*Plant Foods for Human Nutrition* **58:** 1–10, 2003.
© 2004 *Kluwer Academic Publishers. Printed in the Netherlands.*

# Effect of processing method on the quality of cowpea (*Vigna unguiculata*) flour for akara preparation

A.A. OLOPADE[1], J.O. AKINGBALA[2,*], A.O. OGUNTUNDE[3] and K.O. FALADE[4]
[1]*Federal Institute of Industrial Research Oshodi, Nigeria;* [2]*Chemical Engineering Department, University of The West Indies St. Augustine, Trinidad & Tobago;* [3]*Late, of Food Technology Department, University of Ibadan, Ibadan, Nigeria;* [4]*Food Technology Department, University of Ibadan, Ibadan, Nigeria (*author for correspondence; e-mail: jakingba@uwi.tt)*

Received 12 December 2000; accepted in revised form 21 August 2001

**Abstract.** Cowpeas were prepared into flour by wet dehulling, wet milling into paste and drying; wet dehulling, drying and milling; and wet dehulling, wet milling and foam mat drying. Proximate chemical composition and functional properties (water and fat absorption capacities, foaming capacity, foam stability, bulk density, gelation capacity and emulsification capacity) of flours and of paste prepared by wet dehulling, wet milling and no drying, were determined. Akara from fresh paste and pastes reconstituted from flours was organoleptically evaluated. Reconstituted paste of flour from ground dry cotyledons produced the best quality akara, compared with the control. Akara from reconstituted foam mat dried and ground dry paste flours were less acceptable.

**Key words:** Akara, Cowpea flour, Processing quality, Sensory quality

UNIVERSITY OF IBADAN LIBRARY

## Introduction

Cowpeas are the second important source of protein, next to meat in Nigeria [1, 2]. They are cooked plain, mixed with other foods or processed into formulated recipes such as moinmoin, a steamed paste, or akara, a deep fried paste product. These paste products (moinmoin and akara), are still prepared using the traditional methods. The production of fresh paste from cowpeas is a major constraint in cowpea utilization and considerable efforts have been made to produce ready-to-use cowpea flours which can be rehyderated to paste, thus reducing the time and labor of paste production [3–6]. Previous research has shown that cowpea flour can be made into acceptable moinmoin [1]. However, the preparation of akara from reconstituted flour has not been as successful, due mainly to rehydration problems of the flours [1, 2, 4]. The objective of this work was to evaluate three processes viz. dry milling of cotyledons, dry milling of paste and foam mat drying of paste in the production of flour for akara preparation.

## Materials and methods

White (Sokoto) and brown (Drum) varieties of cowpeas were purchased from Bodija market Ibadan, Nigeria. Refined vegetable oil and refined table salt were purchased from the same market. Sodium palmitate (Lever Brothers Nigeria Ltd.) was used to stabilize paste foam for extrusion and drying.

### *Preparation of cowpea flour*

Cowpea flours were prepared as presented in Figure 1. The cowpeas (200 g) were steeped in 300 ml water for 10 min to soften the testa, which was removed manually and washed off. The cleaned cotyledons were converted into flour following the different processes (Figure 1). The dry cotyledons of flour A and the dry paste of flour B were ground using a hammer mill to pass through a screen of 0.8 mm opening. The paste of flour C, after mixing, was extruded on wire gauze, using a caterer's syringe, and dried at 70 °C for 2 h. The resultant dry foams were milled using a hammer mill to pass through 0.8 mm screen.

## Chemical analyses

Proximate compositions of cowpeas and flours (moisture, crude fiber, fat, ash and crude protein [Nx 6.25]), were determined by AOAC methods [7]. Carbohydrate content was determined by difference.

### *Functional properties of flours*

Foaming capacity and foam stability were determined as described by Sathe et al. [8]; water and fat absorption capacities were determined as described by Sosulski [19] and Sosulski et al. [10], respectively. Emulsion capacity was determined according to the method of Yasumatsu et al. [11] and gelation capacity by the method of Coffman & Garcia [12]. Bulk density of the flour was determined according to the method described by Okaka & Potter [13].

UNIVERSITY OF IBADAN LIBRARY

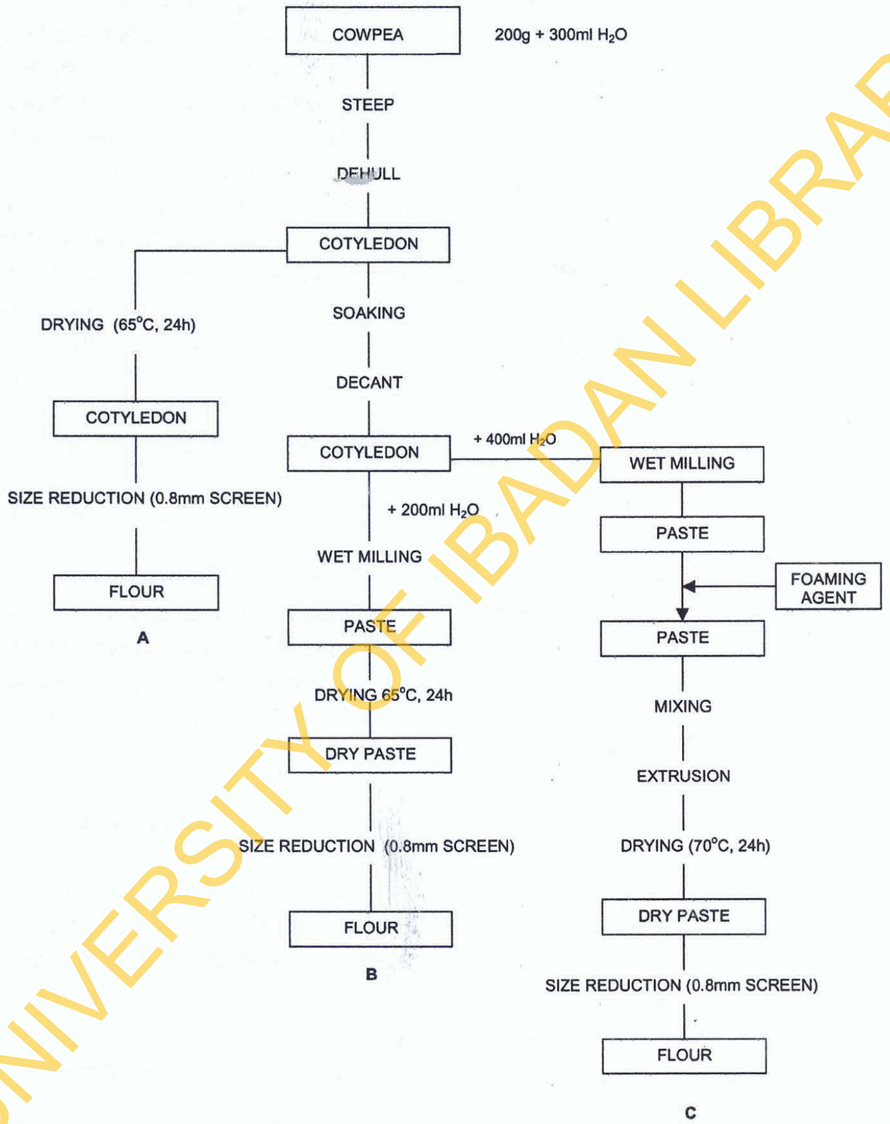


*Figure 1.* Production of cowpea flour from dry milled cotyledon (A), wet milled cotyledon (B) and foam-mat dried paste (C).

UNIVERSITY OF IBADAN LIBRARY

*Preparation of akara*

Akara was made from freshly prepared paste and paste from reconstituted flours. The freshly prepared paste was made by soaking 200 g cowpea in 300 ml water for 10 min to soften the testa for manual removal. The clean cotyledons were steeped in 300 ml water for 30 min; the water was drained, and the softened cotyledons blended in a Kenwood food mixer at speed 6 for 4 min.into a paste. Seasonings (20 g chopped pepper, 20 g onions and 10 g salt) were mixed in the paste. Tablespoon (15 ml) portions of the mixture were deep fried in vegetable oil at 190 °C for 4 min on each side. The akara was removed from the oil, drained of excess oil and stored in an incubator at 30 °C for sensory evaluation. Flours A, B, C (200 g), prepared as described in Figure 1, were each rehydrated with 300 ml water. The mixture was stirred manually using a plastic spatula, then whipped in a Kenwood food mixer at setting 6 for 4 min. Seasonings were added and the mixture fried into akara using the same procedure described for the paste. The akaras produced were stored at 30 °C for sensory evaluation.

*Sensory evaluation*

The akara samples were coded and presented to a ten person panel of judges who were familiar with the product for sensory evaluation. The ten person trained panel scored the color, flavor, texture and overall acceptability of the akara using a nine point scale, where 9 indicated 'liked extremely' and 1, 'dislike extremely'.

## Statistical analysis

Means were tested for differences using Analysis of Variance, and separated by the Duncan's Multiple Range Test [14] when a significant F value was noted. Significance was accepted at $p \leq 0.05$.

## Results and discussion

*Proximate chemical composition*

The proximate composition of the flours was essentially similar (Table 1) and within the range generally reported [4, 5, 15] for cowpeas (Table 1). Protein contents of the cowpeas were not different ($p < 0.05$). The fat content of cowpeas was small and not of much nutritional significance. The difference

UNIVERSITY OF IBADAN LIBRARY

*Table 1.* Mean[1,2] chemical compositions of cowpea flour samples (dry weight basis)

| Sample | Moisture (%) | Protein (%) | Fat (%) | Crude fiber (%) | Ash (%) | Carbohydrate (%) |
|---|---|---|---|---|---|---|
| Whole bean flour (white) | $10.4^{a}$ | $23.9^{d}$ | $1.7^{b}$ | $2.60^{a}$ | $3.33^{a}$ | $68.5^{a}$ |
| Whole bean flour (brown) | $10.5^{a}$ | $25.0^{c}$ | $2.40^{a}$ | $2.28^{b}$ | $3.19^{c}$ | $67.2^{def}$ |
| Wet-dehulled and wet-milled (white) flour (WWDW) | $8.5^{cd}$ | $25.0^{c}$ | $1.82^{b}$ | $2.08^{c}$ | $3.22^{b}$ | $67.9^{bc}$ |
| Wet-dehulled and wet-milled (brown) flour (BWDW) | $8.9^{bc}$ | $25.2^{bc}$ | $1.46^{c}$ | $1.92^{d}$ | $3.16^{c}$ | $68.3^{ab}$ |
| Wet-dehulled and dry-milled (white) flour (WWDD) | $8.9^{bc}$ | $25.9^{a}$ | $1.76^{b}$ | $1.83^{d}$ | $3.14^{c}$ | $67.4^{ef}$ |
| Wet-dehulled and dry-milled (brown) flour (BWDD) | $8.4^{d}$ | $25.5^{ab}$ | $2.40^{a}$ | $1.84^{d}$ | $3.35^{a}$ | $66.9^{f}$ |
| Foam-mat dried (white) flour (WFD) | $7.6^{e}$ | $25.8^{a}$ | $1.84^{b}$ | $1.50^{e}$ | $3.30^{a}$ | $67.6^{cd}$ |
| Foam-mat dried (brown) flour (BFD) | $7.7^{e}$ | $25.7^{a}$ | $1.55^{c}$ | $1.82^{d}$ | $3.26^{b}$ | $67.7^{cd}$ |

[1] Means of 3 replicates.
[2] Means with the same superscripts in a column are not different ($p < 0.05$).

UNIVERSITY OF IBADAN LIBRARY

in the crude fiber contents of the whole flour and the dehulled samples was due to the removal of the testa in the dehulled samples. The wet dehulled, dry milled flour had a greater ash content due to the greater amounts of minerals lost during steeping of the cotyledons for softening of the wet milled samples.The greater ash content of the foam mat dried sample was probably a function of the metal mesh on which the sample was dried.

*Foaming capacity*

Foaming capacity of the flour ranged from 17.0 in the foam mat dried flour to 41.0 in the wet dehulled dry milled flour (Table 2). Incorporation of air into the paste is essential for good crumb structure of akara [1]. Henshaw & Lawal [16] reported that processing involving soaking appears to lower gelation and foaming capacities of cowpea flour, which is consistent with the observation in this work.

*Water and fat absorption capacities*

Water absorption capacity of the flours ranged from 97% in the wet dehulled, dry milled flour to 151% in the foam mat dried flour sample. The fat absorption capacity of the foam mat dried flour was greater than that of the wet dehulled, wet milled flour, which was similar to the wet dehulled dry milled flour ($p < 0.05$). The high water and fat absorption capacities of the foam mat dried flour may have been due to the emulsifying property of monoglycerol palmitate used as a foam stabilizer, while the greater water and fat absorptions of the whole grain flour may have been due to the greater fiber content of this flour (Table 1). Henshaw & Lawal [16] attributed the increased fat absorption capacity of cowpea flour to the heat denaturation of protein, which could have occurred in the foam mat dried sample, which was dried at 70 °C.

*Gelation capacity*

The least gelation capacities of the flours ranged from 17 to 19% (Table 2). This was similar to 18% reported for cowpea flour by Abbey & Ibeh [17]. Sathe et al. [8] associated the gelling properties of legumes to the amounts of carbohydrates, protein and lipids present in the flours. Interactions among these components may have a significant role in the functional properties of the flours. The similarity in the gelation property of the flours may have been due to the similarity in their proximate chemical compositions (Table 1).

UNIVERSITY OF IBADAN LIBRARY

*Table 2.* Mean[1,2] functional properties of cowpea flours

| Flour sample | FC (%) | WAC (%) | FAC (%) | GC (%) | EC (%) | Bulk density (g/ml) |
|---|---|---|---|---|---|---|
| Whole bean (white) | ND | $108^{cd}$ | $104^{ab}$ | ND | ND | $0.68^{b}$ |
| Whole bean (brown) | ND | $122^{bc}$ | $107^{ab}$ | ND | ND | $0.67^{b}$ |
| Wet-dehulled and wet-milled (white) | $32.5^{b}$ | $127^{b}$ | $88^{b}$ | $19^{a}$ | $48.15^{b}$ | $0.80^{a}$ |
| Wet-dehulled and wet-milled (brown) | $43.5^{a}$ | $100^{d}$ | $95^{b}$ | $17^{b}$ | $53.29^{a}$ | $0.71^{b}$ |
| Wet-dehulled and dry-milled (white) | $34.0^{b}$ | $116^{bc}$ | $86^{b}$ | $18^{ab}$ | $54.8^{a}$ | $0.81^{a}$ |
| Wet-dehulled and dry-milled (brown) | $41.0^{a}$ | $97^{d}$ | $92^{b}$ | $17^{b}$ | $54.8^{a}$ | $0.69^{b}$ |
| Foam-mat dried (white) | $16.5^{c}$ | $150^{a}$ | $117^{a}$ | $18^{ab}$ | $48.6^{b}$ | $0.59^{c}$ |
| Foam-mat dried (brown) | $17.0^{c}$ | $151^{a}$ | $118^{a}$ | $19^{a}$ | $31.5^{c}$ | $0.57^{c}$ |

[1] Means of 3 replicates.
[2] Means in the same column with the same superscripts are not different $p < 0.05$.
ND – Not determined; FC = foaming capacity; WAC = water absorption capacity; EC = emulsion capacity; FAC = fat absorption capacity; GC = gelation capacity.

UNIVERSITY OF IBADAN LIBRARY

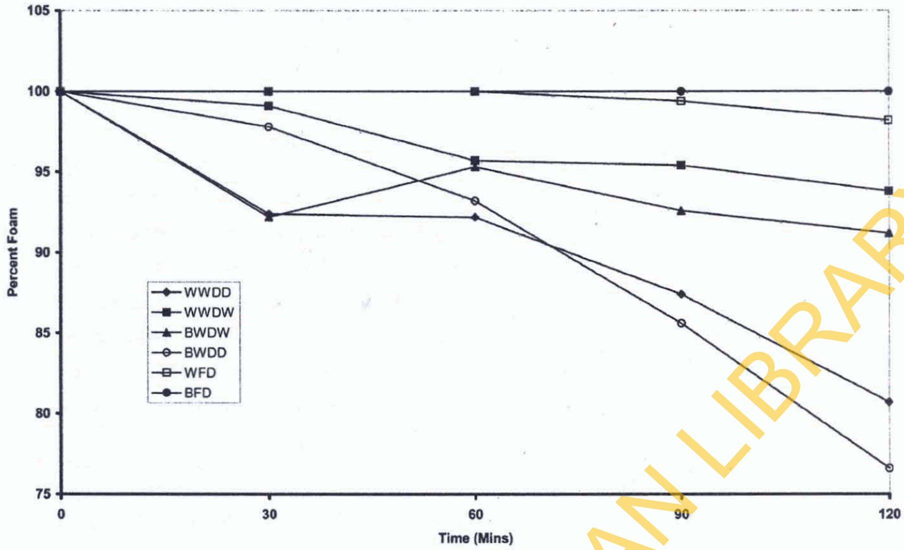


*Figure 2.* Stability of cowpea flour foams. WWDD = –◆–; WWDW = –■–; BWDW = –▲–; BWDD = –○–; WFD = –□–; BFD = –●–.

*Emulsification capacity*

The emulsification capacity of the foam mat dried flour was lower than those of wet dehulled, wet milled and wet dehulled, dry milled flours, which were similar (Table 2). Marayana & Rao [18] reported that heat reduced the emulsification properties of winged bean.

*Bulk density*

Foam mat dried cowpea flour had the least bulk density due to the air incorporated during foam formation. The greater porosity of the particles of this flour may have resulted in the greater water and fat absorption capacities observed. The objective of foam mat drying of the paste in this experiment was to improve the rehydration of the flour; thus, possibly through this, the foaming property, may have been negated by the heat (70 °C) used in drying the foam. The bulk density of the wet dehulled, wet milled flour (0.81 g/ml), was greater than that of the wet dehulled, dry milled sample (0.69 g/ml), but the wet milled flour had greater water absorption capacity probably because the particles are aggregates of smaller particles.

UNIVERSITY OF IBADAN LIBRARY

*Table 3.* Mean[1,2] sensory evaluation scores[3] of akara

| Akara sample | Color | Flavor | Texture | Overall acceptability |
|---|---|---|---|---|
| Cowpea paste (white) | $6.6^{c}$ | $5.4^{b}$ | $6.1^{b}$ | $6.4^{c}$ |
| Cowpea paste (brown) | $7.7^{ab}$ | $7.9^{a}$ | $8.0^{a}$ | $8.1^{a}$ |
| Wet-dehulled and wet-milled (white) flour | $8.0^{ab}$ | $7.3^{a}$ | $8.1^{a}$ | $7.8^{ab}$ |
| Wet-dehulled and wet-milled (brown) flour | $8.4^{a}$ | $7.6^{a}$ | $7.8^{a}$ | $7.7^{ab}$ |
| Wet-dehulled and dry-milled (white) flour | $4.3^{d}$ | $5.0^{b}$ | $3.8^{c}$ | $4.3^{d}$ |
| Wet-dehulled and dry-milled (brown) flour | $7.0^{bc}$ | $7.1^{a}$ | $7.6^{a}$ | $7.0^{b}$ |
| Foam-mat dried paste flour (white) | $4.4^{d}$ | $4.7^{b}$ | $4.3^{c}$ | $4.3^{d}$ |
| Foam-mat dried paste flour (brown) | $4.1^{d}$ | $3.5^{c}$ | $3.2^{c}$ | $3.5^{e}$ |

[1] Means of 3 replicates.
[2] Means with the same superscripts are not different $p < 0.05$.
[3] 1 = Dislike extremely; 9 = Like extremely.

### *Foam stability*

The foam mat dried flour produced the most stable foam (Figure 2). Foam from the wet dehulled, dry milled flour was greater up to 1 h when the foam is crucial in the production of akara. Generally during the production of akara, the paste is whipped to incorporate air just before frying. Thus, it appears that the foaming capacity of the paste would be a better index of akara texture than foam stability.

### *Sensory evaluation*

The flavor, texture and overall acceptability scores of akara made from wet dehulled, dry milled and wet dehulled, wet milled flours were rated similarly to those of akara made from fresh paste (control). Akara made from the wet dehulled, dry milled flour had better color ratings than akara made from the paste and from wet dehulled, wet milled flours (Table 3). Akara made from the foam mat dried flour had poor flavor, texture, color and overall acceptability. The foam mat dried flour had a grey color imparted by the foam stabilizing agent, which the panelists did not like. The poor texture rating of akara made from the foam mat dried flour was due to the dense, oily crumb, caused by the high water, high fat, and low foaming capacity of the flour.

UNIVERSITY OF IBADAN LIBRARY

## References


1. Dovlo FE, Williams CE, Zoaka L (1976) Cowpeas: Home Preparation and Use in West Africa. Ottawa, Canada: International Development Research Centre, pp 20–28.
2. Williams CE (1980) Cowpea Flour Innovation in a Traditional Dish and Its Acceptability in Selected Areas of Oyo Division. PhD dissertation, University of Ibadan, Nigeria.
3. MacWatters KH, Brentley BB (1982) Characteristic of akara prepared from cowpea paste and meal. J Food Tech 36: 66–69.
4. MacWatters KH (1983) Compositional, physical and sensory characteristics of akara processed from cowpea paste and Nigerian cowpea flour. Cereal Chem 60: 333–336.
5. Ngoddy PO, Enwere NJ, Onuorah VT (1986) Cowpea flour performance in akara and moinmoin preparation. Cowpea Sci 26: 101–109.
6. MacWatters KH, Ressurection AVA, Fletcher SM (1990) Response of American consumers to akara, a traditional West African food made from cowpea paste. J Food Sci Tech 25: 551–557.
7. AOAC (1984) Official Methods of Analysis, 14th ed. Washington, DC: Association of Official Analytical Chemists.
8. Sathe SK, Desphande SS, Salunkhe DK (1982) Functional properties of winged bean (*Phosphocarpus tetragonolebus* L. DC) proteins. J Food Sci 47: 503–509.
9. Sosulski FW (1962) The centrifuge method for determining flour absorptivity in hard red spring wheats. Cereal Chem 39: 444.
10. Sosulski FW, Humbert ES, Bui K, Jonnes JD (1976) Functional properties of rapeseed flours, concentrate and isolate. J Food Sci 41: 1349.
11. Yatsumatsu K, Sawada K, Moritaka S, Misaki M, Toda J, Wada TT, Ishii K (1972) Studies on the functional properties of food grade soybean products IV. Whipping and emulsifying properties of soybean products. J Agric Biol Chem 36: 719–727.
12. Coffman CW, Garcia VV (1977) Functional properties of amino acid content of protein isolate from mung bean flour. J Food Tech 12: 473.
13. Okaka JC, Potter NN (1979) Physicochemical and functional properties of cowpea products processed to reduce beany flavour. J Food Sci 44: 1235–1238.
14. Duncan DB (1955) Multiple range and multiple F-tests. Biometrics 11: 1–42.
15. Elias LG, Colindres R, Bressani R (1964) The nutritive values of eight varieties of cowpea (*Vigna sinensis*). J Food Sci 29: 118–122.
16. Henshaw FO, Lawal SA (1993) Effect of processing methods on the functional properties of cowpea flour. J Trp Sci 33: 377–385.
17. Abbey BW, Ibeh GO (1988) Functional properties of raw and heat processed cowpea (*Vigna unguiculata*) flour. J Food Sci 49: 1534.
18. Marayana N, Rao N (1982) Functional properties of raw and heat processed winged bean (*Phosphocarpus tetragonolobus*) flour. J Food Sci 49: 1534.


UNIVERSITY OF IBADAN LIBRARY