05±1.11[a]	31.00±0.43[b]
pH 6	43.70±0.88[d]	51.00±1.72[b]	65.20±2.01[a]	46.50±0.64[c]
pH 8	74.00±1.03[c]	86.70±0.85[a]	70.15±1.01[d]	77.00±0.50[b]
pH 10	79.68±1.03[c]	93.00±1.17[a]	76.80±0.91[d]	84.34±1.63[b]
pH 12	76.23±12.3[c]	88.00±0.91[a]	73.05±0.50[d]	80.45±1.14[b]

Values not denoted by the same superscript in the same row are significantly different ($p \leq 0.05$), Means±standard error of mean from triplicate determinations

difference ($P \leq 0.05$) between Akidi and other varieties. Carbohydrate value ranged from 53.56 to 57.36%. There was significant difference ($P \leq 0.05$) between Odudu and other varieties. Energy value varied from 337.57 to 360.67 kcal/100 g, with Jokada having the least value (337.57 kcal/100 g) and Akidi had the highest value (360.67 kcal/100 g). There was significant difference ($P \leq 0.05$) when Akidi was compared to other varieties.

The mineral composition of cowpea seeds ranged from 424.00 to 582.00mg/100g, 445.05 to 645.00mg/100g 4.00 to 4.82mg/100g, 128.54 to 145.12mg/100g and 5.55 to 6.13mg/100g for calcium, phosphorus, iron magnesium and copper. They were significantly different ($P \leq 0.05$).

However, the variations in the chemical compositions recorded in the varieties evaluated may be attributed to soil type, cultural practices, environmental condition and genetic factors.

Some functional properties of local varieties of cowpea seeds grown in Nigeria are presented in Table 3. Water absorption capacity of cowpea seeds varied between 1.60 and 1.94 g/g. there was no significant difference ($p \geq 0.05$) among varieties. These varieties had good water absorption values, this suggests that their flour would be useful functional ingredients in bakery products. Oil absorption capacity ranged from 0.39 to 0.53 g/g and showed no significant difference ($p \geq 0.05$). The ability of the protein of these cowpea varieties to bind fat is important since fat act as flavour retainer and increase the mouth feel when used in food preparations, such as sausages. Bulk density values of 0.29 and 0.040 g mL were recorded and these values were not significant ($p \geq 0.05$) among varieties. Foam capacity and stability of these varieties investigated showed high value. This implies that these varieties may be useful as aerating agents in food systems such as akara and :moi-moi which require the production of stable high foam volumes when whipped. Cowpea seeds had minimum nitrogen solubility index of 15.00%, 18.67%, 24.00% and 20.40% at pH 4.5 while maximum solubility values were recorded at pH 10. In food preparations where maximum solubility of protein is desired, as in ageous emulsions and gel food preparations, these cowpea varieties looks very promising.

Conclusion: The results of this study support consumption of local cowpea varieties grown in Nigeria. Large scale cultivation of these varieties should also be encouraged in order to accelerate acceptability, widen baseline of consumption and lend it to exportable status.

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