FRACTIONAL NUTRIENT COMPOSITION OF ACHA (*DIGITARIAEXILIS)*

S. D. Sudik and P. G. Gofwan
Department of Animal Health and Production, Plateau State College of Agriculture, Garkawa, Nigeria
E-mail: **davidsudik@yahoo.com** phone No: +2348065633541

Abstract

Nutrient composition of acha fractions (whole grain, endosperm and hull) of the variety Digitaria exilis with respect to proximate, amino acid profile, fibre fraction, anti-nutritional factors and minerals was examined with the view to determine their levels of inclusion in the diet humans or livestock. The results showed profound coefficient of variation in crude fibre, total ash and protein/fat ratio and less variation in ether extract, crude protein, carbohydrate and gross energy: The crude fibre and total ash content was higher in the hull and whole grain, respectively and both were lower in endosperm while the protein/fat ratio was higher in the endosperm and lower in the hull. All the amino acids examined were higher in the endosperm followed by hull. The fibre fractions, anti-nutritional factors and minerals contents followed the order: hull>WG>Endo. In conclusion, it was observed that differences exist among D. exilis fractions and the use of each either in human or livestock nutrition required supplementation.

Key words: Acha, nutrient composition, fractional differences and supplementation

Introduction

Among the less privileged families in sub-Sahara Africa, Asian and Pacific countries, cereals form bulk of feedstuffs providing macro- and micro-nutrients typified by calories, protein, minerals and vitamins for life sustenance Sudik (2016). In particular, crops mainly wheat, barley, oats and rye which are found in cool-season and rice, maize, sorghum and millet, which are found in warm-season are expensive because of the pressure mounted on them by man, animal and food industries. Another cerealacha (*Digitariaexilis*) is produced in subsistence levels and is not given attention in development programmes Ballogou*et al*. (2013). When this crop is given equal treatment as the conventional cereals, increased availability of cereals in the tropics to mitigate food shortage may be guaranteed.

Acha is native to West Africa and is grown in most West African countries (Jideani, 2012). There are actually two varieties of acha: white acha (*Digitariaexilis*) and black acha (*Digitariaiburua*).The *D. exilis* is usually 30-75 cm tall and has white and small seeds while the *D. iburua* is taller and may reach 1.4 m and has black and bigger seeds (Adoukonou-Sagbaja, 2010; Jideani, 2012). The white acha is the most diverse and widely cultivated. It is called acha, ipouaga, feningué, findi, kansambahon and ova in Nigeria, Benin, Burkina Faso, Guinea, Mali and Togo respectively while the black acha is called iburu, and is restricted to Bauchi - Plateau states areas of Nigeria as well as in northern regions of Togo and Benin Gyang and Wuyep (2005). The acha is not a demanding crop and tolerates wide ranges of climate and soil fertility (Philip and Itodo, 2006).

The acha grain is like rice which is surrounded by a husk and this is about 23% of the paddy acha measured between 1.5 and 1.8 mm long and approximately 0.9 mm wide (Ballogou *et al*., 2013). The hull or hull is obtained by dehulling the grain during milling and is considered as waste (Sudik, 2016). Determining the nutrient composition of acha's hulls is one way of searching for alternative fibre in monogastric feeding and this forms one focus of this study.

Several author shave reported the composition of acha while some review works have been documented which confirms the nutritive potential of acha grains. However, most of these failed to distinguish which form of acha was being referred to in their studies. Besides, information on the comparative evaluation of the nutrient compositions of the acha fractions typified by proximate, amino acid profile, fibre fractions and mineral is rare. This thus forms the main focus of this study aimed at determining the fractional nutrient composition of acha (D. exilis).

Materials and Methods

Location of the study

The research study was conducted in the Central Research Laboratory of the Federal University of Technology, Akure, Nigeria. Akure is located in the rain forest zone of Nigeria which lies between latitude 7^0 15' North and longitude 5^0 12' 0" East. The atmospheric temperature usually ranged between 28^0C and 31^0C and mean annual relative humidity is usually about 80% (Ajebefun, 2011).

Acha samples preparation

The samples of whole grain, endosperm and hull of the two species of acha (*D. exilis*) were obtained from an acha milling house in Jos, Plateau State, Nigeria. The whole grains and endosperms were sorted to remove foreign materials and thereafter washed several times to remove sands (de-stoning). The washed samples were spread on a flat trail and sun dried for 4 days depending of the intensity of the sun. The hull was cleaned by hand picking. The cleaned whole grains, endosperms and hull were thereafter milled using laboratory hammer mill to pass through 0.5mm sieve. They were properly labeled and stored in screw-capped bottles prior to analysis.

Chemical composition

Proximate composition of the samples was determined by the procedure: dry matter by drying in an oven at 105^oC until a constant weight was obtained, ether extract by Soxhlet extraction with diethyl ether, ash by incineration in a muffle furnace at 550^oC for 3hr, nitrogen was determined by the micro-Kjeldahl method and the crude protein was subsequently calculated by multiplying the nitrogen content by a factor of 6.25 (AOAC, 2000). Carbohydrate content was estimated by the subtraction of moisture + crude protein + lipid + ash + crude fibre from 100%. All determinations were expressed on a dry matter basis.

The insoluble and soluble dietary fibre contents were quantified using the enzymatic procedure according to Van Soest and Robertson (1985). The neutral-detergent fibre (NDF), acid-detergent fibre (ADF) and lignin (ADL) were determined with Foss Fiber Tech (Model: Fibertech^{TM} 1020, China). Hemicellulose was estimated by subtracting ADF from NDF and cellulose by subtracting ADL from ADF.

Prior to macro-elements and micro-elements determinations, the ash obtained in the proximate analysis was dissolved in 10% HCl, filtered with filter paper and made up to standard volume with distill water. Flame photometer (Jenway flame photometer Model: PFP7, UK) was used to determine sodium and potassium contents of the samples. Calcium, iron, magnesium, zinc, manganese and copper were determined using Atomic Absorption Spectrophotometer (Buck Scientific Ltd, Model: 210 /211 VGP). Phosphorus content was determined by employing Vanadomolybate method and read on Jenway UV/visible spectrophotometer (Model: 6850, China).Mean values of these determinations are reported in this study on dry weight basis.

The determination of phytate was by the calorimetric procedure of Reddy *et al* (1978) and Agbede and Aletor (2003). Oxalate content was determined as previously reported by Day and Underwood (1986) while tannin content was determined by the qualitative method of Makkar and Goodchild (1996).

The amino acids were determined using an automatic amino acid analyzer (AAA) (INGOS, Czech Republic). In brief samples were subjected to acid hydrolysis in the presence of 6 M HCl after oxidation (formic acid + hydrogen peroxide, 9:1 v/v, 20 hr at 4^oC) (Beniter, 1989). The gross energy of the samples was determined against thermocouple grade benzoic acid using bomb calorimeter (Model: C2K combustion calorimeter, UK).

Statistical analysis

SPSS (17) software (SPSS Inc., Chicago, USA) was used to calculate the mean, standard deviation (SD) and coefficient of variation (CV %) of each parameter measured.

Results and Discussion

Proximate composition and calorie value

This present study attempted to compare the nutritive potential of acha fraction (*Digitariaexilis*) with respect to their proximate composition, energy value, amino acid profile, fibre fractions, minerals and anti-nutritional factors. Reports comparing nutritional potential of whole grain (WG), endosperm (Endo) and hull in acha are limited.

This thus explains the purpose of this study. Table 1 shows the proximate composition of the fractions in *D. exilis*. The crude fibre, total ash and protein/fat ratio varied widely among the fractions as evident by higher coefficient of variation (31.90, 18.92 and 13.07, respectively) and less variations in ether extract, crude protein, carbohydrate and gross energy as indicated by lower coefficient of variation (ranging from 8.53 to 1.77). The crude fibre was higher in the hull (11.02±2.84) and lower in the endosperm (5'63±2.84); the total ash was higher in the WG (6.00±0.86) and lower in the endosperm (4.44±0.86) while the protein/fat ratio was higher in the endosperm (2.80±0.32) and lower in the hull (2.16±0.32) implying that fractional differences in respect to the proximate composition exist, which suggests that depending on which fraction is used, the derivable nutrients will vary. Generally, the nutritive values presently observed fall within the values previously reported in cereals (Alais, and Linden, 1991; Eliason and Larsson, 1993; Temple *etal.*, 1996).

Amino acid profile

Table 2 shows the amino acid profile of *D. exilis* fractions. The Endo in most cases had the highest TNEAA, TCEAA and TEAA followed by the hull. This thus suggests fractional differences exist in the amino acid profiles of the *D. exilis* fractions. In general, only cysteine, histidine, isoleucine, leucine , methionine, threonine and valine of the Endo fractions compared favourably with the FAO/WHO (1994) recommended values while the other AA were not only lower than that of FAO/WHO (1994)recommended values but with that of whole egg (NAS, 1996; EFRT, 2000) suggesting that when any of the acha fractions is to be used in food formulations there is a need for the supplementation of the AA or feeding of foods rich in these AAs alongside is imperative so as to avert the precipitation of AA deficiency symptoms on consumption. This study suggests that acha is not a proteinous feed resource.

Fibre fractions and anti-nutritional factors

Table 3 shows that fractional differences exist in the fibre components of acha. Profound variations in the fibre fractions as evidenced by the high CV in the fractions were observed. The hull in all cases contained higher percent of all the fibre fractions, followed by WG and Endo (hull>WG>Endo). Also, there were fractional differences in the phytate, oxalate and tannin contents Phytate contents in all the samples were higher than the range of 112.00-287.00 mg/100g (Adeyeye and Fabgohun, 2005) and oxalate in range of 1.56-1.98 mg/100g in most of Nigerian crops (Adeyeye, 2013) while the tannin content fall within the range of 0.30-0.90g/100g earlier reported for *Canavaliaensiformis* and 0.80-7.80 g/100g for *Mucunapruriens* (Agbede and Aletor, 2003) implying the wholesomeness of acha products and by-products as foods and feed resources. High dietary fibre is known to increase bulk with a consequential decrease in nutrient digestibility, absorption and utilization. Phytate has the ability to chelate divalent cations (CA, Mg, Fe and Zn) and interfere with their bioavailability while tannin has been reported to have the potential to bind with dietary proteins and digestive enzymes and makes them not readily digestible (Agbede and Aletor, 2003).

Minerals

Table 4 depicts that the fractions contained nutritionally needed minerals which varied slightly as evidence in their CV values. Of interest is that the mineral concentration is highest in the hulls followed by the whole grain and endosperms which suggest that hull, which is a waste from acha processing, could be a useful feed stuff that could contribute substantially to the mineral concentration in monogastric diets. This is in agreement with the report of Lasztity (1984) that dietary minerals are more concentrated in the hull than in the endosperm. In addition, the commonly eaten fraction is the endosperm, which from this study showed that it has the lowest mineral concentration compared with the WG and hull. By extension, the food preparations that largely depend on the Endosperm may need to be complemented with organic or inorganic mineral supplement to prevent the precipitation of mineral deficiency symptoms on consumption.

In conclusion, the present study showed that differences exist among D. exilis fractions with respect to the proximate composition, energy, amino acid profile, fibre fractions, anti-nutrients factors and mineral.

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Table 1: Proximate composition (g/100g DM) and Gross energy (J/100g) of acha

Parameters	WG	Endo.	Hull	Mean	±SD	CV
Total Ash	6.00	4.44	4.61	4.53	0.86	18.91
Crude protein	11.12	12.60	11.40	12.00	0.79	6.55
Ether extract	4.66	4.50	5.29	4.90	0.42	8.53
Crude Fibre	6.78	5.63	11.02	8.90	2.84	31.90
Carbohydrate	72.59	71.51	67.85	69.68	2.48	3.57
Gross energy	160.25	160.88	155.72	158.95	2.85	1.77
Protein/fat	2.39	2.80	2.16	2.48	0.32	13.07

WG= whole grain, Endo= endosperm, ±SD = standard deviation, CV= coefficient of variation, MC=moisture content, NFE=nitrogen free extract.

Table 2: Amino acid profile (g/16 N) of acha fractions

Parameters	WG	Endo	Hull	Mean	±SD	CV	FAO/ WHO[22]	Whole egg[23, 24]
Total non-essential amino acids (TNEAA)								
Alanine	3.33	4.02	3.44	3.60	0.37	10.31	-	-
Aspartic acid	2.94	3.46	3.04	3.15	0.28	8.77	-	-
Glutamic acid	5.58	5.89	5.77	5.75	0.16	2.72	-	-
Serine	2.38	2.36	2.46	2.43	0.05	1.90	-	-
Total conditionally essential amino acids (TCEAA)								
Arginine	3.63	3.38	3.79	3.60	0.21	5.74	-	6.1
Cystine	1.42	1.85	1.57	1.50	0.08	5.03	-	1.8
Glycine	3.31	3.17	3.42	3.30	0.13	3.80	-	-
Proline	2.55	3.05	2.63	2.74	0.27	9.79	-	-
Tyrosine	2.70	2.07	2.79	2.52	0.39	15.57	-	4.0
Total essential amino acids (TEAA)								
Histidine	1.89	2.98	1.95	2.27	0.61	26.95	2.40	2.4
Isoleucine	3.18	4.32	3.28	3.59	0.63	17.57	4.00	5.6
Leucine	8.40	8.76	8.68	8.61	0.19	2.19	7.00	8.3
Lysine	2.80	3.20	2.89	2.96	0.21	7.08	5.50	6.3
Methionine	2.57	3.64	2.65	2.62	0.04	1.66	-	3.2
Phenylalanine	3.78	4.15	3.90	3.94	0.19	4.79	-	5.1
Threonine	3.78	5.15	3.90	3.84	0.06	1.57	4.00	5.1
Valine	4.17	5.11	4.23	4.17	0.06	1.44	5.00	7.6

WG= whole grain, Endo= endosperm, ±SD = standard deviation, CV = coefficient of variation,

Table 3: Fibre fractions (g/100g) and anti-nutrients (g/kg) values in acha

Parameters	WG	Endo.	Hull	Mean	±SD	CV
Fibre fractions						
NDF	48.24	4.31	50.00	34.18	25.89	75.69
ADF	32.59	2.30	38.64	23.18	19.47	78.13
ADL	10.80	0.21	8.52	6.51	5.57	85.62
Hemicellulose	15.65	2.01	30.12	15.93	14.06	96.63
Cellulose	21.79	2.09	26.12	16.67	12.81	76.85
Anti-nutritional factors						
Phytate	0.27	0.17	0.35	0.26	0.09	34.25
Oxalate	0.01	0.01	0.02	0.01	0.01	43.30
Tannin	0.01	0.01	0.01	0.01	0.00	0.00

WG= whole grain, Endo= endosperm, ±SD = standard deviation, CV = coefficient of variation, NDF =neutral detergent fibre, ADF= acid detergent fibre and ADL= Acid detergent lignin

Table 4: Mineral contents (g100/g) and mineral ratios of acha fractions

Parameters	WG	Endo.	Hull	Mean	±SD	CV
Macro-elements (g/100g)						
Calcium (Ca)	0.04	0.03	0.05	0.04	0.01	25.00
Phosphorus (P)	0.06	0.04	0.07	0.06	0.02	26.96
Potassium (K)	0.07	0.05	0.09	0.07	0.02	28.57
Sodium (Na)	0.02	0.01	0.05	0.03	0.02	78.06
Magnesium (Mg)	0.06	0.04	0.07	0.06	0.02	26.96
Micro-elements (mg/1kg)						
Iron (Fe)	0.02	0.02	0.04	0.03	0.01	43.30
Copper (Cu)	0.01	0.01	0.02	0.01	0.01	43.30
Manganese (Mn)	0.04	0.02	0.03	0.03	0.01	33.33
Zinc (Zn)	0.04	0.03	0.04	0.04	0.01	15.75

WG= whole grain, Endo= endosperm, ±SD = standard deviation, CV = coefficient of variation.