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Full Length Research Paper

The mineral composition of bambara groundnut (*Vigna subterranea* (L) Verdc) grown in Southern Africa

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The mineral content of nine landraces of bambara groundnut cultivated in Botswana, Namibia and Swaziland respectively was investigated. The raw seeds were analysed for Ca, K, Mg, Na, P, Cu, Fe and Zn. The ranges (mg/100 g dry matter) obtained for the macro minerals are: Ca 37-128, K 1545-2200, Mg 159-335, Na 16-25, P 313-563, and for the micro minerals (ppm): Cu 3.0-13.2, Fe 23.0-150 and Zn 13.9-77.0. There were similarities and differences in the components determined in the landraces grown in a particular country and between the same landraces grown in different countries. This legume is a good source of, Ca, K, Mg, P and Fe. The Mg and P contents are similar to those of groundnut (*Arachis hypogaea*, P 376 and Mg 168). Landraces grown in Swaziland seem to have higher mineral contents than those grown in Botswana and Namibia. The concentration of the minerals in this legume indicates that they could be useful in the diets of consumers in Botswana, Swaziland and Namibia.

Key words: Bambara groundnut, minerals, landrace, Botswana, Namibia, Swaziland.

INTRODUCTION

Legumes are a cheap source of protein and minerals in many African countries, since animal protein is very expensive. Bambara groundnut (*Vigna subterranea* (L.) Verdc) is one of the many legumes that can provide the protein and minerals. The seeds are a complete food, as they contain sufficient quantities of proteins, carbohydrate and lipids (Brough and Azam-Ali, 1992). This legume can positively contribute to food security and help to alleviate nutritional problems. However, it has been classified as an underutilized crop and is only receiving more attention in the recent past. This crop is drought resistant; it tolerates poor soils and is fairly resistant to pests and diseases.

Bambara groundnut is extensively cultivated in Africa at a subsistence level and is the third most important legume crop after cowpea and groundnut (Kay, 1979) and it is widely consumed in Southern Africa. The imamture seeds are boiled and eaten as a snack. The mature seeds are boiled and eaten as part of a main meal but they can also be ground into flour and be used in making porridge. The dried seeds can also be soaked and the testa removed and the seeds ground into a paste. The latter can be made into different steamed or fried products (Obizoba, 1983). Efforts are being made to popularize this legume, hence the formation of BAMNET in 1995. However in order to promote this crop as a good source of nutrients, the composition should be determined. The objective of this study was to quantitatively determine the minerals, Ca, K, Mg, Na, P, Cu, Fe and Zn in the nine landraces grown in Botswana, Namibia and Swaziland respectively.

MATERIALS AND METHODS

The Association of Official Analytical Chemists (AOAC) (1996) procedures were used for the analyses. The seeds of the nine landraces were grown in Botswana, Namibia and Swaziland respectively as part of the BAMFOOD project. The dried mature seeds of each landrace were ground using a Thomas –Wiley laboratory mill. The ground seeds were passed through a 2 mm sieve and oven dried at 70ºC to constant weight. The Kjeldahl apparatus was used to digest the samples (1.25 g) for each landrace. The digested samples were used for the determination of the minerals. The major minerals determined were: Ca, Mg, P, Na, K and the micro-minerals estimated were: Fe, Cu and Zn. Ca, Cu, Fe, Mg and Zn concentrations were measured using a GBC 908 Atomic Absorption Spectrophotometer. Phosphorus was determined using an ultra violet 160 Spectrophotometer and K and Na using a Corning 410 flame photometer. All analyses were carried out in duplicate and the mean calculated. The data were analysed using Analysis of Variance (ANOVA). Duncan's multiple range test was used to com-

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Table 1. Ca, Mg and P contents (mg/100 g) of bambara groundnuts grown in Southern Africa.

Variety	Botswana			Namibia			Swaziland		
	Ca	Mg	P	Ca	Mg	P	Ca	Mg	P
NC 1	68b	279de	488bcde	57bcd	335a	450defg	60bcd	332ab	313m
NC 2	55bcd	301cde	418fghij	55bcd	324abc	414ghij	43de	305bcd	338m
UR/SR	53bcde	297cde	404hijkl	64bc	182g	543ab	51bcde	170g	437defghi
OM 1	51bcde	292de	485bcde	37e	273e	365kjml	49cde	308abcd	346klm
Dip C	54bcde	177g	411ghijk	45de	176g	525abc	37e	163g	371ijklm
AHM 968	64bc	159g	476cdefg	55bcd	219f	475cdefg	58bcd	184g	400hijkl
AS 17	52bcde	160g	503abcd	53bcde	174g	421efghij	43de	165g	561a
Gab C	59bcd	167g	488bcde	45de	174g	558a	56bcd	174g	466cdefgh
AHM 753	68b	163g	464cdefgh	47.0cde	174g	563a	128a	233f	404hijkl
S.E	Ca	Mg	P						
	5.19	9.24	0.476						

Means with the same letter(s) are not significantly different (P >0.05); S.E. Standard error

pare the mean values. Significance was accepted at P≤ 0.05. The landrace was the only variable.

RESULTS AND DISCUSSION

The results obtained for the Ca, Mg and P contents are given in Table 1. There were similarities and differences among the landraces studied. AHM 753 from Swaziland has the highest content of Ca and is significantly different (p> 0.05) from the other landraces grown in the three countries. The lowest content of Ca is found in OM1 (Namibia) and Dip C (Swaziland). These landraces have similar Ca content to UR/SR, OM 1, Dip C, AS 17 grown in Botswana, Dip C, AS 17, Gab C and AHM 753 grown in Namibia, and NC 2 UR/SR, OM 1 and AS 17 grown in Swaziland. Within a country the following were observed: In Botswana the Ca contents of the nine landraces were similar. In Namibia, the landraces NC 1, NC 2, Dip C, AHM 968, AS 17, Gab C and AHM 753 have similar Ca con-tents, while in Swaziland AHM 753 Ca contents is signi-ficantly different from the other landraces.

The Mg contents in AS 17, Gab C, NC 2 and Dip C are similar in all the three countries studied. Furthermore, NC1 and UR/SR have similar Mg content in landraces grown in Namibia and Swaziland but different from those grown in Botswana. The AHM 753, grown in Botswana and Namibia have similar Mg content but different from that grown in Swaziland. AHM 968 from Botswana and Swaziland has similar Mg content. OM1 landraces from Botswana, Namibia and Swaziland have similar Mg contents. For the variation of Mg contents in the land-races within a country, those in Botswana, NC 1, NC 2 UR/SR, OM 1 have similar values but significantly different from the other five landraces which have similar Mg contents. In Namibia UR/SR, Dip C, AS 17, Gab C and AHM 753 have similar Mg contents but different from those of the other landraces. While in Swaziland UR/SR, Dip C, AHM 968, As 17, and Gab C have similar Mg contents but significantly different from that of the other landraces. The landrace with the highest Mg content is NC1 grown in Namibia; it is similar to NC 2 (Namibia), NC 1 (Swaziland) and OM 1 (Swaziland) but significantly different from the other landraces.

The P contents in NC 1, NC 2, AHM 968 in Botswana and Namibia are similar, while UR/SR, Dip C, AS 17, Gab C and AHM 753 cultivated in Botswana and Swaziland have similar P contents. AHM 753 from Namibia have the highest content of P and it is similar to AS 17 from Swaziland and Botswana Gab C and Dip C grown in Namibia. NC1 cultivated in Swaziland have the lowest amount of P and it is similar to NC 2, OM 1 and Dip C grown in Swaziland.

Of all the minerals, the K content is the highest in every landrace (Table 2). The highest content of K is found in UR/SR grown in Botswana and it is significantly different from those of the other landraces grown in the three countries. The landrace with the lowest K content is AS 17 grown in Swaziland and it is similar to Dip C and AS 17 grown in Botswana; NC 1, NC 2, UR, and AHM 753 grown in Swaziland. The potassium content in UR/SR and Dip C in the three countries are significantly different (p >0.05). The contents in NC 1 and NC 2 from Botswana and Swaziland have similar K content and so are OM1 and AHM 753 from Botswana and Namibia. The K contents in AHM 968 from Botswana and Namibia are significantly different. Also, the K contents in Gab C from Namibia and Swaziland are significantly different. In Botswana, the K contents in NC 1, NC 2, OM 1 and AHM 753 are similar, while those for Dip C and AS 17 are also similar. In Namibia the six landraces, NC 1, NC 2, UR/SR, Dip C, Gab C and AHM 753 have similar K contents (p<0.05). In Swaziland the K contents of OM1 is signifi-cantly different from the other landraces. NC 1 NC 2, UR/SR, AS 17 and AHM 753 have similar K contents but different from AHM 968 and Gab C which have the similar K content. The Na contents (Table 2) for AHM

Table 2. Na and K (mg/100 g) contents of bambara groundnuts grown in Southern Africa.

	Botswana		Namibia		Swaziland	
Variety	**Na**	**K**	**Na**	**K**	**Na**	**K**
NC 1	15.9j	1644 fgh	23.5 bcd	1742 cde	20.5 f	1578 hi
NC 2	20.2 f	1644 fgh	20.2 f	1775 cd	21.5 ef	1578 hi
UR/SR	22.5 de	2200 a	17.8 gh	1742 cde	16.2 ij	1578 hi
OM 1	20.2f	1676 efg	20.2 f	1709 def	24.2 abc	1971 b
Dip C	24.5 ab	1578 hi	18.5 g	1807 c	24.5 ab	1676 efg
AHM 968	22.8 cde	1740 cde	23.5 bcd	1644 fgh	23.85abcd	1709 def
AS 17	25.2 a	1578 hi	25.1 a	1676 efg	25.2 a	1545 hi
Gab C	17.8 gh	1742 cde	18.5 g	1807 c	17.5 ghi	1709 def
AHM 753	17.5 ghi	1709 def	17.8 gh	1742 cde	16.5 hij	1611 ghi
S.E	Na	K				
	0.47	23.19				

Means with the same letter(s) are not significantly different (P >0.05)

968, As 17, Gab C, AHM 753 and NC 2 are similar for all the three countries. However the Na contents in NC1 and UR/SR is significantly different in the three countries; AS 17 land-race grown in Botswana, Swaziland and Namibia have the highest content of Na, NC 1 grown in Botswana has the lowest. Its content is similar to that in UR/SR and AHM 753 grown in Swaziland.

Table 3 gives the details of the values obtained for Cu, Fe and Zn. NC 1, NC 2, from Botswana and Swaziland have similar Cu contents. Also, UR/SR, Dip C AS 17 and Gab C Cu contents from the two countries are similar but different from those grown in Namibia. However for OM 1, AHM 968 and AHM 753 the Cu contents are significantly different (p> 0.05) for each country. AHM 753 grown in Swaziland has the highest amount of Cu and it is significantly different in the other landraces grown in the three countries. Gab C grown in Namibia has the lowest Cu content. The land races cultivated in Namibia seem to have a low Cu content compared with the landraces grown in other countries. In Botswana NC 1, NC 2 AHM 968 and AHM 753 have similar Cu content but significantly different from OM 1 Dip C, AS 17and Gab C. In Namibia, UR/SR, OM 1, Dip C, Gab C and AHM 753 the Cu contents are similar but different from NC 1, NC 2, AHM 968 and AS 17. In Swaziland, the Cu contents in UR/SR, OM 1, Dip C, AHM 968 and AS 17 are similar but different from that of NC 2 and AHM 753.

For Fe, the highest content is found in Gab C grown in Botswana and it is significantly different from the other landraces grown in the three countries. The lowest Fe content is in NC 2 grown in Namibia. It is similar to NC 2, UR/SR, OM 1 and AHM 753 grown in Botswana, and AHM 753 grown in Namibia. The lowest Fe content is found in the landraces grown in Namibia and Botswana. In Namibia the Fe contents for OM 1, AHM 968, AS17 and Gab C are similar but different from that of the other landraces. NC 1, NC 2, Dip C, AS 17 and AHM 753 grown in Botswana and Namibia respectively have similar Fe contents but were significantly different from the same landraces grown in Swaziland. The Fe content in Gab C is different for every country.

Zn contents were significantly different in NC 1, UR/SR, AHM 968, AS17, Gab C and AHM 753. AHM 968 grown in Swaziland has the highest content of Zn and it is significantly different for the other land races grown in the three countries while NC 2 grown in Namibia has the lowest Zn content. In Swaziland the Zn contents of OM 1, AS 17, Gab C and AHM 753 are similar but significantly different from those of the other landraces.

Landraces grown in Swaziland seem to have higher mineral contents than those grown in Botswana and Namibia. AHM 753 has the highest content of Cu and Ca. AHM 968 and AS 17 have the highest content of Zn and P, respectively. AS 17 also have the highest content of Na. The data obtained for P mg/100 g (313-561) are similar to the 174-613 obtained by Amarteifio et al. (2002) and 515-642 reported by Kemo (2000). The Fe (23-132 ppm) contents are in agreement with previously reported data; 75-122 (Kemo, 2000), 41.9 (Aganga et al., 2000) and 49-99 (Amarteifio et al., 1997). However the concentration of Ca (37-128 mg/100 g), K (1545-2200 mg/100 g), Mg (159-332 mg/100 g) and Na (16-25 mg/100 g) obtained in this study were slightly more than the Ca (41-58 mg/100 g), K (470-1120 mg/100 g), Mg (125-162 mg/100 g) and Na (0.9-1.1 mg/100 g) determined by Amarteifio et al. (2002). The differences may be due to the environment and crop management. The values reported by Amarteifio et al. (2002) were for landraces grown in Botswana only. The mineral contents (mg/100 g) compare favourably to those of other legumes such as soy bean K (1730 mg/100 g), Mg (250 mg/100 g) and Fe (9.7 ppm); mung bean K (1250 mg/100 g), Ca (89 mg/100 g), Mg (150 mg/100 g), P (360 mg/100 g) and Fe (6.0 ppm) (Holland et al., 1995); and groundnut P (376

Table 3. The micromineral content (ppm) of bambara groundnuts grown in Southern Africa.

Variety	Botswana			Namibia			Swaziland		
	Fe	Cu	Zn	Fe	Cu	Zn	Fe	Cu	Zn
NC 1	51.7 gh	8.8 bc	38.1 ij	51.1gh	5.4gh	53.6 cde	68.8 f	8.5 bcd	16.4 m
NC 2	23.1 j	9.3 b	49.6efg	23.0 j	4.7hij	13.9 m	40.1 hi	8.6 bc	17.1 m
UR/SR	27.7 ij	7.7cde	35.6 jk	64.4 f	4.0ijk	67.5 b	58.5 fg	6.8 ef	51.7def
OM 1	32.4 ij	5.9fg	15.6 m	84.3 e	3.8jk	17.7 m	88.5 e	7.5 de	44.7 gh
Dip C	64.8 f	7.4 e	42.7 hi	69.8 f	3.9jk	31.5 k	131.5 b	7.2 e	34.7 jk
AHM 968	103.9cd	8.9 b	59.0 c	88.3 e	5.0ghi	66.0 b	88.4 e	7.5 de	77.0 a
AS 17	93.8de	7.4 e	30.0 k	89.7 e	5.9 fg	57.3cd	108.4 c	7.1e	46.4 fgh
Gab C	149.5a	6.0f g	51.8def	86.8 e	3.0 k	59.1 c	36.0 i	5.8 fgh	43.2 hi
AHM 753	28.9 ij	9.1 b	24.1 l	28.4 ij	3.5 k	43.7 hi	69.2 f	13.1 a	44.2 gh
S.E	Fe	Cu	Zn						
	1.27	0.34	1.79						

Means with the same letter(s) are not significantly different (P >0.05)

mg/100 g), Mg (168 mg/100 g) (Singh and Diwakar 1993).

CONCLUSION

Bambara groundnut grown in Botswana, Namibia and Swaziland are a good source of minerals particularly K, Mg, P and Fe. This legume can be useful in formulating a balanced diet. It can be also useful in areas where these minerals are deficient in the diet. These findings underline the importance of this indigenous and underutilized legume in a continent with rampant famines and malnutrition.

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