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Characterization of common Nigerian cowpea (*Vigna unguiculata* L. Walp) varieties

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Abstract

Eight cowpea (*Vigna unguiculata* L. Walp) varieties namely Olo-1, Olo-2, Banjara, Karadua, Manyan Fari, Kananado Fari, Kananado Yar and Akidi were characterized based on their physical and functional properties. Physical properties investigated include seed-weight, length to diameter ratio, specific gravity, bulk density, angle of repose and percentage of seed coat. The functional properties examined were water absorption capacity, swelling capacity, cooking time and moisture content. The result of both physical and functional properties showed significant differences ($P = 0.05$) among the cowpea varieties. The specific gravity, ranged from 1.05 to 1.19 with Kananado Yar, Kananado Fari and Banjara having higher values than others, while water absorption capacity ranged from 1.14 to 1.60 g H_2O/g sample for Kananado Fari and Banjara varieties respectively. Apparently, the outcome of this work would provide a basis for upgrading local techniques of cowpea processing in Nigeria.

1. Introduction

Cowpea (*Vigna unguiculata* L. Walp) is the most indigenous grain legume in Nigeria and it is popularly known as "bean" in the local markets with different varietal names attached (Oyenuga, 1968). At present, more than 70% of the world cowpea production is concentrated in three countries—Nigeria, Brazil and Niger (Nnanna & Phillips, 1988). It is an important item in the diet of most Africans and Nigerians in particular. It is a rich source of plant protein (Ozumba, Olatunji, & Koleoso, 1991), containing about 25% protein (Dovlo, Williams, & Zoaka, 1976).

In Africa and Nigeria in particular cowpeas are consumed in different forms (Oguntunde, 1987). Traditional methods of processing cowpeas in the preparation of certain cowpea dishes are cumbersome, tedious and time consuming which limited its acceptability. It is believed that if new processing methods are developed to improve cooking time, the beans could become more readily acceptable to a wider group of consumers (Njoku, Eli, & Ofuya, 1989).

Mohsenin (1970) noted that an understanding of the physical laws governing the responses of the biological materials to various handling and processing methods is a fundamental requirement in the design of machines required for handling them. Henderson and Perry (1981) specified cleaning, sorting, partial or perhaps final grading or classification of agricultural products as being based on their physical properties.

Previous study has shown effect of seed physical properties and chemical composition on the cooking properties of cowpea varieties (Henshaw & Sanni, 1995), while the effect of different processing techniques on textural quality of cowpea (Hung, Chinnan, & McWatters, 1988) and biochemical, nutritional and sensory characteristics of cowpeas (Onayemi, Osibogun, & Obembe, 1986) have been investigated.

Reports on the physical and functional properties of cowpea seeds readily available in Nigerian markets are limited.

This study was therefore undertaken to characterize the common cowpea varieties in Nigerian markets particularly in the western parts of Nigeria for their physical and functional properties needed for upgrading local technologies for processing of cowpea seeds into different products.

2. Materials and methods

Cowpea seeds (Kananado Yar, Kananado Fari, Karadua, Banjara, Olo-1, Olo-2, Manyan Fari and

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Akidi) varieties were purchased from popular markets in the western part of Nigeria. The seeds were cleaned, sorted manually, packaged in moisture proof bags and stored under refrigeration condition (4 °C) until they were used.

Moisture content of the cowpeas was determined using a rapid moisture analyser (BULLER, Germany) after grinding to a powder using a hammer mill (GLEN CRESTON, Stanmore, UK). The cowpea seeds were visually examined for colour, while objective colour determination was carried out with Lovibond tintometer model F using a 1 in. glass cell (W600/OG/l″) for measuring non transparent samples. Temperature of measurement was 30 ± 2 °C. The seeds were placed in the glass cell and positioned in the instrument. Using graduated colour glasses (red, yellow and blue) mounted on racks, a matching colour was obtained.

The texture and degree of attachment of seed coat to the cotyledons were determined as described by the methods of Henshaw and Sanni (1995). Hundred seed weight was determined using a Sartorius analytical balance (Tecator 6110 balance). Specific gravity was determined using the water displacement method (Akinyele, Onigbinde, Hussain, & Omololu, 1986) and bulk density was estimated using a 100 ml measuring cylinder (Mohsenin, 1970).

Length to diameter ratio was determined using Vernier calliper (Moore & Wright, Sheffield England 1140) to measure dimensions of 100 randomly selected seeds. The angle of repose was determined according to the method of Mandhyan, Sharma, and Tyagi (1987). Percentage seed coat was determined according to the method of Akinyele et al. (1986). Water absorption and swelling capacities were determined as described by Onayemi et al. (1986). Soaking time and cooking time were determined by the method of Narasimha and Desikachar (1978).

All the tests were done in triplicate except otherwise stated. Statistical analysis of data was performed using analysis of variance and Duncan's multiple range test procedures (SAS, 1985).

3. Results and discussion

The results of visual observation of cowpea seed varieties are shown in Table 1. Samples with a cream and white seed coat colour had their seed coats strongly attached to the cotyledons while others were found to have the seed coats moderately attached to the cotyledons. Henshaw and Sanni (1995) observed that mostly white and cream seed coat coloured cowpea varieties were firmly attached to the cotyledons. The seed coat texture varied among the seed varieties and was either rough, wrinkled, smooth or glossy. The varieties with rough seed coat were firmly attached to the cotyledons. The finding was supported by the report of Ogunmoyela, Akingbala, and Oyewole (1991) that cowpea varieties with rough testa were more firmly attached to the cotyledons than those with smooth tests. This may be due to a higher content of pectin, which is regarded as the intercellular cementing substances between the cotyledons and the seed coat (Hanson, 1975), in the white and cream varieties. Consequently, the firmly attached seed coat (Manyan Fari and Kananado Fari) varieties would require more energy in form of abrasive force to dry dehull than the rest. Since seed coat removal, particularly if done by the traditional manual wet dehulling process, is time consuming (Hung et al., 1988), the moderately attached seed coat varieties with the exception of Kananado Yar and Akidi that had their seed coats intact even after 24 h soaking, would be preferred. The hilium colour is predominately brown with the exception of Kananado Fari and Kananado Yar having black and grey colours respectively which might enhance the discolouration of cowpea seeds during soaking and cooking.

Table 2 shows the physical properties of cowpea seed varieties. The 100 seed weight was highest in Olo-2 (24.67 g) followed by Manyan Fari (22.0 g) and Karadua (20.30 g), while specific gravity was highest in Kananado Yar (1.186) followed by Kananado Fari (1.168). The average diameter of cowpea seeds ranged from 4.89 to 7.32 mm for Akidi and Manyan Fari

Table 1
External features of cowpea varieties

Variety	Hilium colour	Seed coat			
		Colour	Texture	Attachment to cotyledons	After 24 h soaking
Manyan Fari	Brown	Cream white	Rough	Firm	Intact
Kananado Fari	Black	Cream white	Rough	Firm	Intact
Kananado Yar	Grey	White	Wrinkled	Moderate	Intact
Banjara	Brown	Grey	Smooth	Moderate	Peeled
Karadua	Brown	Brown	Smooth	Moderate	Peeled
Akidi	Brown	Black	Glossy	Moderate	Intact
Olo-1	Brown	Brown	Smooth	Moderate	Peeled
Olo-2	Brown	Reddish brown	Rough	Moderate	Peeled

Table 2
Physical properties of different cowpea varieties

Variety	Length (mm)	Major diameter (mm)	Minor diameter (mm)	Hundred seed weight (g)	Specific gravity	Angle of repose (°)	Length to diameter	Seed coat (%)
Manyan Fari	9.25_b	7.32_a	5.65_a	22.0_b	1.05_b	17.9_c	1.26_{cd}	14.0_a
Kananado Fari	7.87_{de}	6.42_{bc}	4.56_{cd}	15.6_e	1.17_a	21.2_b	1.23_d	10.1_{cd}
Kananado Yar	8.72_{bcd}	6.30_c	4.22_e	15.8_e	1.19_a	21.3_b	1.38_{abcd}	12.5_b
Banjara	9.03_b	6.57_{bc}	4.55_{cde}	20.3_c	1.13_a	19.3_{bc}	1.37_{abcd}	10.3_c
Karadua	8.31_{cd}	6.35_c	4.61_c	1.92_d	1.11_{ab}	20.3_b	1.31_{bcd}	12.1_b
Akidi	7.26_e	4.89_d	3.25_f	9.85_f	1.09_{ab}	24.4_a	1.48_a	ND
Olo-1	8.84_{bc}	6.31_c	4.31_{de}	18.6_d	1.06_b	23.6_a	1.40_{abc}	9.30_d
Olo-2	10.04_a	6.93_{ab}	4.99_{bc}	24.4_a	1.11_{ab}	25.4_a	1.45_{ab}	11.6_b

Means with the same subscript along the column are not significantly different ($P = 0.05$).
ND means not determined.

respectively. The length to diameter ratio was observed to be highest in Akidi (1.48) indicating it as the most slender variety, while Kananado Fari (1.23) variety was the least. The angle of repose varied among the varieties from 17°54′ to 25°24′ while percentage seed coat was 9.30–14.0% which is in accordance with the report of Kay (1979). There seems to be a direct relationship between cowpea seed weight and length to diameter ratio. A knowledge of geometric dimension will help in deciding the clearance between the abrasive surfaces for dehulling and it will also help in designing the grader, cleaner and separator for the seeds. Gravimetric properties such as specific gravity, bulk density, seed weight are all necessary in analysis of separation, design of hopper and blowers. They are also useful in storage and transport of cowpea seeds. The angle of repose would help in predicting the motion of seeds during milling as well as determining the pressure of grains against machine walls so as to decide the choice of materials for fabrication (Mandhyan et al., 1987).

The physical properties are also needed to define and quantify heat transfer problems during heat processing of the seeds (Mohsenin, 1980).

Functional properties of cowpea seed varieties are shown in Table 3. Water absorption capacity after 24 h soaking at 30 ± 2 °C ranged from 1.14 to 1.60 g H_2O/g sample for Kananado Fari and Banjara respectively. Seeds with a moderately attached seed coat absorbed more water than firmly attached seed coats. Taiwo, Akanbi, and Ajibola (1994) attributed increased water absorption of cowpea seeds to larger seed size.

Swelling capacity was observed to vary among the varieties with Banjara (3.16) highest and Kananado Fari (2.30) least. Cowpea seed varieties with white coloured and firmly attached seed coats had least swelling capacity. This might be attributed to restriction by the seed coats as they remained intact even after 24 h soaking in water (Table 1). Cooking time ranged from 35 to 80 min for Banjara/Karadua and Kananado Yar varieties respectively. Ogunmoyela et al. (1991) reported cooking time for some cowpea varieties as 31 and 160 min for least and highest respectively. Cooking mechanism in beans had been shown to be affected by the presence of chelating agents (Rockland & Jones, 1974), the level of phytic acid (Rosenbaum, Hennenberry, & Baker, 1965; Longe, 1983), the amylose/amylopectin level (Juliano, Onate, & Del-Mundo, 1965), length of storage (Jackson & Varriano-Martson, 1981) and structural and chemical differences in seed coat components (Hambly, 1932). It was observed that the lower the moisture content, the longer the cooking time. The results of moisture content (Table 3) indicate a safe moisture level in all cowpea varieties, which is in agreement with the recommendation of

Table 3
Functional properties of different cowpea varieties

Cowpea variety	Water absorption capacity (g H_2O/g samples)	Swelling capacity	Bulk density (g/ml)	Cooking time (min)	Moisture content (%)
Manyan Fari	1.28_{bc}	2.39_d	0.611_b	39_e	12.10_b
Kananado Fari	1.14_d	2.30_d	0.692_a	62_b	12.50
Kananado Yar	1.34_{bc}	2.59_c	0.712_a	80_a	11.40
Banjara	1.60_a	3.16_a	0.721_a	35_e	12.40
Karadua	1.22_{cd}	2.67_c	0.705_a	35_e	12.55
Akidi	ND	ND	0.698_a	51_d	ND
Olo-1	1.29_{bc}	2.80_b	0.648_b	50_d	12.30_{ab}
Olo-2	1.41_b	2.69_c	0.644_b	57_c	12.30_{ab}

Means with the same subscript along the column are not significantly different ($P = 0.05$).
ND means not determined.

Table 4
Comparative colour analysis of the cowpea seed varietes (in Lovibond units)

Cowpea variety	Neutral tint	Orange	Green	Yellow	Blue
Manyan Fari	0.30	1.28	–	1.02	–
Kananado Fari	0.13	1.10	–	1.00	–
Kananado Yar	0.37	1.10	–	1.13	–
Banjara	1.47	2.20	–	2.23	–
Karadua	1.53	2.00	–	1.47	–
Akidi	5.86	–	3.74	–	0.73
Olo-1	2.70	4.47	–	2.63	–
Olo-2	1.73	2.47	–	1.07	–

Yellow + blue = green; red + yellow = orange.
Neutral tint – The lowest value of either red, blue or yellow combined with equal measured values of the other two colours (Goose & Binstead, 1973).

Kay (1979). Since heat transfer within cowpea seeds is expected to be primarily by conduction, the seeds having a smaller diameter should receive heat faster at the core, but this study showed that cooking time was not seed-size dependent, suggesting that other factors may be responsible. Table 4 shows the result of comparative colour analysis for the cowpea seed varieties.

The colour of the cowpea varieties measured was dull because all three colour slides, red, blue and yellow together, are needed to make a match (Goose & Binstead, 1973). The reading showed that all the samples were predominantly yellow with the exception of Akidi which had traces of blue colour. However, the reading of the white coated samples were not significantly different from each other, but significantly different from the brown, grey and black coloured seed coats. Kananado Yar appeared to be most white (1.13 yellow units), while Kananado Fari was the dullest of the white seed coated varieties, apparently influenced by its black hilum.

Akidi was the darkest (neutral tint 5.86, green 3.74 and blue 0.73 units) of all the samples, in accordance with the visual colour observation (Table 1).

Among the brown coloured seed coats, Banjara was the dullest (1.47 units), followed by Karadua (1.53 units), Olo-2 (1.73 units) and finally Olo-1 (2.7 units) which had the most attractive brown colour. Apparently women from western region of Nigeria usually prefer these brown coloured cowpeas varieties because of colour, cooking time, texture and taste.

4. Conclusion

The investigations carried out have shown that both physical and functional properties vary considerably among different varieties of cowpeas available in Nigerian markets. Physical properties of cowpea seed varieties as determined would serve as the basis for upgrading the traditional methods of processing cowpeas, while their functional properties show their suitability for processing.

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