PJN

ISSN 1680-5194

PAKISTAN JOURNAL OF NUTRITION

ANSInet

308 Lasani Town, Sargodha Road, Faisalabad - Pakistan

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Pakistan Journal of Nutrition 11 (9): 841-844, 2012
ISSN 1680-5194

Nutrient and Antinutrient Composition of Mungbean (*Vigna radiata*), Acha (*Digitaria exilis*) and Crayfish (*Astacus fluviatilis*) Flours

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Abstract: This study evaluated nutrient and antinutrient composition of mungbean, acha and crayfish flours with a purpose of blending them for the production of breakfast cereals. The mungbean grains, acha grains and crayfish were cleaned. A part of the mungbean grains were dehulled. The samples were separately dried and milled into fine flours. The flour samples were analyzed for proximate, mineral and antinutrient composition using standard methods. Results showed that the crude protein, crude fat and ash contents were highest in crayfish (64.30%, 9.20% and 11.47% respectively) and these differed significantly from other samples ($p<0.05$). Undehulled mungbean had the highest fibre content (4.34%) while carbohydrate values were highest in acha (73.40%). Crayfish had the highest values in all the minerals studied with the exception of iodine which was present in traces. Phytate and tannin contents were highest in undehulled mungbean (576.23 mg/100 g and 331.15 mg/100 g) respectively, while acha had the highest oxalate content (265.30 mg/100 g). The nutrient and antinutrient composition of these flours show that they have nutrient potential and their blends could be explored for the production of breakfast cereals and other food products.

Key words: Nutrient, antinutrient, mungbean, acha, crayfish, flours

INTRODUCTION

Mungbean (*Vigna radiata)* is a legume which is mostly cultivated and consumed in the Asian countries and is fast gaining popularity in African countries. It is also known as green gram, golden gram, Oregon pea, *chickasano* pea, *chiroko* pea or simply mung. The crop is said to have originated from India (Akpapunam, 1996). Mungbean is a low altitude crop grown from sea level to approximately 2000 m, usually as a dry land crop. It thrives best on a good loamy soil with well distributed rainfall of 70-90 cm/year. It is drought resistant and susceptible to water logging and is grown mainly in India, Indonesia, China, Burma and Bangladesh (Duke, 1983). Mungbean originating from an area in Southeast Asia deemed to be an ecological analogue of south-eastern Nigeria has been successfully introduced and grown in Nigeria (Agugo, 2003).

Acha (*Digitaria exilis*) is grown throughout the savannah areas of West Africa and is not cultivated outside Africa. It is capable of thriving in poor rocky and marginal soils (Gomez and Gupta, 1993). Acha is the smallest in all species of millet. In northern Nigeria, the grain is commonly called acha or hungry rice and is harvested 3-4 months after sowing. It is one of the staple cereal foods of northern Nigeria during the dry season (Temple and Bassa, 1991).

The name ‘crayfish’ comes from the old French word *escrevisse*, from the same root as crawl. The word has been modified to crayfish by association with fish (Bert and Scott, 2006). Crayfish or crawfish or crawdads (*Astacus fluviatilis*) are members of the super families *Astacoidea* and *Parastacoidea* (Wikipedia, 2010). They are crustaceans and are also known as fresh water lobsters; they are also closely related to lobsters, crabs and shrimps. Crayfish are omnivores, they eat plants, animals and decaying organisms and they are nocturnal in nature (Enchanted learning, 2010). In Nigeria, crayfish is generally used as a food condiment. In some parts of southern Nigeria however, crayfish is used as a source of animal protein and often forms the main source of dietary protein. Few if any studies have been done to evaluate the nutritive value of crayfish as a supplement to cereal and/or legume protein (Obizoba, 1985).

MATERIALS AND METHODS

Sources of materials: Mungbean was purchased from the Department of Agronomy, Michael Okpara University of Agriculture Umudike, Umuahia, Nigeria. Acha was purchased from Terminus market, Jos, Plateau state, Nigeria and crayfish from Umuahia Main Market, Abia state, Nigeria.

Preparation of samples: Mungbean, acha and crayfish were handpicked to remove spoilt grains, stones and other foreign materials. Part of the mungbean was dehulled manually using mortar and pestle (dry dehulling). The hulls were separated from the seeds by winnowing and handpicking to remove undehulled

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mungbean. Dehulled and undehulled mungbean were reduced in size using corona hand mill (Apartado 842). The acha, dehulled mungbean, undehulled mungbean and crayfish were milled into fine flour using Thomas Wiler laboratory hammer mill model ED-5 (70 mm mesh size).

Chemical analysis: Chemical analysis was carried out on all samples in triplicate. Moisture content of samples were determined using oven drying method as described by Pearson (1976), fat content was determined using the Soxhlet extraction method of Pearson (1976). Protein was determined using microKjeidahl method as described by Onwuka (2005) and ash content was determined using AOAC (1995). Crude fibre was determined using acid and alkaline digestion methods (AOAC, 1995), carbohydrate content was determined by difference method (Triebold and Aurand, 1973). Minerals were determined after wet-ashing using concentrated nitric acid and perchloric acid (1:1,v/v), using Atomic Absorption Spectrophotometer (AOAC, 1995). Vitamin C contents were determined using AOAC (2005) procedure while vitamin A was determined using the spectrophotometer method (AOAC, 1995).
Phytate level was determined by a colorimetric procedure described by Vaintraub and Laptera (1988); tannins were determined by spectrophotometric method described by Latta and Eskin (1980) and oxalate was determined using the analytical method described by Onwuka (2005).

Data analysis: Data was analyzed statistically using means, standard deviation, standard error of means and one way analysis of variance. The Duncan's New Studentized Multiple Range Test (DMRT) was used to separate and compare means at $p<0.05$ (Steel and Torrie, 1960).

RESULTS AND DISCUSSION

Table 1 presents proximate and antinutrient content of mungbean, acha and crayfish flours. The moisture content ranged from 10.74% to 12.98%. Crayfish (CR) had the highest moisture value which was comparable to that of acha ($p>0.05$) but their values differed significantly from that of dehulled and undehulled mungbean (10.74% and 10.85%) respectively ($p<0.05$). There was no significant difference between the moisture content of Dehulled Mungbean (DMB) and Undehulled Mungbean (UDMB) ($p>0.05$). The lower moisture content of all the samples tested shows that they will have better keeping quality. Moisture content in excess of 14% in flours has greater danger of bacteria action and mould growth which produce undesirable changes (Ihekoronye and Ngoddy, 1985).

The Crude Protein (CP) content ranged from 8.38% to 64.30%. Crayfish (CR) had the highest crude protein (64.30%) which differed significantly from those of the other samples ($p<0.05$). Acha had the lowest protein value (8.38%). The CP content of DMB differed significantly from that of UDMB (31.31% vs. 27.67%) respectively ($p<0.05$). The low protein content of acha (8.38%) could be that it is a cereal. Animals and legumes have higher protein content when compared to cereals (Aylward and Jul, 1975).
Crude Fat (CF) content ranged from 1.72% to 9.20%. CR had the highest CF value (9.20%) which differed significantly from other samples ($p<0.05$). There was no significant difference between the CF content of UDMB and that of DMB (1.75% vs. 1.72%) respectively ($p>0.05$). Mubarak (2005) also reported a comparable value of crude fat in UDMB and DMB (1.85% and 1.82%) respectively.
The ash content values ranged from 2.25% to 11.47%. Crayfish had the highest value (11.47%) while acha had the least value (2.25%). The high ash content of CR was expected because CR is a crustacean which is a good source of minerals (Enchanted learning, 2010). The ash content of UDMB was comparable to that of DMB (3.30% vs. 3.23%) respectively ($p>0.05$). The comparable value ($p>0.05$) in the ash content of UDMB and DMB could be as a result of the method used in dehulling. Mubarak (2005) reported a significant decrease in ash content (3.76% to 3.60%) due to dehulling of mungbean using water.
Fibre content ranged from 1.20% to 4.34%, with UDMB recording the highest value while acha had the least. There was a significant difference in the fibre content of UDMB and DMB (4.34% vs. 3.98%) respectively ($p<0.05$). The high fibre content of the UDMB could be as a result of the presence of the hulls. Gomez and Gupta (1993) reported higher fibre content in acha (8.5%) while Onyenuga (1968) reported a lower content (0.4%). These disparities in the value of fibre content of acha by these researchers and the present study may be as a result of efficiency of treatment method and/or varietal differences.
Carbohydrate (CHO) values ranged from 0.25% to 73.40% and varied significantly from each other ($p<0.05$). Acha had the highest value (73.40%) while CR had the lowest value (0.25%). There was a significant difference in the CHO content of UDMB and DMB (53.38% vs. 49.02%) respectively ($p<0.05$). Anyika (2003) reported total CHO value of 83.38% for unfermented acha, Nnam and Nwokocha (2003) reported a value of 75% CHO for acha. Cereals and legumes are known to be the major source of CHO worldwide (Mann, 2001).
Phytate, tannins and oxalate content were in traces in crayfish. The phytate content of the samples varied significantly from each other ($p<0.05$). Dehulling of mungbean reduced phytate content from

Table 1: Proximate and antinutrient content of mungbean acha and crayfish flours

Parameters	Undehulled mungbean	Dehulled mungbean	Acha	Crayfish
Moisture (%)	10.85^{b}±0.76	10.74^{b}±0.26	12.73^{a}±0.00	12.98^{a}±0.22
Protein (%)	27.67^{c}±0.30	31.31^{b}±0.34	8.38^{d}±0.31	64.30^{a}±0.34
Fat (%)	1.75^{c}±0.00	1.72^{c}±0.00	2.04^{b}±0.08	9.20^{a}±0.26
Ash (%)	3.30^{b}±0.00	3.23^{b}±0.00	2.25^{c}±0.06	11.47^{a}±0.00
Fibre (%)	4.34^{a}±0.00	3.98^{b}±0.00	1.20^{d}±0.00	1.80^{c}±0.00
Carbohydrate (%)	53.38^{b}±0.03	49.02^{c}±0.00	73.40^{a}±0.00	0.25^{d}±0.00
Phytate (mg/100 g)	576.23^{a}±0.35	452.16^{b}±0.16	114.22^{c}±0.18	traces
Tannins (mg/100 g)	331.15^{a}±0.10	230.32^{b}±0.25	9.31^{c}±0.12	traces
Oxalate (mg/100 g)	128.27^{b}±0.10	120.34^{c}±0.19	265.30^{a}±0.52	traces

Mean ± SEM of three determinations.

$^{a-d}$Values of means in the same row with different superscript differed from each other ($p<0.05$)

Table 2: Micronutrient composition of mungbean, acha and crayfish flours

Parameters	Undehulled mungbean	Dehulled mungbean	Acha	Crayfish
Zinc (mg/100 g)	2.72^{c}±0.00	2.69^{c}±0.00	4.17^{b}±0.00	43.30^{a}±0.00
Copper (mg/100 g)	1.87^{c}±0.00	1.85^{c}±0.00	8.15^{b}±0.00	30.21^{a}±0.07
Calcium (mg/100 g)	35.30^{c}±0.00	33.60^{d}±0.00	6.70^{b}±0.00	823.00^{a}±0.14
Iron (mg/100 g)	10.20^{c}±0.00	9.80^{c}±0.00	22.86^{b}±0.00	195.00^{a}±0.73
Iodine (mg/100 g)	4.57^{b}±0.07	3.05^{c}±0.00	28.45^{a}±0.00	traces
Ascorbate (mg/100 g)	3.98^{a}±0.00	3.86^{a}±0.00	traces	1.20^{b}±0.00
Vitamin A (IU)	17.22^{a}±0.02	17.21^{a}±0.02	0.19^{c}±0.00	4.70^{b}±0.01

Mean ± SEM of three determinations.

$^{a-d}$Values of means in the same row with different superscript differed from each other ($p<0.05$)

576.23mg/100g to 452.16 mg/100 g. Phytate value in acha was 114.22 mg/100 mg. The phytate value of UDMB differed significantly from the phytate value of DMB (576.23 mg/100 g vs. 452.16 mg/100 g) ($p<0.05$). Tannins followed the same trend as phytate in all the samples tested. There was a significant reduction in oxalate content as a result of dehulling mungbean from 128.27 mg/100 g to 120.34 mg/100 g ($p<0.05$). Acha had the highest oxalate content (265.32 mg/100 g) which was significantly higher than that of the rest of the samples tested ($p<0.05$).

The observed decrease in phytate, tannin and oxalate in dehulled mungbean was due to dehulling. Dehulling has been shown as one of the effective processing technique for reducing tannins (Dolvo *et al*., 1976). Addy and Eteshola (1984) reported that greater percentage of total tannins present in legumes is located in the hulls. Dehulling removes tannins from the seed coat into the surrounding medium. Wise (1983) showed that phytate contains phosphorus and iron (as monoferrous phosphate). These nutrients under certain treatments are made available and subsequently leached out of the products. The higher phytate, tannin and oxalate content in the present study could be due to dry dehulling.

Table 2 presents the micronutrient composition of mungbean, acha and crayfish. The zinc (Zn), copper (Cu) and iron (Fe) values differed significantly from each other ($p<0.05$) except for the values of dehulled and undehulled mungbean which were similar ($p<0.05$). Crayfish had the highest Zn, Cu and Fe content (43.30 mg/100 g), 30.21 mg/100 g, 195 mg/100 g) respectively while dehulled mungbean had the least Zn, Cu and Fe content (2.69 mg/100 g, 1.85 mg/100 g, 9.80 mg/100 g) respectively.

The reduction in the Zn, Cu and Fe content of dehulled mungbean was due to treatment (dehulling). The higher but comparable ($p>0.05$) values in Zn, Cu and Fe content for the undehulled mungbean as compared to the dehulled mungbean was because the undehulled mungbean contains the micronutrients and chelating agents. The micronutrient in undehulled mungbean may not be available as compared with those in the dehulled products. The increases in Zn, Cu and Fe content of CR were ascribed to decreased levels (traces) of antinutrients (phytate, tannin and oxalate) which bind with Zn, Cu and Fe and make them unavailable.

Calcium (Ca) content varied significantly from each other ($p<0.05$). Calcium content ranged from 6.70 mg/100 g in acha to 823 mg/100 g in CR. The lower Ca content in acha as compared to the other products was attributed to grain type and varietal differences. The higher Ca content in UDMB as compared to DMB could be due to treatment (dehulling).

Iodine (I_2) value varied significantly from each other ($p<0.05$) in all the samples tested. Crayfish had traces of I_2. Acha had the highest I_2 value (28.45 mg/100 g). The traces of I_2 in CR could be because CR is a fresh water food. Fresh water foods are not known to contain I_2 (Mar and Terra, 2010). Generally the I_2 content of foods of both animal and vegetable origin is related to the soil in which they are grown (Stanbury and Dunn, 2001).

The ascorbate and vitamin A content of the samples followed a similar trend and were significantly different from each other ($p<0.05$) except that acha had traces of ascorbate. Whole grain cereals are totally devoid of ascorbic acid and practically devoid of vitamin A activity (www.besthomeremedies.com).

Conclusion: The proximate, antinutrient and mineral composition of mungbean, acha and crayfish flours shows that they have high nutrient potential and their blends could be explored for the production of breakfast cereals and other food products.

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