THE NUTRIENT COMPOSITION OF BAMBARA GROUNDNUT LANDRACES (VIGNA SUBTERREANEA, (L.) VERDC.) CULTIVATED IN SOUTHERN AFRICA

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Abstract

Bambara groundnut has been classified as an underutilized crop, and described as a complete food. In this study the dry matter, ash, crude protein, crude fat, neutral detergent fibre (NDF), acid detergent fibre (ADF) and acid detergent lignin (ADL) were determined for nine landraces cultivated in Botswana, Namibia and Swaziland respectively. The Association of Official Analytical Chemists methods were used for the analysis. The results (g/100 g) obtained were: dry matter 92.17–94.00, ash 3.57–4.85, crude protein 17.10– 22.94, crude fat 4.90–7.24, ADF 6.53–10.65, NDF 14.10–25.82, and ADL 0.19–3.44. The landraces grown in Botswana had more protein (20.66–22.94) compared with those grown in Namibia (19.28–20.53) and Swaziland (17.10–19.91) respectively. In contrast, the landraces grown in Swaziland had higher values for NDF (16.33–25.82) compared with those grown in Namibia (15.80–21.19) and Botswana (14.10–21.71) respectively. The fat content was overall low which is in line with good nutritional requirements. There were intra and inter country composition similarities and differences amongst the landraces. The results show that the crop is a good source of protein and fibre. Its enhanced utilization can positively contribute towards food security.

Key words: Bambara groundnut, landraces, nutritional composition, Botswana, Namibia, Swaziland

INTRODUCTION

In many developing countries there is protein deficient malnutrition because people cannot afford to buy animal protein. As a result various efforts are being made to solve this problem through the popularization and utilization of less popular foodstuffs such as bambara groundnut. For many people in the rural areas their main source of cheap protein is legumes, and their diet is dominated by starchy staple foods such as maize, sorghum or rice. This crop originated from North Africa and the name Bambara, is a district on the Upper Niger near Timbucktoo (Swa-nevelder, 1998). It is an indigenous African legume which is a rich source of cheap vegetable protein. This legume with other legumes can help to alleviate nutritional protein deficiency in these countries. This crop has been classified as an underutilized, but it has a great potential to contributing to food security in Africa. It is grown for its edible seeds that are a rich source of protein and carbohydrate (Brough and Azam-Ali, 1992). Among the positive attributes of this crop are its tolerance to drought, relative resistance to pests, diseases and the ability to produce some yield in poor soils too poor to support the growth of other legumes such as *Arachis hypogaea* (Brough and Azam-Ali, 1992). Bambara groundnut features prominently in Botswana's farming systems and is next to *Vigna unguiculata* (L) Walp (cowpea) and *Arachis hypogaea* (groundnut) in terms of production and consumption (Karikari et al. 1996). The colour of the seeds vary-white, cream, red, black and may be mottled with colours such as brown, red or black. There are preferences for the different seed colours, with the southern and central districts of Botswana people preferring the white and cream coloured landraces and in the northern part close to the Zimbabwean border, the red landraces are preferred (Amarteifio and Karikari, 2003). Notwithstanding the use of bambara groundnut in this region, there is limited information on the composition of the different landraces available. The objectives of the study were to determine the dry matter, ash, crude protein, crude fat, neutral detergent fibre, acid detergent fibre and acid detergent lignin of nine landraces of bambara groundnuts grown in Botswana, Namibia and Swaziland respectively and to statistically determine if there were significant differences in nutrient composition among them.

MATERIALS AND METHODS

The seeds of the nine landraces were grown in Botswana, Namibia and Swaziland respectively as part of the BAMFOOD project. The experimental design was randomised complete block design and the number of replicates were

four (Karikari, 2008). Botswana is situated in latitude 24°45´S and longitude 25°55´E and shares a common border with Namibia, Zambia, Zimbabwe and South Africa. The summer (rainy season) is from November to March and the winter season is from April to October. Namibia is situated in latitude 22°34´S and longitude 17°06´E and Swaziland, is situated in latitude 26º49´S and longitude 31°38´E. These countries are loca-ted in the eastern and southern hemispheres with similar climatic conditions (Worldatlas, 2008). The dried matured seeds were sorted out and damaged seeds discarded. The seeds were ground using a Thomas Wiley laboratory mill to pass through a 2 mm sieve; this was used for all the analyses. The experiments were performed in triplicate and the mean calculated. The results for crude protein, crude fat, ash, and fibre are given in g per 100 g dry matter. For the dry matter it is given in g/100 g of fresh sample of bambara groundnut. The dry matter, ash, crude protein and fibre were determined using the Association of Official Analytical Chemists (AOAC, 1999) methods. For the dry matter 2.0 g samples were dried in an oven at 70°C to constant weight. The ash content was determined by completely burning 2.00 g samples in a muffle furnace (Labcon, type RM 7) for three hours at 600ºC. They were allowed to cool to room temperature in a desiccator and then weighed. Crude protein was estimated using the Kjeldahl method and was calculated by multiplying the percentage nitrogen by 6.25, the conversion factor. The acid detergent fibre, neutral detergent fibre and acid detergent lignin were determined using the Ankom 200/220 instrument. Crude fat was measured using the ANKOM XT 10 extractor. The data were analysed using the analyses of variance (ANOVA). Duncan's multiple range test was used to compare the mean values. Significance was accepted at $P \leq 0.05$.

RESULTS AND DISCUSSION

The results obtained for the dry matter and ash contents are given in Table 1. The dry matter contents were similar for NC 1, OM 1 and AHM 968 grown in the three different countries. The inter country values ranged from 92.17–94.0 and Dip C grown in Botswana had the highest value while NC 2 and UR/SR grown in Swaziland had the lowest values. The intra country ranges obtained were 92.83–94.0, 92.50–93.67 and 92.17–92.83 for the landraces grown in Botswana, Namibia and Swaziland respectively. All the landraces in the different countries had similar ash contents. Across the three countries the

Tab. 1: The dry matter and ash contents (g/100 g) fresh sample and ash (g/100 g dry matter of bambara ground-nuts cultivated in Southern Africa

Landrace	Botswana		Namibia		Swaziland	
	DM	Ash	DM	Ash	DM	Ash
NC 1	92.83 defgh	4.47 abc	92.83 defgh	3.95 bcd	92.33 gh	3.98 abcd
NC 2	93.17 bcdef	3.92 bcd	92.83 defgh	4.31 abcd	92.17 h	3.97 bcd
UR/SR	93.17 bcdef	4.29 abcd	93.17 bcdef	4.47 abc	92.17 h	4.34 abcd
OM 1	93.50 abcd	4.28 abcd	93.17 bcdef	3.57 d	92.83 defgh	3.72 cd
Dip C	94.00 a	4.25 abcd	93.50 abcd	4.27 abcd	92.83 defgh	4.03 abcd
AHM 968	93.00 cdefg	4.66 ab	92.50 fgh	4.69 ab	92.83 defgh	4.85 a
AS 17	93.33 abcde	4.64 ab	93.67 abc	4.49 abc	92.67 efgh	4.68 ab
Gab C	93.83 ab	4.62 ab	93.50 abcd	4.50 abc	92.83 defgh	4.49 abc
AHM 753	93.83 ab	4.09 abcd	93.67 abc	4.47 abc	92.83 defgh	4.31 abcd
S.E	0.21	0.25				

DM = dry matter, S.E = Standard error

Means with the same letter(s) in a row are not significantly different ($P \leq 0.05$)

ash content ranged from 3.57 for OM 1 cultivated in Namibia to 4.85 for AHM 968 grown in Swaziland. The intra-country values ranged from 3.92–4.66, 3.95–4.69 and 3.72–4.85 for Botswana, Namibia and Swaziland respectively.

The data obtained for the crude protein and crude fat are shown in Table 2. The values obtained for the crude protein were 21.10–22.94 for those grown in Botswana, 19.28–20.53 for Namibia and 17.10–19.91 for Swaziland. Landraces grown in Botswana had higher crude protein values compared with those cultivated in Namibia and Swaziland respectively. This may be due to the differences in the soils and the environment. The inter country values for the crude protein ranged from 17.10–22.94. AS 17 from Botswana had the highest protein content (22.94) and NC 2 from Swaziland had the lowest (17.10). The protein content compares favourably with those of other legumes such as cowpeas, *Vigna unguiculata*, 23.1% and pigeon peas, *Cajanus cajan* 20.9% (FAO, 1968). The landraces NC 1, NC 2, UR/SR, OM 1, and Dip C had protein contents which were significantly different in the three countries studied. For AHM 968, AS 17 and Gab C, the contents for those grown in Namibia and Swaziland were similar ($P \leq 0.05$) but significantly different ($P \geq 0.05$) from those grown in Botswana. This legume has high protein content and would be useful in the diets to improve protein consumption and would reduce protein malnutrition deficiency if consumed in adequate quantities.

The crude fat contents are low, making bambara groundnuts good for a low fat diet requirement. Across the three countries crude fat ranged from 4.90–7.24. For UR/SR and Gab C, the crude fat contents were similar for the three countries. The range of values within each country was 4.90–6.62, Botswana; 5.61–6.66 Namibia; and 6.10–7.24 for Swaziland.

The overall ADF range of values across the three countries was 6.53–10.65, whereas the values for those grown in Botswana, Namibia and Swaziland were 7.83–10.65, 6.53–9.37 and 7.25–9.75 respectively (Table 3). Statistically NC 1, Dip C, Gab C and AHM 753 had similar values ($P \leq 0.05$) in the three countries. However, for NC 2, the values were all significantly different.

The ADL values for UR/SR and Gab C were similar in the three countries; however, there were similarities and differences for the other landraces. The ranges of values obtained in the different countries were: 0.39–2.20, 0.19–2.26 and 1.10–3.44 for Botswana, Namibia and Swaziland respectively.

This crop is a good source of NDF judging from the data obtained which ranged from 14.10–25.82. Within each country the results were: Botswana, 14.10–21.71; Namibia, 15.80–21.19 and Swaziland, 16.33–25.82. The data obtained were similar for six of the nine landraces

Tab. 2: The crude protein and crude fat contents (g/100 g dry matter) of bambara groundnuts grown in southern Africa

Landrace	Botswana		Namibia		Swaziland	
	CP	CF	CP	CF	CP	CF
NC 1	22.72 a	5.89 fgh	20.16 efghi	6.36 bcdefg	18.54 kl	6.95 ab
NC 2	22.63 ab	5.59 h	20.53 defg	6.15 cdefgh	17.10 m	6.80 abc
UR/SR	21.47 cd	6.06 defgh	19.38 ghijk	6.38 bcdefg	18.84 jkl	6.36 bcdefg
OM 1	20.66 def	5.99 efgh	19.38 ghijk	6.66 abcd	17.72 lm	6.45 bcdef
Dip C	21.57 bcd	6.32 bcdefg	19.94 efghij	5.61 h	19.13 ijk	6.10 defgh
AHM 968	21.10 de	4.90 i	19.28 hijk	6.03 defgh	18.79 jkl	6.40 bcdef
AS 17	22.94 a	5.74 gh	20.44 defgh	6.08 defgh	19.91 efghij	6.88 ab
Gab C	22.41 abc	6.08 defgh	20.29 efghi	6.49 bcdef	19.85 fghij	6.34 bcdefg
AHM 753	21.10 de	6.62 abcde	20.10 efghi	6.39 bcdefg	18.53 kl	7.24 a
SE	0.292	0.155				

CP = Crude protein; CF = crude fat; S.E = Standard error

Means with the same letter(s) in a row are not significantly different ($P \leq 0.05$)

Tab. 3: Fibre contents (g/100 g dry matter) of Bambara groundnuts grown in Southern Africa

Landrace	Botswana			Namibia			Swaziland		
	ADF	ADL	NDF	ADF	ADL	NDF	ADF	ADL	NDF
NC 1	10.21 ab	0.39 hi	20.92 bcde	9.37 abcd	1.18 cdefghi	21.19 bcd	9.33 abcd	1.44 bcdefg	25.82 a
NC 2	9.94 ab	0.55 ghi	21.71 bc	6.53 j	0.19 i	18.14 cdefgh	8.44 cdefgh	1.28 bcdefgh	22.51 b
UR/SR	8.50 cdefghi	1.26 bcdefgh	21.47 bcd	7.85 fghij	1.75 bcdef	18.67 bcdefgh	7.25 j	2.12 bcd	22.00 bc
OM 1	10.65 a	1.25 bcdefgh	15.70 hi	7.79 fghij	1.65 bcdef	15.80 hi	8.16 defghi	3.44 a	18.66 bcdefgh
Dip C	8.50 cdefghi	0.86 fghi	19.60 bcdefgh	7.85 fghij	2.26 b	17.20 efghi	7.27 ij	1.72 bcdef	16.33 ghi
AHM 968	7.83 fghij	2.20 bc	14.10 i	7.83 fghij	0.91 efghi	16.87 fghi	9.53 abcd	1.47 bcdefg	20.52 bcdef
AS 17	9.81 abc	1.17 defghi	19.74 bcdefg	7.74 ghij	0.30 hi	19.33 bcdefgh	7.65 hij	1.66 bcdef	18.12 cdefgh
Gab C	9.19 bcdef	0.90 efghi	21.43 bcd	9.13 bcdefg	0.39 hi	20.67 bcdef	8.46 cdefghi	1.13 defghi	21.05 bcde
AHM 753	9.25 abcde	1.90 bcde	17.64 defghi	9.02 bcdefgh	0.45 ghi	19.41 bcdefgh	9.75 abc	1.74 bcdef	18.17 cdefgh
S.E	0.422	0.243	1.146						

ADF = Acid detergent fibre; ADL = Acid detergent lignin;. NDF = Neutral detergent fibre; S.E = Standard error
Means with the same letters in a row are not significantly different $P \leq 0.05$.

grown in the three different countries; UR/SR, OM 1, Dip C, AS 17, Gab C and AHM 753. Nutritionists recommend a high fibre diet which this crop can provide if eaten in sufficient quantities.

The values obtained for the dry matter in this study (92.2–94.0) are in agreement with the 90.7–91.5 reported for six of the landraces grown in Botswana (Amarteifio et al., 2002), 87.7–92.5 and 91.6–93.0 (Onimawo et al., 1998), for samples grown in Nigeria and 91.6–93.0 (Kemo, 2000) for four landraces different from those in this study and grown in Botswana. The crude protein content of 17.10–22.94 reported here compares favourably with 15.1–22.1, 17.5–21.2 and 15.2–17.6 obtained by Amarteifio et al. (2002), Onimawo et al. (1998) and Kemo (2000) respectively. The current crude fat value of 4.90–7.24 determined is in agreement with the 5.5–7.0, 6.6–7.3 and 7.3–8.5 estimated by Amarteifo et al. (2002), Kemo (2000) and Onimawo (1998) respectively. The ash content, 3.57–4.85 is similar to data in the literature, 3.2–4.7 (Amarteifio et al., 2002), 3.7–4.3 (Kemo, 2000), and 4.0–5.0 (Onimawo et al., 1998). For the fibre, only literature for ADF and NDF was available for comparison. The ADF value of 6.53–10.65 is similar to the 6.8–8.9 reported by Amarteifio et al. (2002). However the current NDF value of 14.10–25.82 is much higher than the 9.7–12.0 previously reported by Amarteifio et al. (2002). Data for comparison of ADL and the nutrient value of bambara groundnut grown in Swaziland and Namibia were not available in the literature for comparison. The differences in nutrient content may be due to different soils, crop management, and environmental conditions.

CONCLUSION

The results show that the landraces grown in the three different countries did not exhibit marked differences in the components determined. Bambara groundnut has been shown to be a good source of protein and fibre and should be better utilized for nutrition. It is hoped these results will encourage extensive cultivation of bambara groundnuts in the three countries to boost food security. Furthermore, staple cereal diets could be improved by complementing them with bambara groundnuts. However, it is worth noting that other factors such as bioavailability and the effects of processing should be taken into consideration when deciding on the nutrient value of foods. Future work involving the effect of processing on the nutrient composition of these landraces will further promote their utilization.

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