Nutritional value of wild, leafy plants consumed by the Vhavenda

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1. Holmgren K, Karlén W., Lauritzen S.E., Lee-Thorp J., Partridge T.C., Piketh S., Repinski P., Stevenson C., Svanered O. and Tyson P.D. (1999). A 3000-year high-resolution record of palaeoclimate for north-eastern South Africa. *Holocene* **9**, 295–309.
2. Hendy C.H. (1971). The isotopic geochemistry of speleothems – I. The calculation of the effects of different modes of formation on the isotopic composition of speleothems and their applicability as palaeoclimatic indicators. *Geochim. et Cosmochim.* **35**, 801–824
3. Schwarcz H.P. (1986). Geochronology and isotopic geochemistry of speleothems. In *Handbook of Environmental Isotope Geochemistry 2*, eds P. Fritz and J. Ch. Fontes. pp. 271–303. Elsevier, Amsterdam.
4. Holmgren K., Karlén W. and Shaw P. (1995). Paleoclimatic significance of variations in stable isotopic composition and petrology of a late Pleistocene stalagmite from Botswana. *Quat. Res.* **43**, 320–328.
5. Lauritzen S.E. (1995). High-resolution paleotemperature proxy record during the last interglaciation in Norway from speleothems. *Quat. Res.* **43**, 133–146.
6. Dorale J.A., Edwards R.L., Ito E. and González L.A. (1998). Climate and vegetation history of the midcontinent from 75 to 25 ka: a speleothem record from Crevice Cave, Missouri, USA. *Science* **282**, 1871–1874.
7. Jouzel J. (1999). Calibrating the isotopic paleothermometer. *Science* **286**, 910–911.
8. Lauritzen S.E. and Lundberg J. (1999). Calibration of the speleothem delta function: an absolute temperature record for the Holocene in northern Norway. *Holocene* **9**, 659–669.
9. Williams P.W., Marshall A., Ford D.C. and Jenkinson A.V. (1999). Palaeoclimatic interpretation of stable isotope data from Holocene speleothems of the Waitomo District, North Island, New Zealand. *Holocene* **9**, 649–657.
10. White W.B. (1981). Reflectance spectra and color in speleothems. *Nat. Speleolog. Soc. Bull.* **43**, 20–26.
11. Lauritzen S.E., Ford D.C. and Schwarcz H.P. (1986). Humic substances in speleothem matrix — Paleoclimatic significance. *Proc., 9th Int. Speleol. Congress, Barcelona*, **1**, 77–79.
12. Shopow Y.Y., Ford D.C. and Schwarcz H.P. (1994). Luminescent microbanding in speleothems: high-resolution chronology and paleoclimate. *Geol.* **22**, 407–410.
13. Ramseyer K., Miano T., D'Orazio V., Wildberger A., Wagner T. and Geister J. (1997). Nature and origin of organic matter in carbonates from speleothems, marine cements and coral skeletons. *Org. Geochem.* **26**, 361–378.
14. Baker A., Genty D. and Smart P.L. (1998). High-resolution records of soil humification and paleoclimate change from variations in speleothem luminescence excitation and emission wavelengths. *Geol.* **26**, 903–906.
15. Genty D. and Quinif Y. (1996). Annually laminated sequences in the internal structure of some Belgian stalagmites — importance for paleoclimatology. *J. Sed. Res.* **66**, 275–288.
16. Railsback L.B., Brook G.A., Chen J., Kalin R. and Fleischer C.J. (1994). Environmental controls on the petrology of a late Holocene speleothem from Botswana with annual layers of aragonite and calcite. *J. Sed. Res.* **A64**, 147–155.
17. Baker A., Proctor C.J. and Barnnes W.L. (1999). Variations in stalagmite luminescence laminae structure at Poole's Cavern, England, AD 1910–1996: calibration of a palaeoprecipitation proxy. *Holocene* **9**, 683–688.
18. Brook G.A., Rafter M.A., Railsback L.B., Sheen S-W. and Lundberg J. (1999). A high-resolution proxy record of rainfall and ENSO since AD 1550 from layering in stalagmites from Anjohibe Cave, Madagascar. *Holocene* **9**, 695–705.
19. Qin X, Tan M., Liu T., Wang X., Li T. and Lu J. (1999). Spectral analysis of a 1000-year stalagmite lamina-thickness record from Shihua Cavern, Beijing, China, and its climatic significance. *Holocene* **9**, 689–694.
20. Tyson P.D., Mason S.J, Jones M.Q.W. and Cooper G. R. J. (1998). Global warming and geothermal profiles: the surface rock-temperature response in South Africa. *Geophys. Res. Lett.* **25**, 2711–2713.
21. Mason S.J. and Tyson P.D. (1999). The occurrence and predictability of droughts over southern Africa, In *Drought, a Global Assessment*, vol. 1., ed. D.A. Wilhite, pp. 113–134. Routledge, London.
22. Meentmeyer V. (1978). Macroclimate and lignin control of litter decomposition rates. *Ecology* **59**, 465–472.
23. Tyson P.D. (1986). *Climatic Change and Variability in Southern Africa*. Oxford University Press, Cape Town.
24. Talma A.S. and Vogel J.C. (1992). Late Quaternary paleotemperatures derived from a speleothem from Cango Caves, Cape Province, South Africa. *Quat. Res.* **37**, 203–213.

Nutritional value of wild, leafy plants consumed by the Vhavenda

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We investigated the use and nutrient composition of edible wild plants commonly used in Venda. Information on their eating habits was sought from 412 women in the districts of Thohoyandou, Mutale, Dzanani and Vuwani, who were regular consumers of wild, green, leafy vegetables. The ten most commonly used vegetables were identified through a 'grid matrix' test among sixteen randomly selected hawkers selling wild plants in Thohoyandou markets in 1996. The ten plants studied were: *delelele mandande, thebe, vowa, mushidzhi, murudi, mutohotoho, delele lupfumo, phuri, nngu,* and *muxe.* Data on plant usage was obtained by means of a questionnaire. Nutritional analysis of the vegetables investigated was conducted by the CSIR. Harvesting was mainly in summer with the surplus stored in either a dried-cooked or dried-raw form for at least six months. Frequency of consumption was once per week per plant with fairly large serving sizes of 180–270 g. *Murudi* was found to have the highest content of micronutrients, being exceptionally high in folate (418 µg/100 g), vitamin C (37.0 mg/100 g) and beta-carotene (9.22 mg/100 g). All the plants examined were good sources of dietary fibre. *Vowa, phuri* and *nngu* were also rich sources of vitamin C. *Delele mandande* was the only poor source of beta-carotene and iron. Health educators should promote the nutritional benefits of wild vegetables in rural communities in order to increase micronutrient intake.

Background

There is growing awareness of the potential benefits of wild plants.[1] Many of these plants provide people with their basic needs in terms of food, shelter, medicine and as a source of income.[2] The scarcity of some of these wild resources is, however, becoming a major problem in many rural areas of southern Africa due to droughts, population pressure and overexploitation. Consequently, knowledge of traditional wild foods may be lost to future generations.[3,4]

The Vhavenda consume various types of indigenous plants and have a wealth of knowledge on their use.[16] Apart from eating them they also use plants for oils, polishes, dyes, medicine, firewood, baskets, beverages and artifacts. The plants are also employed as structural materials to build huts, storage structures, kraals and other animal enclosures.[16]

The staple food of the Vhavenda is a porridge called *vhuswa.* This is generally made from maize meal but sometimes also from sorghum and millet. *Vhuswa* is always accompanied by a side dish (*tshisevho*), which is either meat, green vegetables or some other delicacy such as mopane worms, locusts, crickets or ants.[16–18] The edible wild, green, leafy vegetables are known as *miroho.* The plant parts that are eaten include leaves, flowers, seeds, or a combination of these. Collection of wild plants takes place throughout the year, traditionally by women.[16]

There are about 1400 edible plant species in southern Africa, although data on the nutrient composition of these plants have been obtained for only about one fifth of these.[5] Quin[6] was one of the first researchers to document the extensive use of edible wild

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Table 1. Summary of estimated typical recipes for cooking wild plants prior to analysis.

Plant name	Plant part (100 g)	Water added (ml)	Time taken (min)	Other ingredient added
Delele mandande	Fruit[a]	380	10	¼ teaspoon $NaHCO_3$[b]
Thebe	Leaves	250	7	–
Vowa	Leaves	250	7	–
Mushidzhi	Leaves	450	15	–
Murudi	Leaves	700	50	–
Mutohotoho	Leaves	650	35	–
Delele lupfumo	Leaves	380	10	¼ teaspoon $NaHCO_3$[b]
Phuri	Leaves and flowers	300	10	–
Nngu	Leaves	270	12	–
Muxe	Leaves	650	35	–

[a]Leaves are also eaten, however, only the fruit was available at the time of collection.
[b]Bicarbonate of soda.

plants among the Pedi. In 1967, Van der Merwe *et al.*[7] collected 24 different wild plant specimens in northern Natal. In the 1980s fairly extensive research was done in this field. Wehmeyer and Rose[3] documented the nutrient composition of 15 types of leaves and fruit used as traditional foods in the Transkei (Eastern Cape Province). This was followed by a report on the nutritional composition of more than 300 samples of the edible parts of wild species collected in the Northern Cape Province (Namaqualand), Venda, Mpumalanga, Eastern Cape Province (Karoo), Namibia and southern Zimbabwe.[5] In 1982, Fox and Norwood-Young[4] published a comprehensive book on the botany and uses of wild plants in Southern Africa. This did not, however, include data on the nutrient composition of the individual plants.

In 1996 an indigenous plant programme was started at the University of the North. The objectives of this programme were to identify useful plants with market potential in the Northern Province; selection of priority species and end-products; and to analyse priority species for nutrient composition. This article presents data on the nutrient composition, method of preparation and storage, and frequency of consumption of edible wild plants commonly consumed in Venda.

Materials and methods

The study was undertaken in the Thohoyandou, Mutale, Dzanani and Vuwani districts of Venda in 1997. Venda is the most northerly region of the Northern Province. It is a small, fertile area of 6500 square kilometres with a population of about half a million inhabitants known as the Vhavenda.[8] The majority live in rural and semi-rural villages. Thohoyandou, the principal town of the region, is urbanized and industrialized. The climate is subtropical and the annual rainfall ranges from 300 to 2000 mm. In summer the average temperature is 25°C and in winter 15°C.[9]

The study sample comprised 412 women aged 20 years or older, residing in the districts of Thohoyandou, Mutale, Dzanani and Vuwani. Selection criteria for inclusion in the study group were women who were regular consumers of one or more of the selected wild, green, leafy vegetables.

We investigated the nutritional composition of the ten most commonly consumed wild, green, leafy vegetables. It is generally understood that indigenous plants are wild species that have either evolved in the area of study or migrated there by natural means. Naturalized plants are wild plants that have not evolved in the area of study but were introduced intentionally or accidentally. In this report the term wild plants includes both indigenous and naturalized wild plants. To determine which plants were the most commonly eaten, a 'grid matrix' test was conducted in 1996. Sixteen randomly selected hawkers selling wild plants in Thohoyandou markets were interviewed and requested to identify those plants which were most frequently bought from them. The 10 green, leafy plants which occurred most frequently on this matrix were the ones selected for study. They included the following indigenous and naturalized plants according to their local names: *phuri, thebe, vowa, nngu, mushidzhi, muxe, delele lupfumo, delele mandande, murudi* and *mutohotoho* (Table 4).

A questionnaire was used to obtain data on plant usage and was adapted from an existing one developed by the Indigenous Plant Programme (IPP) team at the University of the North. The first part included socio-demographic information relevant to the study population. The second part comprised specific questions about each plant: parts eaten; harvesting; seasonal usage; cooking methods; and frequency of consumption. Vouchers of each plant were collected and identified by the University of the North's herbarium (UNIN).

A fresh sample of each plant examined was collected early in the morning (in summer), and transported in a cool-bag to the CSIR Food Science and Technology division for preparation and analysis. Prior to analysis each plant was cooked according to the customary method used in Venda. This was determined by the researcher, who observed and timed the cooking period of each vegetable. This was done by taking an average cooking time after observation of three different users preparing the vegetables (Table 1). *Murudi* is cooked for a long period in a lot of water to remove its bitter taste.[4] Analysis of each cooked plant was

Table 2. The most frequently used food items in the diets of Vhavenda[a] and Bapedi[b] adults.

Food items of Vhavenda	Food items of Bapedi
Maize porridge (refined)	Maize porridge (refined)
Miroho[c] (green leafy vegetables)	Tea
Brown bread	Sugar (white)
Chicken	Brown bread
Sugar	Chicken
Peanuts	*Marog* (green leafy vegetables)
Tea	Non-dairy creamer
Banana	Tomato and onion
Beef	Cooked dry beans
Mabundu[d]	White bread
Tshidzimba[e]	Hard margarine
Fish (canned pilchard or fresh)	Fried egg
Margarine	Sorghum beer
Orange	Cooked cabbage
Soft drinks	Cold drink
Sweets	Peanut butter
Mashondzha (mopani worms)	White rice
Biscuits	Banana
Apple	Whole milk
Eggs	Jam

[a]List of foods adapted from the study by Vorster *et al.*[11]
[b]List of foods adapted from the study by Steyn *et al.*[12]
[c]Dish is cooked with tomato, onion, peanuts and occasionally potato.
[d]Thin maize porridge, fermented with millet.
[e]Dish made of cooked dried beans, maize meal and peanuts.

done in duplicate according to standard CSIR (Food Quality Programme) procedures using analytical methods (AM) compiled by Sampson.[10] Briefly they are as follows:

Protein content was determined by the Kjeldahl method whereby nitrogenous compounds are broken down and converted to ammonia, which is distilled into a boric acid solution and determined by titration with standard hydrochloric acid solution. The nitrogen value found was then multiplied by an appropriate factor to give the protein content (AM047). The ash determination was carried out at 520°C in a muffle furnace (AM045). The mineral content of the materials was determined by atomic spectroscopy after dry-ashing to convert organic matter into inorganic compounds (AM051). Total dietary fibre was determined by gelatinizing duplicate samples of foods with termamyl (heat-stable alpha-amylase) and enzymatically digesting with protease and amyloglucosidase to remove protein and starch (AM077).

The microfluorometric method (AM031) was used to determine the total vitamin C (ascorbic acid and dehydroascorbic acid) of the foods. Beta-carotene was determined by extraction from samples in appropriate solvent and determined by HPLC (AM037). Validation methods for all the above are described in the CSIR manual.[10]

Results

Table 2 presents a summary of frequently consumed food items by adults living in rural areas of the Northern Province.[11,12] Green, leafy vegetables were commonly consumed by people residing in this province and were the second most commonly used food item of the Vhavenda.

Table 3 gives data on the socioeconomic status of the participants. Most of the women (71%) were unemployed, although 67% indicated that a family member was employed and supporting the family. Nearly 60% of the participants' household income was less than R1000 per month, and supported a large family (37% supported five or six family members).

Table 4 presents a summary on the uses of the vegetables studied. Most of the plants were harvested during summer and stored either in a dried-cooked or dried-raw form for at least six months. All these plants are boiled and eaten with either tomatoes and/or groundnuts. Respondents indicated that these plants were consumed once a week with serving sizes being 1–2 cups (180–270 g).

The nutrient contents of the vegetables are presented in Table 5. *Murudi* has the highest protein content (6.8 g/100 g) and generally was the greatest sources of micronutrients. It is exceptionally high in calcium (206 mg/100 g), folate (418 μg/100 g), vitamin C (37.0 mg/100 g), and beta-carotene (9.22 mg/100 g). All the vegetables are good sources of dietary fibre. *Delele mandande* is the only poor source of beta-carotene and iron. With tomato, onion and peanuts included, there is a substantial increase in energy, protein, folate, vitamin C and calcium intake of the serving, depending of course on the amount added. In this instance, we have considered average portion sizes.

Table 3. Socioeconomic status of the respondents (n = 412).

Characteristics	Number*	Percentage
Employment		
Yes	118	28.9
No	291	71.1
Family member in employment		
Yes	274	67.3
No	113	32.7
Source of household Income		
Salary	222	63.1
Pension	107	30.4
Grant	2	3.4
Hawking	11	3.1
Household income/month		
<R100	5	1.3
R100–R500	136	34.0
R600–R1000	85	21.3
>R1000	174	43.5
Family size		
1 (living alone)	8	2.0
2–4	137	33.6
5–6	152	37.3
7–8	79	19.4
9–12	26	6.4
>12	6	1.5

*Number does not always add up to 412 since not all respondents answered every question.

Discussion

The wild plants consumed by people in Venda make an important contribution to their daily nutrient intake with respect to calcium, iron, zinc and beta-carotene. Studies in the province indicated that deficiencies of major concern are those of energy, vitamin A, vitamin C, folate, niacin, riboflavin, iron and calcium.[13-15] A daily serving (180 g) of many of the wild vegetables will make a significant contribution to the daily requirement

Table 4. Summary of ten wild, green, leafy vegetables studied in Venda.

Plant name		Edible part	Harvesting practices		Storage		Cooking method		Plant consumption
Botanical	Local		Time	Season	Form	Time (months)		Added condiments	Serving portion (g)
Amaranthus esculentus	*Delele mandande*	Leaves, fruit, seeds	Anytime	Summer	Dried-raw	>9–12	Boiling	Tomatoes, onion, sodium bicarbonate	270/180
Amaranthus hybridus	*Thebe*	Leaves	Anytime	Summer	Dried-cooked, dried-raw	>3–6	Boiling	Tomatoes, groundnuts	180/42.5
Amaranthus standleyanus	*Vowa*	Leaves	Anytime	Summer	Dried-cooked	>3–6	Boiling	Tomatoes, groundnuts	180/42.5
Bidens pilosa	*Mushidzhi*	Leaves	Anytime	Summer	Dried-cooked	>9–12	Boiling	Tomatoes, groundnuts	180/90
Corchorus tridens	*Delele lupfumo*	Leaves	Anytime	Summer	Dried-raw	>9–12	Boiling	Tomatoes, onion, sodium bicarbonate	270/180
Cleome gynandra	*Murudi*	Leaves	Anytime	Summer	Dried-cooked	>9–12	Boiling	Tomatoes, groundnuts	270/180
Cleome monophylla	*Mutohotoho*	Leaves	Anytime	Summer	Dried-cooked	>3–6	Boiling	Tomatoes, sodium bicarbonate	180/42.5
Cleome maxima	*Phuri/Thanga*	Leaves, flowers, fruit, seeds	Morning/ Afternoon	Summer	Dried-cooked	>9–12	Boiling	Tomatoes, groundnuts	270/180
Mormordica foetida	*Nngu*	Leaves	Anytime	All year round	Dried-raw	>9–12	Boiling	Tomatoes, groundnuts	42.5
Solanum retroflexum	*Muxe*	Leaves	Anytime	Summer	Dried-cooked	6–12	Boiling	Tomatoes, groundnuts	90

*The two most common serving sizes are indicated. Each vegetable was eaten once a week on average.

Table 5. Nutrient content of ten wild, leafy vegetables studied in Venda.

Plant name		Nutrient content per 100 g of plant								
Botanical	Local	Energy (kJ)	Protein (g)	Fibre (g)	Beta-carotene (mg)	Folate (µg)	Vit. C (mg)	Calcium (mg)	Iron (mg)	Zinc (mg)
Amaranthus esculentus	*Delele mandande*	40.0	1.13	3.08	0.21	24.3	2.4	0.94	0.46	0.36
Amaranthus hybridus	*Thebe*	79.0	3.15	3.33	6.23	40.8	2.7	3.00	9.77	0.80
Amaranthus standleyanus	*Vowa*	85.0	3.06	3.03	4.81	65.3	22.3	2.66	4.78	0.32
Bidens pilosa	*Mushidzhi*	89.0	2.98	3.77	5.81	12.6	2.9	1.05	4.22	0.78
Cleome gynandra	*Murudi*	191.0	6.82	4.48	9.22	417.6	37.0	206.0	9.70	1.29
Cleome monophylla	*Mutohotoho*	73.0	2.99	2.70	3.98	50.5	13.2	1.90	9.24	0.43
Corchorus tridens	*Delele lupfumo*	33.0	1.63	2.08	3.20	6.0	2.5	0.98	11.50	0.28
Cleome maxima	*Phuri/Thanga*	112.0	3.11	4.01	4.63	9.3	24.4	1.30	6.86	0.61
Mormordica foetida	*Nngu*	94.0	3.30	3.15	5.41	40.6	20.6	1.06	3.38	0.42
Solanum retroflexum	*Muxe*	81.0	3.65	2.73	7.56	5.2	7.5	1.48	9.34	0.55
Tomato & onion (35 g)[a]		45.9	0.42	0.60	0.10	4.5	6.3	3.50	0.18	0.05
Peanuts (15 g)[a]		364.7	3.96	1.32	0	18.9	0	13.20	0.27	0.99
Tomato + onion + peanuts[a]		410.6	4.38	1.92	0.10	23.5	6.3	16.70	0.45	1.04
RDA[b]	Child 4–6 years	7560	24.00			75.0	45.0	800	10.00	10.00
RDA[b]	Women 25–50	9240	50.00			180.0	60.0	800	15.00	12.00

[a]Added ingredients.[20]
[b]Recommended dietary allowance.[19]

of iron, vitamin C, folate and beta-carotene.

It is important to consider the bioavailability of these plant nutrients when eaten. Green, leafy vegetables contain phylates and oxalates which interfere with the absorption of calcium and iron.[13] Tea is commonly drunk in the province, yet it contains polyphenols that are contra-indicated in the absorption of nutrients such as calcium and iron.[13] Consequently, calcium and iron requirements may not be adequately met by green, leafy vegetables only. However, iron absorption will be enhanced when the vegetable is a good source of vitamin C.[14] Unfortunately, sodium bicarbonate is sometimes added to enhance the green colour of the leaves and this has a detrimental effect on vitamin C content.

The conservation and optimal use of indigenous plants should be addressed through education. Billet has emphasized the importance of teaching people not to harvest carelessly but only to remove the needed part(s) of the plant instead of removing the whole plant. Conservation of indigenous species will achieve more sustainable agriculture as those plants are better adapted to a given area than exotic plants.[2,18]

Health educators should also consider promoting the nutritional benefits of wild vegetables in rural communities, particularly by vulnerable groups such as children and pregnant women, as they can significantly contribute to the micronutrient content of the diet. The nutrient content of the plants described in this article have been incorporated in the latest South African Food Composition Tables[21], and are thus now available to health educators and nutritionists.

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1. Venter S. (1995). Edible and medical uses of indigenous vegetable crops. *Roodeplaat Bull.* **45**, 18–20.
2. Alleman J., Venter S. and van den Heever E. (1995). Indigenous vegetable research. *Roodeplaat Bull.* **45**, 14–15.
3. Wehmeyer A.S. and Rose E.F. (1983). Important indigenous plants used in the Transkei as food supplements. *Bothalia* **14**, 613–615.
4. Fox F.W. and Norwood-Young M.E.N. (1982). *Food from the Veld: Edible Wild Plants of Southern Africa.* Delta Books, Cape Town.
5. Wehmeyer, A.S. (1986). Edible wild plants of southern africa: data on the nutrient contents of over 300 species. Unpublished report, CSIR, Pretoria.
6. Quin P.J. (1959). *Foods and Feeding Habits of the Pedi.* Witwatersrand University Press, Johannesburg.
7. Van der Merwe A., Burger I.M. and Wehmeyer A.S. (1967). *Suid-Afrikaanse Veldkosse: 1. Makatinivlakte, Noord Natal.* CSIR, Pretoria.
8. Zöllner E. and Carlier N.D. (1991). Breastfeeding and weaning practices in Venda 1990. *S. Afr. Med. J.* **83**, 580–583.
9. Weather Bureau (1996). *Climate of South Africa: Climate Statistics up to 1994.* Pretoria.
10. Sampson K. (1996). *Food Quality Programme: Analytical Methods.* CSIR, Pretoria.
11. Vorster H.H., Venter C.S., Menssink E., *et al.* (1994). Adequate nutritional status despite restricted dietary variety in adult rural Vendas. *S. Afr. J. Clin. Nutr.* **7**(2), 3–16.
12. Steyn N.P., Burger S., Monyeki K., Alberts M. and Nthangeni G. (1999). *Dietary Intake of the Adult Population of Dikgale.* UNIN Press, Sovenga.
13. Steyn N.P., Badenhorst C.J. and Nel J.H. (1993). The meal patterns and snacking habits of schoolchildren in two rural areas of Lebowa. *S. Afr. J. Food. Sci. Nutr.* **5**(1), 5–9.
14. Badenhorst C.J., Steyn N.P., Jooste P.L., *et al.* (1993). Nutritional status of Pedi school children aged 6–14 years in two rural areas of Lebowa: a comprehensive nutritional survey of dietary intake, anthropometric, biochemical, haematological, and clinical measurements. *S. Afr. J. Food. Sci. Nutr.* **5**(4), 112–119.
15. Steyn N.P., Nel J.H., Tichelaar H.Y., *et al.* (1994). Malnutrition in Pedi preschool children, their siblings and caretakers. *S. Afr. J. Clin. Nutr.* **7**(4), 12–18.
16. Mabogo D.E.N. (1990). *The ethnobotany of the Vhavenda.* M.Sc. thesis, University of Pretoria, Pretoria.
17. Stayt H.A. (1968). *The BaVenda.* Frank Cass, London.
18. Singo N.M. (1996). *A Survey of the Indigenous Relishes of the Vhavenda and their Agricultural Potential.* M.SC. thesis, University of Pretoria, Pretoria.
19. National Academy of Science. (1989). *Recommended Dietary Allowances,* 10th edn. National Academy Press, Washington, D.C.
20. Langenhoven M., Kruger M., Gouws E and Faber M. (1991). *MRC Food Composition Tables,* 3rd edn. Medical Research Council, Parow.
21. Kruger M., Sayed N., Langenhoven M and Holing F. (1998). *Composition of South African Foods – Vegetables and Fruits.* Medical Research Council, Parow.