

SHORT NOTE

Chemical composition and *in vitro* protein digestibility of hulled and de-hulled Bambara groundnut [*Vigna subterranea* (L.) Verdc.] seeds

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World demand for protein is increasing and more food protein is required from both conventional and new sources. Hence, the food industry should include high quality protein in its products of ready-made rations, especially for infants (Eltayeb *et al.*, 2010).

Bambara groundnut (*Vigna subterranea* (L.) Verdc.) is the third most important grain legume after groundnut and cowpea in sub-Saharan Africa. Also, it is a major source of cheap dietary phytoprotein for both humans and livestock in the Sudano-Sahelian parts of tropical Africa and Asia where animal protein is expensive (Olaleke *et al.*, 2006). Due to the high price of meat and fish, much emphasis is now placed on grain legumes as a source of proteins in all the developing countries.

Bambara groundnut is essentially grown for human consumption. The seed makes a complete food, as it contains sufficient quantities of protein, carbohydrate and fat. Several workers have examined the biochemical composition of the seed (Domfeh *et al.*, 1970; Oluyemi *et al.*, 1976; Oliveira, 1976). The seeds contain 63% carbohydrate, 19% protein and 6.5% oil. Despite the relatively low oil content, some tribes in Congo roast the seeds and pound them for oil extraction

(Karikari, 1971). The gross energy value of bambara groundnut seed is greater than that of other common pulses such as cowpea, lentil and pigeon pea (FAO, 1982). In Sudan, it's grown in rainfed areas of Darfur, Kordofan and Gadarif regions. This study was aimed to determine the protein digestibility of hulled and dehulled Bambara groundnuts.

Bambara groundnut seeds were collected from Um-Gouna (Southern Darfur, Sudan), during the harvesting period in 2010. The seeds were carefully cleaned from foreign materials, washed and sun dried.

Bambara groundnut seeds were soaked in water (1:3 w/v) for 18 hours at room temperature, manually de-hulled, sun dried, milled into fine powder and then passed through 60 mm mesh sieve. The flour was bottled and kept at 5°C for further analysis.

Proximate analysis of hulled bambara groundnut seeds, de-hulled bambara groundnut flour and hulls of bambara groundnuts were conducted for the contents of moisture, ash and fat in triplicates Crude protein was calculated as $N \times 6.25$. Crude fiber was determined using acid/alkali digestion method according to the AOCS (1985). Total carbohydrate content was calculated by subtracting the previous components from 100.

The *in vitro* protein digestibility of bambara groundnuts and de-hulled bambara groundnuts flour were measured according to the three-enzyme method described by Hsu *et al.* (1977) and Satterlee *et al.* (1977) in which a multi-enzyme solution of 1.6 mg trypsin, 3.1 mg chymotrypsin, and 1.3 mg peptidase per milliliter was used.

Amino acid composition of flours of bambara groundnuts seeds and de-hulled bambara groundnuts were measured on hydrolysates using amino acid analyzer (Sykam-S7130) based on high performance liquid chromatography technique. Two hundred mg of sample were taken in hydrolysis tube, then 5 ml of 6 N HCl were added to the sample in the tube, tightly closed and incubated at 110°C for 24 hours. After incubation, the solution was filtered and 200 µl of the filtrate were evaporated to dryness at 140°C for an hour. After dryness, each hydrolysate was diluted with 1 ml of 0.12 N citrate

buffers pH 2.2, as well as the amino acid standards. An aliquot of 150 μ l of sample hydrolysate was injected in a cation separation column at 130⁰C. Ninhydrin solution and an eluent buffer were delivered simultaneously into a high temperature reactor coil (16 m long) at a flow rate of 0.7 ml/min. The buffer/ninhydrin mixture was heated in the reactor at 130⁰C for 2 minutes to accelerate chemical reaction of amino acids with ninhydrine. The products of the reaction mixture were detected at wavelengths of 570 nm and 440 nm on a dual channel photometer. The amino acid composition was calculated from the standards obtained from the integrator and expressed as percentages.

Table 1 shows the proximate analysis of bambara groundnuts seeds, de-hulled bambara groundnuts and hulls of bambara groundnuts.

Table 1. Chemical composition and *in-vitro* protein digestibility of bambara groundnuts seeds, de-hulled bambara groundnuts and the hulls of bambara groundnuts.

Component (%)	Hulled	Dehulled	Hulls
Moisture	4.00 \pm 0.03	7.50 \pm 0.04	8.00 \pm 0.02
Crude protein	29.17 \pm 0.05	32.16 \pm 0.04	5.43 \pm 0.04
Ash	4.17 \pm 0.01	3.24 \pm 0.01	4.02 \pm 0.03
Fat	5.20 \pm 0.03	6.49 \pm 0.02	1.63 \pm 0.04
Crude fiber	4.69 \pm 0.04	1.08 \pm 0.03	64.13 \pm 0.03
Carbohydrate	56.77 \pm 0.03	57.03 \pm 0.04	24.79 \pm 0.03
<i>In vitro</i> protein digestibility	79.24 \pm 0.05	81.95 \pm 0.05	ND

ND \equiv Not determined.

The moisture content of bambara groundnut seeds (4.0 \pm 0.03%) was lower than (7.5 \pm 0.04%) of dehulled and (8.0 \pm 0.02%) of hulls and was within the range of (3.0-4.0%) reported by Duke (1981). It is lower than (10.12% and 14.7%) as reported by Omoikhje *et al.* (2006) and Chittaranjan (2007), respectively, and higher than (2.07%) determined by Olaleke *et al.* (2006). The low moisture content will afford a long shelf life for the legume flours (Olaleke *et al.*, 2006). The protein

content ($29.17\pm 0.05\%$) was lower than ($32.16\pm 0.04\%$) of dehulled and higher than those reported by Chittaranjan (2007), Yagoub and Abdalla (2007); Olaleke *et al.* (2006) and Omoikhoje *et al.* (2006) of (22.2%, 22.10%, 11.56% and 19.61%), respectively and ($5.43\pm 0.04\%$) of hulled seed. These variations may probably be due to the varietal differences and soil condition.

The ash content ($4.17\pm 0.01\%$) was higher than ($3.24\pm 0.01\%$) of dehulled ($4.02\pm 0.03\%$) of hulls and (3.24%, 3.41% and 3.76%) reported by Chittaranjan (2007), Omoikhoje *et al.* (2006) and Yagoub and Abdalla (2007), respectively, and it is lower than (4.28%) as found by Olaleke *et al.* (2006). Generally, the end products made from the low ash content samples were brighter and more uniform in colour than those made from the high ash content (Eltayeb, 2005).

The fat content ($5.20\pm 0.03\%$) was lower than ($6.49\pm 0.02\%$) of dehulled, higher than (5.0%) reported by Yagoub and Abdalla (2007) and ($1.63\pm 0.04\%$) of hulls; and lower than (6.45%, 6.6% and 6.72%) determined by Omoikhje *et al.* (2006), Chittaranjan (2007) and Olaleke *et al.* (2006), respectively.

Crude fiber content ($4.69\pm 0.04\%$) was higher than ($1.08\pm 0.03\%$) of dehulled and (2.07%, 3.72% and 4.45%) reported by Olaleke *et al.* (2006); Yagoub and Abdalla (2007) and Omoikhje *et al.* (2006), respectively, and it was much lower than (64.13 ± 0.03) of hulls.

The carbohydrate content ($56.77\pm 0.03\%$) was lower than ($57.03\pm 0.04\%$) of dehulled and (63.56%, 65.0% and 73.30%) reported by Chittaranjan (2007), Yagoub and Abdalla (2007) and Olaleke *et al.* (2006), respectively and, higher than (54.95%) reported by Omoikhje *et al.* (2006) and (24.79 ± 0.03) of hulls.

The *in vitro* protein digestibility ($79.24\pm 0.05\%$) was lower than ($81.95\pm 0.05\%$) of dehulled, and in close agreement with (78.75%) reported by Yagoub and Abdalla (2007). Bambara groundnuts seeds are also reported to contain trypsin and a chymotrypsin inhibitor, which act as anti-nutritional factors. Roasting the nuts helps greatly reduce the trypsin

inhibitors and subsequently improves their nutritional value (Chittaranjan, 2007).

Table 2 shows that glutamic and aspartic acids contents of de-hulled bambara groundnuts (21.19 and 10.96 g/100g protein) were the predominant amino acids and higher than (21.12 and 10.94g/100g protein) of bambara groundnuts seeds. Glutamic acid was higher than (17.00g/100g protein) while the aspartic acid content was lower than (11.90 g/100g protein) reported by Evans and Boulter (1974). The estimated methionine content (0.92g/100g protein) was higher than (0.88g/100g protein) of bambara groundnuts seeds and lower than (1.18 g/100g protein).

Cystine content (0.69g/100g protein) was lower than (0.81 g/100g protein) of bambara groundnuts seeds and (1.14 g/100g protein). Lysine content (7.13g/100g protein) was higher than (7.00 g/100g protein) of bambara groundnuts seeds and lower than (7.70 g/100g protein). Phenylalanine and leucine contents (6.24 and 8.25g/100g protein) were higher than (6.20 and 8.00g/100g protein) of bambara groundnuts seeds and (5.80 and 7.4 g/100g protein) as determined. However, lysine, phenylalanine and leucine contents exceeded the contents recommended by FAO/WHO (1985). The total essential amino acids (37.0g/100g protein) was higher than (36.25 g/100g protein) of bambara groundnuts seeds and also exceeded the value of (36.00 g/100g protein) reported by FAO/WHO (1985).

It could be concluded that, de-hulling process increased the quantities of protein and *in vitro* protein digestibility. Some of the essential amino acids, particularly lysine, was also increased. In view of the fact that cereal grains are generally deficient in lysine, bambara groundnut seeds will be of great value in the complementation of the essential amino acids in the production of cereal-based products.

Table 2. Amino acid content (g/100g protein) of bambara groundnut seeds.

Amino acid	Samples treatment		
	g/100g protein		
	HBG	DBG	FAO/WHO*
Methionine	0.88	0.92	3.5
Tyrosine	1.88	2.09	---
Phenylalanine	6.20	6.24	6.0
Leucine	8.00	8.25	7.0
Isoleucine	3.47	3.87	4.0
Lysine	7.00	7.13	5.5
Threonine	3.78	3.54	4.0
Valine	5.05	4.96	5.0
Tryptophan	ND	ND	1.0
Total essential amino acids	36.26	37.00	36.00
Histidine	3.26	3.30	---
Arginine	8.60	8.69	---
Cystine	0.81	0.69	---
Aspartic acid	10.94	10.96	---
Glutamic acid	21.12	21.19	---
Serine	4.13	4.05	---
Glycine	3.17	2.75	---
Alanine	5.79	5.89	---
Proline	5.92	5.48	---
Total nonessential amino acids	63.74	63.00	---

*Provisional amino acids pattern recommended by FAO/WHO (1985).

HBG: Hulled bambara groundnuts.

DBG: De-hulled bambara groundnuts.

ND: Not determined.

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التركيب الكيميائي وهضمية البروتين لبذور الفول أبوقوي
(*Vigna subterranea* (L.) Verdc.) غير المقشر والمقشر

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الخلاصة

هدفت هذه الدراسة لمعرفة أثر التقشير على التركيب الكيميائي وهضمية البروتين لبذور الفول أبوقوي. عملية التقشير أدت إلى زيادة في محتوى الرطوبة، البروتين، الدهون، الكربوهيدرات وهضمية البروتين من $0.03 \pm 4.0\%$ ، $0.05 \pm 29.17\%$ ، $0.03 \pm 5.20\%$ ، $0.03 \pm 56.77\%$ و $0.05 \pm 79.24\%$ إلى $0.04 \pm 7.5\%$ ، $0.04 \pm 32.16\%$ ، $0.02 \pm 6.49\%$ ، $0.04 \pm 57.03\%$ و $0.05 \pm 81.95\%$ على التوالي. أيضاً زادت محتوى بعض الأحماض الأمينية الأساسية مثل الميوثين التيروسين، الفينيل ألانين، ليوسين، آيسوليوسين واللايسين. تشجع هذه الدراسة استخدام دقيق بذور الفول أبوقوي في إنتاج بعض المخبوزات السودانية باعتبارها مصدراً جيداً للبروتين.