THE NUTRIENT CONTENT OF THE MARAMA BEAN (*Tylosema esculentum*), AN UNDERUTILISED LEGUME FROM SOUTHERN AFRICA

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ABSTRACT

Keywords: *Namibia, Botswana, marama bean, nutrient content, legume*

Nutrient analyses were performed on marama beans (*Tylosema esculentum*) from different locations in Namibia and Botswana and from three consecutive rainy seasons. The marama beans were roasted conventionally, as the beans are seldom eaten raw. Results from this study show that the roasted Namibian and Botswana marama beans contain high levels of protein. The fatty acids are unsaturated and 87% are a combination of oleic acid, linoleic acid and palmitic acid. The bean also contains significant amounts of vitamins (A, B_3, B_6, folic acid, B_{12} and E) and minerals (iodine, iron and zinc).

INTRODUCTION

In order to meet the future food and nutrition demands of an increasing population in southern Africa and to make optimal use of marginal land, little-known plant species should be investigated. The marama bean plant (*Tylosema esculentum*) is a perennial legume producing beans. It is native to dry areas with little seasonal rainfall and, being a legume, particularly important in subsistence agriculture (Fox and Norwood Young, 1982). Usually accepted by the local population and better adapted to existing environmental conditions, these neglected crops have the potential to provide a more stable food supply for drought-stricken Africa (Vietmeyer, 1986).

The marama bean plant is a widespread perennial legume that grows naturally in large populations in Namibia and Botswana and in smaller populations in the Gauteng Province of South Africa. It grows at altitudes of between 1 000 and 1 500 m with 300 to 700 mm rainfall, and at a minimum temperature above 15 °C and a maximum of approximately 33 °C. It is dormant in winter and regrows from the tuber in spring. The plant grows in well-drained, fine, generally calcareous sands, but also in regions of harder calcareous conglomerates, at pH 6 to 8, with very little organic matter, nitrate or phosphate (Lawlor, 2004).

Numerous annual prostrate runners emerge from the plant in spring. The runners can reach a length of 6 m and bear Y-shaped tendrils. The plant has characteristic, bilobed leaves, which are glaucous-green and leathery when young, turning soft and reddish-brown when older. The small yellow flowers produce rounded, oblong pods which are at first pale-pink in colour, changing to apple-green, then to a dark purplish-pink and, finally, brown. Young pods of approximately 6 cm in length are light green, but ripen in late autumn, turning into brown woody pods with two or more chestnut-brown seeds inside (NAS, 1979). The pods usually contain two seeds, but as many as six can be produced (Watt and Beyer Brandwijk, 1962). Because of its slimy texture and lack of flavour, the marama bean is seldom eaten raw (Rachie, 1979). The beans contain a trypsin inhibitor, but this inhibitor's activity is normally destroyed by heat (Bower *et al*., 1988). After roasting, the beans have a delicious nutty flavour that has been compared to roasted cashews.

The purpose of this study was to determine the nutrient content of the marama bean in order to determine its possible contribution to alleviating malnutrition in the southern African region. In the region, approximately 13.7% of children under the age of 5 are stunted (have low height for their age), while 6.6% under the age of 5 are wasted (have low weight for their height) (UNSCN, 2004). In South Africa alone, one in five children suffer from chronic malnutrition. A 1999 Health Department survey in that country showed that 21.6% of all South African children between the ages of 1 and 9 are stunted due to malnutrition (healtoronto.com, 2005).

MATERIALS AND METHODS

Sampling sites

Locations within Namibia and Botswana, where the marama bean plant grows in natural abundance (Figure 1), were chosen as sampling sites for this study of the quality characteristics of the marama bean, namely:

- the Sandveld Research Farm area, east of Epukiro, 60 km north-east of Gobabis, in eastern Namibia (22°01' 04" South, 19°08' 13" East), and
- the Ghanzi/D'Kar area in western Botswana (21°25' 03" South, 21°23' 28" East/21°18' 45" South, 21°33' 41" East).

Sampling

For the nutrient analyses, sampling was done during the rainy season (December to March) of three consecutive

years: 2001/2, 2002/3, and 2003/4. Pod-bearing matured beans were collected from within a radius of 100 km at each location described above. Collections were made about 2–5 km apart, and approximately 100 to 200 beans were collected at each collection point. Samples were sealed in paper bags and numbered according to location and date. Collection points were kept the same for each consecutive year. No young (green) beans were collected, as it was stated by Rachie (1979) that beans are never eaten young and raw (green).

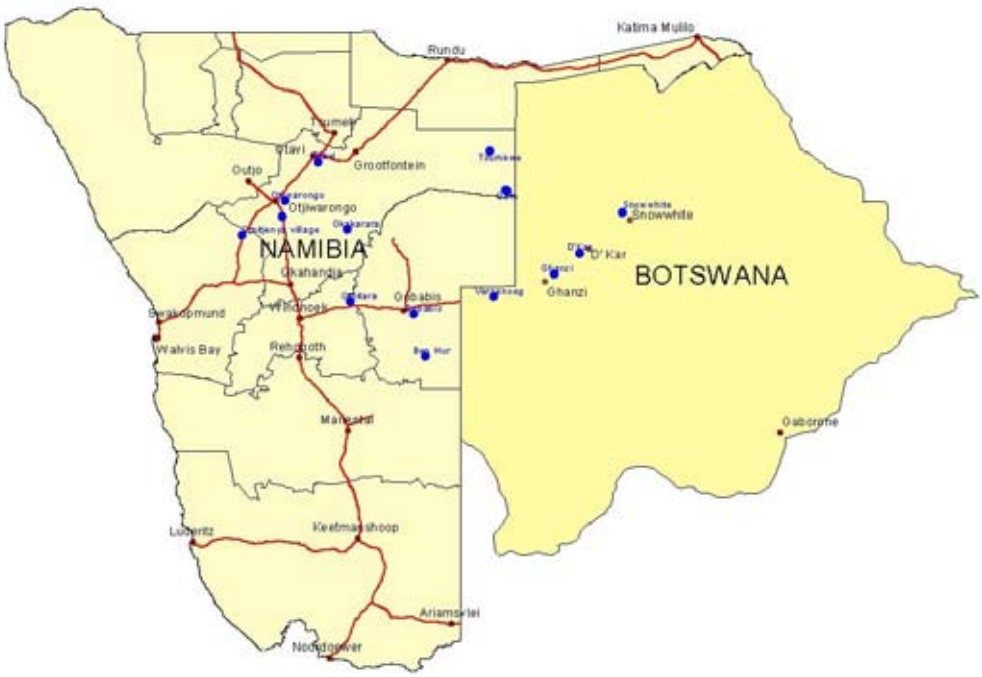

Figure 1. Map of Botswana and Namibia showing the distribution of marama bean plants in Namibia and Botswana (Agricultural Laboratory; Ministry of Agriculture, Water and Forestry, 2004).

Approximately 8 kg depodded beans were oven-roasted at the Agricultural Research Council (ARC) laboratory at Irene, South Africa, by roasting them in sand baths filled with ordinary sand that was preheated to a temperature of 160 °C at an oven temperature of 180 °C. The beans were roasted in the preheated sand for 10 minutes, left to cool overnight, and then shelled to remove the kernels. The roasting of the beans was done in Miele ovens (model H217) and, as part of the standard procedure, the temperature of the sand was measured with a hand-model Kane-Mane 1012-type temperature probe (Campbell *et al*., 1980) until it reached 160 °C.

Table 1. Nutritional analyses conducted at various laboratories

Analyses	Laboratory	Method	Reference
Dry matter	ARC, Irene	ARC-accredited	AOAC (1999)
Ash	ARC, Irene	ARC-accredited	AOAC (1999)
Protein (N X 6.25)	ARC, Irene	ARC-accredited	AOAC (1999)
Fat	ARC, Irene	ARC-accredited, Soxtec	
Crude fibre	ARC, Irene	ARC-accredited	AOAC (1999)
Non-structural carbohydrates	ARC, Irene	Non-ARC-accredited, spectrophotometric measurements	ARC (2000)
Vitamin A	ARC, Irene	ARC-accredited	Thompson *et al*. (1980) Manz & Philipp (1981) Fox (1985)
Vitamin B_1	ARC, Irene	ARC-accredited	Ollilainin *et al*. (1993)
Vitamin B_2	ARC, Irene	ARC-accredited	Sims & Shoemaker (1993)
Vitamin B_3	SGS, Midrand		Chan *et al*. (2000)
Vitamin B_6	SGS, Midrand	Microbiological method MI 002	
Vitamin D	SGS, Midrand	High performance liquid chromatography	Thompson *et al*. (1980) Hulshof (2002)
Vitamin E	ARC, Irene	ARC-accredited	Thompson *et al*. (1980) Hulshof (2002)
Trace minerals	ISCW, Pretoria	Flame emission spectroscopy Atomic absorption spectrometry	AOAC (1999) Zasoski & Burau (1977)
Amino acids	ARC, Irene	ARC-accredited	Einarsson *et al*. (1983) Cunico *et al*. (1986)
Fatty acids	ARC, Irene	ARC-accredited	Christopherson & Glass (1969)

Experimental procedure

Nutrient analyses were conducted on the roasted marama bean samples from the first year (2001/2) of collection, in order to determine their nutrient content. Nutrient values close to the recommended daily allowance (RDA) (NAS, 2001) were again determined in the second (2002/3) and third (2003/4) years of the study.

Analyses (Table 1) were all conducted in South Africa at the ARC laboratory in Irene; the Institute for Soil, Climate and Water (ISCW) laboratory in Pretoria; and the Société Générale de Surveillance (SGS) laboratory in Midrand. Methods accredited by the South African National Accreditation System (SANAS), according to International Organization for Standardization (ISO) 17025, were used in the analyses.

The content of the shelled nuts of the roasted marama bean samples (approximately 5 kg) was chopped, mixed and ground prior to being analysed, to ensure an even mixture of the roasted samples. Analyses were conducted in duplicate on roasted, shelled, ground marama beans.

Nutrient analyses

Proximate analyses were carried out to determine the percentages of total moisture, fat, protein (N x 6.25) and ash according to accepted Association of Official Analytical Chemists International (AOAC, 1999) methods (Table 1).

Vitamins A, B_1, B_2, B_{12}, D and K were determined by high performance liquid chromatography and fluorescence methods (ARC-accredited methods). Vitamins B_3 and B_6 were determined according to microbiological methods (SGS laboratory), as presented in Table 1.

Phosphorus was determined spectrophotometrically. Potassium and sodium were determined by flame emission spectroscopy (ISCW methods). Other minerals and trace minerals were analysed by means of flame atomic absorption spectrophotometry. The method used for the analysis of amino acids involved separation by high-performance liquid chromatography, using a fluorescence detector (ARC-accredited method). A gas chromatographic method was used for the determination of fatty acids.

RESULTS AND DISCUSSION

Analyses of marama beans: 2001/2 rainy season

Proximate analyses (2001/2)

According to the proximate analyses (Table 2), the marama bean contains 34.71% protein and is a good source of this nutrient. It compares well with other literature on the marama, in which a protein content of 34.3% was reported (Wehmeyer *et al.*, 1969). The RDA for protein is 19 g per day for children aged 5, 46 g per day for women aged 30, and 56 g per day for men aged 30 (NAS, 2001).

Table 2. Proximate analyses of Namibia and Botswana marama beans per 100 g dry matter (2001/2)

Nutrient	Unit	Namibian marama bean	Botswana marama bean	Mean[1]
Dry matter	g	95.93	96.50	96.22
Ash	g	3.29	3.08	3.19
Protein	g	33.97	35.44	34.71
Fat	g	39.93	40.18	40.06
TNC[2]	g	13.64	14.50	14.07
Fibre	g	4.34	3.53	3.94
Total dietary fibre	g	50.85	50.77	50.81
Energy	MJ/100 g	2.26	2.29	2.28

[1] *Namibian and Botswana marama bean*

[2] *TNC = total non-structural carbohydrates*

The fat content of the Namibia and Botswana marama bean is similar (39.93% and 40.18%, respectively), and compares well with the other values of between 36–43% fat reported in the literature (Wehmeyer *et al.*, 1969). The amount of energy contained in the marama bean is 2.28 MJ/100 g, which compares well with the Bower *et al.* (1988) study, in which 2.66 MJ/100 g was reported.

Analyses of vitamins (2001/2)

The marama bean contains several vitamins, as presented in Table 3.

Table 3. Vitamin analyses of Namibia and Botswana marama beans per 100 g dry matter (2001/2)

Vitamin	Unit	Namibia marama bean	Botswana marama bean	Mean[1]
A	mg	0.29	0.25	0.27
B_1	mg	0.45	0.3	0.38
B_2	mg	0.048	0.07	0.06
B_3	mg	11.12	7.30	9.21
B_6	mg	1.67	1.74	1.71
Folic acid	mg	0.188	0.09	0.14
B_{12}	mg	0.005	0.003	0.004
D	IU[2]	126.4	139.32	132.9
E	mg	7.02	5.51	6.27
K	mg	0.226	0.212	0.22

[1] *Namibia and Botswana marama bean*

[2] *International Unit*

Of importance amongst the vitamins are vitamin A (essential for proper eyesight), folic acid (vital to women during pregnancy) and vitamin B_{12} (normally only produced in animal tissue), as presented in Table 4.

Table 4. Vitamin analyses of the marama bean compared to the recommended daily allowance per 100g dry matter

Vitamin	Unit	RDA children aged 5	RDA men aged 30	RDA women aged 30	marama bean
A	mg	0.5	1.0	0.8	0.27
Folic acid	mg	0.4	0.9	0.7	0.14
B_{12}	mg	0.001	0.002	0.002	0.004

Mineral analyses (2001/2)

As presented in Table 5, the marama bean is high in calcium (241 mg/100 g), a mineral essential for maintaining the health of bones and teeth. The RDA for calcium is 800 mg per day for children aged 5, and 1 000 mg per day for women and men aged 30 (NAS 2001). It contains iodine (0.06 mg/100 g), needed for cognitive development. The RDA for iodine is 0.09 mg per day for children aged 5 and 0.150 mg per day for women and men aged 30. It is adequate in magnesium (274.5 mg/100 g), a catalyst needed for many biochemical and physiological processes in the human body. The RDA for magnesium is 130 mg per day for children aged 5, and 310 mg per day for women and men aged 30 (ibid.).

Table 5. Mineral analyses of Namibia and Botswana marama beans per 100 g dry matter (2001/2)

Mineral	Unit	Namibia marama bean	Botswana marama bean	Mean[1]
Calcium	mg	274	208	241
Chloride	mg	69.4	54.5	61.95
Fluorine	mg	3	3	3
Iodine	mg	0.048	0.064	0.06
Magnesium	mg	273	276	274.5
Phosphorus	mg	503	406	454
Potassium	mg	954	836	895
Sodium	mg	64.5	63	63.75

[1] Namibia and Botswana marama bean

Analyses of trace minerals (2001/2)

Analyses of trace minerals in the marama bean (Table 6) show that it contains iron (3.95 mg/100 g), essential to prevent nutritional anaemia. The RDA for iron is 10 mg per day for children aged 5, 18 mg per day for women aged 30, and 8 mg per day for men aged 30 (NAS 2001). The marama bean contains zinc (6.2 mg/100 g), a trace mineral essential for growth and protein metabolism. The RDA for zinc is 5 mg per day for children aged 5, 8 mg per day for women aged 30, and 18 mg per day for men aged 30 (ibid.).

Fatty acid analyses (2001/2)

The marama bean contains high levels of the fatty acid oleic acid (42.16% of total fatty acids) and linoleic acid (31.11% of total fatty acids), as presented in Table 7. These findings are in agreement with previous studies, which report values of 48.5% oleic acid and 19.2% linoleic acid (Bower *et al.*, 1988), and 34.8% oleic acid and 26.3% linoleic acid (Bousquet, 1983). From a health perspective these long-chain unsaturated fats are regarded as being healthier than saturated fats.

Table 6. Analyses of trace minerals in Namibia and Botswana marama beans per 100 g dry matter (2001/2)

Trace mineral	Unit	Namibia marama bean	Botswana marama bean	Mean[1]
Barium	mg	0.392	0.783	0.59
Chromium	mg	0.07	0.04	0.06
Cobalt	mg	0.02	0.016	0.02
Copper	mg	1.18	0.89	1.04
Iron	mg	4.1	3.8	3.95
Lead	mg	0.097	0.148	0.12
Manganese	mg	1.9	1.8	1.85
Molybdenum	mg	0.015	0.0167	0.02
Nickel	mg	0.198	0.328	0.12
Selenium	mg	0.071	0.087	0.08
Strontium	mg	0.272	0.114	0.20
Tin	mg	1.59	3.79	2.69
Titanium	mg	1.12	2.14	1.63
Vanadium	mg	0.008	0.027	0.02
Zinc	mg	6.4	6.0	6.2

[1] Namibia and Botswana marama bean

Table 7. Percentage fatty acids of the total fatty acids in Namibia and Botswana marama beans per 100 g dry matter (2001/2)

Fatty acid	Unit[1]	Namibia marama bean	Botswana marama bean	Mean[2]
C16:0 (Palmitic acid)	%	13.98	13.62	13.80
C16:1 (Palmitoleic acid)	%	0.58	0.53	0.56
C18:0 (Stearic acid)	%	7.63	8.47	8.05
C18:1 (Oleic acid)	%	38.41	45.91	42.16
C18:2 (Linoleic acid)	%	34.89	27.32	31.11
C18:3 (Linolenic acid)	%	0.00	0.00	0.00
C20:0 (Arachidic acid)	%	2.56	2.43	2.50
C20:1 (Arachidonic acid)	%	0.39	0.41	0.40
C22:0 (Behenic acid)	%	1.56	1.31	1.44

[1] % total fatty acids

[2] Namibia and Botswana marama bean

Amino acid analyses (2001/2)

When analysed for amino acids, the amino acids methionine and cystine (sulphur-containing amino acid) are limiting in the marama bean (Table 8). This is in agreement with previous literature on the marama bean, where methionine and cystine were also found to be limiting (Bousquet, 1983; Bower *et al.*, 1988). Methionine is one of the nine essential amino acids that cannot be synthesised by the human body. Cystine is regarded as a semi-essential amino acid. Thus, the marama bean is not a complete protein, due to its limiting essential amino acids.

Table 8. Amino acid content of Namibia and Botswana marama beans per 100 g dry matter (2001/2)

Amino acid	Namibia marama bean	Botswana marama bean	Mean[1]
Alanine	1.26	1.09	1.17
Arginine	1.46	2.03	1.74
Aspartic acid	2.20	2.39	2.30
Cystine	0.545	0.563	0.55
Glutamic acid	3.08	3.27	3.17
Glycine	1.27	1.41	1.34
Histidine	0.60	0.73	0.66
Isoleucine	1.24	1.06	1.15
Leucine	1.53	1.24	1.38
Lysine	1.05	1.07	0.56
Methionine	0.10	0.01	0.05
Phenylalanine	1.09	1.11	1.10
Proline	1.35	1.21	1.28
Serine	0.98	0.96	0.97
Threonine	1.13	1.13	1.13
Tryptophan	0.70	0.67	0.68
Tyrosine	3.36	3.38	3.37
Valine	1.06	1.15	1.11

1 Namibia and Botswana marama bean

Comparative analyses of selective nutrients from three rainy seasons: 2001/2, 2002/3 and 2003/4

Nutrients were selected according to adequacy in RDAs for children aged 5, men aged 30, and women aged 30. Subsequently, nutritional analyses were conducted on roasted marama bean samples from Namibia and Botswana in two more consecutive years (2002/3, 2003/4), and these were compared with the values obtained in 2001/2.

Values obtained from the proximate analyses on roasted Namibia and Botswana marama beans from the rainy seasons of 2001/2, 2002/3 and 2003/4 were similar, as presented in Table 9. The analyses showed that the mineral and trace mineral contents from the different seasons were similar, except for chromium and vitamin B_{12}, which showed higher values during 2002/3 and 2003/4 for both the Namibia and Botswana marama beans. The amount of zinc was also lower in 2002/3 and 2003/4 than in 2001, for both the Namibia and Botswana marama beans. The fatty acid composition of the Namibia and Botswana marama beans was similar throughout all the rainy seasons, as presented in Table 9. Of the total fatty acids contained in the marama beans, 42.03% is oleic acid, 32.12% is linoleic acid, and 12.84% is palmitic acid (Table 10).

Data obtained from the different rainy seasons were statistically analysed by the ARC Biometry Unit using GenStat 2000 software (Department of Statistics, Genstat Committee, Rothamsted). F probability and standard error from the mean are presented in Table 10. The significance of the nutritional values was tested by means of analysis of variance (ANOVA). Multivariate analysis techniques, Principal Component Analysis (PCA) and Canonical Variant Analysis (CVA) were performed to explain most of the variations in the data set. There was no significant difference between the data obtained from Namibia and those from Botswana.

Table 9. Comparison of nutritional analyses for marama beans per 100 g dry matter from rainy seasons 2001/2, 2002/3 and 2003/4

Nutrient	Unit	Namibia marama bean			Namibia mean	Botswana marama bean			Botswana mean
		2001/2	2002/3	2003/4		2001/2	2002/3	2003/4	
Ash	%	3.29	3.35	3.51	3.38	3.08	3.44	3.49	3.34
Dry matter	%	95.93	97.95	97.73	97.27	96.50	98.00	97.90	97.47
Moisture	%	4.07	2.05	2.27	2.80	3.50	2.00	2.10	2.53
Fat	%	39.93	37.06	31.54	36.18	40.18	33.63	31.93	35.25
Protein*	%	33.97	36.94	34.81	35.24	35.44	36.14	41.33	37.64
TNC**	%	13.64	9.35	10.91	11.30	14.50	10.33	12.37	12.40
Vitamin B_6	mg	1.670	0.860	1.960	1.497	1.740	1.600	1.540	1.627
Vitamin B_{12}	mg	0.005	0.020	0.010	0.072	0.003	0.020	0.020	0.014
Chromium	mg	0.07	0.225	0.245	0.18	0.04	0.264	0.233	0.179
Copper	mg	1.18	1.211	1.20	1.197	0.89	0.965	1.342	1.066
Iron	mg	4.10	6.470	4.99	5.19	3.80	4.90	4.48	4.39
Zinc	mg	6.40	4.03	3.87	4.767	6.00	4.20	3.63	4.61
Iodine	mg	0.048	0.054	0.051	0.051	0.064	0.127	0.068	0.086
C16:0 (Palmitic acid)	% total fatty acids	13.98	12.44	12.81	13.08	13.62	12.96	11.24	12.61
C16:1 (Palmitoleic acid)	% total fatty acids	0.58	0.44	0.48	0.50	0.53	0.51	0.28	0.44
C18:0 (Stearic acid)	% total fatty acids	7.63	8.22	7.32	7.72	8.47	7.85	7.64	7.99
C18:1 (Oleic acid)	% total fatty acids	38.41	40.88	42.36	40.55	45.91	41.30	43.31	43.51
C18:2 (Linoleic acid)	% total fatty acids	34.89	33.84	32.02	33.58	27.32	32.38	32.48	30.37
C18:3 (Linolenic acid)	% total fatty acids	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C20:0 (Arachidic acid)	% total fatty acids	2.56	2.48	2.54	2.527	2.43	2.62	2.54	2.530
C20:1 (Arachidonic acid)	% total fatty acids	0.39	0.32	0.38	0.363	0.41	0.33	0.38	0.373
C22:0 (Behenic Acid)	% total fatty acids	1.56	0.65	1.40	1.203	1.31	1.37	1.41	1.363

* *Protein content = N x 6.25*
** *Total non-structural carbohydrate*

Table 10. Statistical analyses of the nutrients of the marama beans from different locations in Namibia and Botswana per 100 g dry matter 2001/2, 2002/3 and 2003/4)

Nutrient	Unit	Namibia mean	Botswana mean	Grand mean	Standard Error from the mean	F probability value
Ash	%	3.38	3.34	3.36	0.102	0.763
Dry matter	%	97.27	97.47	97.37	0.585	0.824
Moisture	%	2.80	2.53	2.67	0.567	0.759
Fat	%	36.18	35.25	35.7	2.490	0.805
Protein*	%	35.24	37.64	36.4	1.450	0.309
TNC**	%	11.30	12.40	11.85	1.229	0.561
Vitamin B_6	mg	1.497	1.627	1.56	0.236	0.717
Vitamin B_{12}	mg	0.072	0.014	0.043	0.046	0.424
Chromium	mg	0.18	0.179	0.180	0.063	0.992
Copper	mg	1.197	1.066	1.131	0.0991	0.402
Iron	mg	5.19	4.39	4.79	0.539	0.357
Zinc	mg	4.767	4.61	4.69	0.768	0.892
Iodine	mg	0.051	0.086	0.069	0.0145	0.159
C16:0 (Palmitic acid)	% total fatty acids	13.08	12.61	12.84	0.599	0.609
C16:1 (Palmitoleic acid)	% total fatty acids	0.50	0.44	0.47	0.0639	0.543
C18:0 (Stearic acid)	% total fatty acids	7.72	7.99	7.86	0.257	0.508
C18:1 (Oleic acid)	% total fatty acids	40.55	43.51	42.03	1.247	0.169
C18:2 (Linoleic acid)	% total fatty acids	33.58	30.37	32.15	1.343	0.207
C20:0 (Arachidic acid)	% total fatty acids	2.527	2.530	2.528	0.0425	0.958
C20:1 (Arachidonic acid)	% total fatty acids	0.363	0.373	0.368	0.0226	0.770
C22:0 (Behenic Acid)	% total fatty acids	1.203	1.363	1.28	0.199	0.601

Statistical analyses by means of CVA showed that the nutritional values of the marama beans are only affected by season and not by location. The nutrients which differed the most within the first season, and contrasted with the other two seasons, were moisture, total non-structural carbohydrates, chromium, iron, zinc, and C20:1 (Arachidonic acid).

To interpret whether the nutrient data obtained were meaningful, nutrient densities were calculated. Nutrient density is used for assessing the nutritional quality of a foodstuff (NAS, 2001). The higher the food's nutrient density, the better it is as a source of nutrients. Comparing nutrient densities, estimates the relative nutritional quality. Table 11 shows the nutrient densities of selected vitamins and minerals for the marama bean on a dry basis. Values >1 indicate a high nutrient density. It is clear from the analyses in Table 11 that the marama bean is an excellent source of calcium, vitamin A, vitamin B_3, vitamin B_6, folic acid, vitamin B_{12}, vitamin E, iron, zinc and iodine.

As shown in Table 12, the nutrient content of the marama bean readily compares with other underutilised legumes cultivated all over Africa.

CONCLUSION

Statistical analyses showed that there were no significant differences between the nutritional values of the two locations from Namibia and Botswana. Significant differences were however found between the nutritional values of different rainy seasons. The marama beans have a protein content of roughly 36% and like other legumes, are rich in the amino acid lysine, but low in the amino acid methionine. The fat content is between 43% and 40% and approaches that

Table 11. Nutrient densities* of the marama bean for different life-stage groups

Nutrient	Children aged 5**	Men aged 30***	Women aged 30****
Calcium	0.99	1.61	1.21
Vitamin A	1.79	1.44	1.37
Vitamin B_3	2.54	2.59	2.48
Vitamin B_6	4.7	4.16	3.95
Folic acid	6.13	3.71	3.12
Vitamin B_{12}	42.78	34.47	26.14
Vitamin E	2.96	3.34	3.17
Cr	16.98	27.35	20.75
Cu	2.5	2.01	1.53
Fe	1.59	2.55	1.29
Zn	1.55	1.67	1.58
Iodine	2.52	2.44	1.85

* Dietary References Intakes (NAS, 2001)
** RDA for energy – 7 531.4 kJ per day
*** RDA for energy – 12 133.8 kJ per day
**** RDA for energy – 9 205 kJ per day

Table 12. Nutrient content of the marama bean compared with other African legumes per 100 g dry matter

Nutrient	Unit	Bambara groundnut (South Africa)*	Pigeon peas*	Cow peas**	Marama beans
Protein	%	16.22	17.14	23.68	36.44
Fat	%	5.86	1.59	1.68	34.05
Fibre	%	3.98	7.32	3.92	4.00
Ca	mg	0.11	0.19	78	241
Fe	mg	2.26	4.24	7.60	4.0
Vitamin A	mg	0.53	1.64	n/a	0.27

* Venter & Coertze (1997)
** Fox & Norwood Young (1982)

of a peanut. The oil is high in the long chain unsaturated fatty acids. Of the total fatty acids, 42% is oleic acid (C18:1) and 32% is linoleic acid (C18:2). The marama bean is a nutritional and valuable food and can be successfully used in programmes specifically aimed at improving household food security and in programmes aimed to improve nutrition in Southern Africa.

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