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# An Assessment of Minerals and Protein Contents in Selected South African Bottle Gourd Landraces [*Lageraria siceraria (Mol. Standl.)*]

**Nkanyiso Justice Sithole[1], Albert Thembinkosi Modi[2*] and Kirthee Pillay[3]**

***Crop Science, School of Agricultural, Earth and Environmental Sciences, University of KwaZulu-Natal, Private Bag X01, Scottsville 3209, Pietermaritzburg, South Africa***
***Telephone: +2733 260 6076, Fax: +2733 260 6094***
***E-mail: 1. nkanyisoj@gmail.com, 2. modiat@ukzn.ac.za, 3. pillayk@ukzn.ac.za***

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**ABSTRACT** Bottle gourd (*Lagenaria siceraria*) is an under-researched crop in South Africa, which has the potential to boost food security. However, the nutritional information on the crop is scant. This led to a need to determine the nutritional value of this crop and its potential to meet the Recommended Dietary Allowances (RDA) for various nutrients. The experiment was conducted at a controlled environmental facility with two landraces, which were compared with two commercial pumpkin cultivars. All varieties were found to be good sources of calcium, iron, magnesium and zinc, as well as nitrogen, manganese and copper. With response to the leaf harvesting at different times during crop growth, most varieties had higher nutrients during the early stages of development and before flowering. All varieties were shown to meet the RDA for all reported nutrients. These results suggest that bottle gourd has the potential to be used as a crop to achieve household food security.

## INTRODUCTION

Africa is the only developing continent in the world with increasing numbers of undernourished individuals (FAO 2014). In Africa, sub-Saharan Africa has the highest prevalence of malnutrition with more than one in four people being chronically hungry (FAO 2014). In South Africa, malnutrition is attributed to food insecurity with one in four households experiencing hunger (Shisana et al. 2013). According to Berti et al. (2014), the South African diet often lacks variety and micronutrient deficiencies especially of vitamin A, iron and zinc are widespread. Issues surrounding food insecurity have been mostly associated with a lack of access to nutritious foods at the household level (Hart 2011) rather than the availability of food at a country level because South Africa is deemed to be food secure at a national level. In order to have a healthy nation that can promote development, the relationship between nutrition and health should be reinforced (Achu et al. 2005). One way that has been proposed is to review the previously neglected African leafy vegetables (Modi et al. 2006; Odhav et al. 2007; Schönfeldt and Pretorius 2011) as a potential source of nutrients like bottle gourd landraces, which is available for rural households. These species were initially primary sources of food in many communities and have now been marginalized in favour of introduced exotic species.

In South Africa a large number of underutilized crop species exist, of which the nutritional value is relatively unknown (Odhav et al. 2007). Attention should be given to these crops if they are to be promoted for utilization by rural households. Reportedly, these crops may grow in soils with low fertility, are relatively drought tolerant, provide good ground cover and can be harvested within a short period of time after planting (Shiundu 2002). Improved knowledge on the nutritional composition has been proposed to encourage the cultivation and consumption of these crops, more especially those with high nutrient content (Maunder and Meaker 2007; van Jaarsveld et al. 2014). This is a serious challenge that needs to be addressed in order to promote the cultivation of these crops and alleviate poverty, health problems and malnutrition in South Africa. Promoting the consumption of leafy vegetables like bottle gourd can offer some solutions to this problem.

*Address for correspondence:*
Nkanyiso J. Sithole
Crop Science, School of Agricultural, Earth and Environmental Sciences,
University of KwaZulu-Natal, Private Bag X01, Scottsville 3209,
Pietermaritzburg, South Africa
*E-mail:* nkanyiso@gmail.com

Several studies conducted in sub-Saharan Africa (Odhav et al. 2007; Uusiku et al. 2010; Schönfeldt and Pretorius 2011) have evaluated the nutritional content of several traditional underutilized crops and their potential contribution to household nutrition and food security. Some progress has been made for other leafy vegetables such as, *Amaranthusdubius, Amaranthushybridus, Amaranthusspinosus, Asystasiagangetica, Bidenspilosa, Centellaasiatica, Ceratothecatriloba, Chenopodium album, Cleome monophylla, Cucumismetuliferus, Emexaustralis, Galinsogaparviflora* and *Justicia flava*. However, bottle gourd (*Lagenaria siceraria*) has not benefited from these efforts and remains under-researched. This is despite the knowledge that bottle gourd is well known for its nutritional value and medicinal properties in other countries such as India and Pakistan (Milind and Satbir 2011). The edible portion of a bottle gourd contains carbohydrates, proteins, fats and minerals including phosphorous and calcium (Ahmad et al. 2011). It is a good source of vitamin B complex, vitamin C (ascorbic acid), β-carotene, amino acids and pectin dietary soluble fibers (Duke 1999; Habibur-Rahman 2003; Modgil et al. 2004). This information is derived from other countries; South African bottle gourd landraces remain underutilized in favour of introduced species whose nutritional information is well defined. It is also difficult to superimpose information from other places to local conditions because of landrace variability. This highlights the need for research on local bottle gourd landraces in order to successfully promote them as viable alternatives to introduced elite cultivars.

The primary aim of this study was to assess the contents of selected minerals and protein of bottle gourd landraces at different stages of crop growth, and in doing so, determine optimum harvest times. Secondary to this, the study evaluated the nutritional potential of bottle gourd leaves by estimating their potential contribution to meeting dietary requirements. Such information could be a starting point in developing valuable knowledge about the crop, allowing better food selection and improvement of the nutritional status of rural South Africans.

## METHODOLOGY

### Plant Material

Seeds bottle gourd (*Lagenaria siceraria*), pumpkin (*Cucurbita maxima*) were used as planting material. For bottle gourd, seeds were derived from three local landraces. Two of the landraces (M01 and M02, respectively) were from South Africa [Richards Bay (28°19'S, 32°06'E; 30 masl) and Nkandla (28°21'S, 31°22'E; 1301 masl) and one (M03) was from Zimbabwe [Chimbwanda East (18º19'S 31º12'E; 1484 masl). Seeds of two pumpkin hybrids (GOH and GRH) were purchased from McDonalds Seed company.

### Experimental Design and Trial Management

Semi-controlled environment conditions (27°/15°C day/night; 60% RH and natural day length) were used to grow plants. Temperature and relative humidity were monitored electronically using a HOBO 2K logger (Onset Computer Corporation, Bourne, USA). A pot trial was laid out as a randomized complete block design with two treatment factors varieties (landraces and conventional species), and harvesting time (sequential). The harvesting treatments included: 1) harvesting once, two weeks after crop establishment, 2) harvesting every two weeks until termination of the experiment, and 3) no harvest (control).

A total of 96, 10 liter drained pots were filled with soil collected from the University of KwaZulu-Natal Research Farm. Seedlings were established in seedling trays for 23 days. Thereafter, seedlings were transplanted into pots. All pots were connected to an online drip irrigation system and irrigation was scheduled to meet full crop water requirements (100% ETc). Physical and chemical characteristics of the soil were: clay loamy texture, brown color, 1.70 percent organic carbon, 0.23 nitrogen, 20 $mg.L^{-1}$ phosphorus, 227 mg.L-1 potassium, pH (KCL) of 5.16, 36.1 FC (v%) and a permanent wilting point of 22.0 (v%). The pots were hand weeded every 5 days to ensure there was no competition for water and solar radiation. Plants were sprayed with Cypermethrin® (15: 10 L) for control of aphids. Fertilizer was not applied in order to simulate the predominant conditions under which subsistence farmers cultivate the crop; in most cases people in rural areas do not apply fertilizer.

### Data Collection

Leaves were initially harvested at a crop development stage after emergence when all four leaves were fully expanded and exposed. Subsequent from this stage, sequential harvesting was performed whereby the first leaf from the ground was removed from the stem with the petiole. The sequential harvesting was done based on the traditional system (Modi 2009). Immediately after harvesting, the leaves were freeze-dried at -53°C for three days. Thereafter, the material was ground under liquid nitrogen using a mortar and pestle and stored at -12°C. Minerals nutrients in the leaves were determined according to Hunter (1975). Soluble proteins and nitrogen were determined according to Kanellis and Kalaitzis (1992) and Marais and Evenwell (1983), respectively.

**Assessment of Nutritional Composition**

The recommended dietary allowance (RDA) data were derived from means of five analyzed samples. Nutrient retention factors for "vegetables, greens, boiled, little water drain" (USDA Table of Nutrient Retention Factors 2007) were used to account for nutrient losses during cooking. The following nutrient retention factors were used: phosphorus and potassium = 0.90, and calcium, magnesium, sodium, copper, iron and zinc (USDA Table of Retention Factors 2007). The USDA Table of Nutrient Retention Factors (2007) does not provide nutrient retention factors for "vegetables, greens, boiled, little water for protein and manganese". For this calculation, it was assumed that there was no loss during cooking and a nutrient retention factor of 1 was used.

Average portion sizes were set at 130 g boiled leaves for adult females (19-30 years old) and 90 g for young children (4-8 years old) (Faber et al. 2007). A raw to cooked yield factor of 1.3 was applied based on the method by van Jaarsveld et al. (2014). The nutrient composition of average portions of cooked leaves was calculated and expressed as a percentage of Dietary Reference Intake (DRIs) [RDA/Adequate Intake (AI) for children (4-8 years old)] and non-pregnant and non-breastfeeding females (19-30 years old) (Ross et al. 2011).

**Statistical Analyses**

Nutrient data obtained from the analysis were entered and analyzed in a spreadsheet using Microsoft Office® Excel 2010. As the data were limited to a few samples, statistical data are not presented in this paper.

## RESULTS

Mean values for mineral content of nutritional importance are presented in Table 1. Hybrid varieties were shown to contain higher levels of minerals than landraces and higher amounts of nutrients were found concentrated in the early stage of crop development. Both landraces and hybrids contained remarkably high amounts of calcium (> 1000 mg 100 $g^{-1}$). The range in calcium was 3108 mg 100 $g^{-1}$ between hybrid varieties and landraces. Phosphorus content in leaves did not vary greatly between landraces and hybrid varieties; it ranged between 306 mg 100 $g^{-1}$ (Landrace M03) and 599 mg 100 $g^{-1}$ (hybrid GOH). High nitrogen content (> 1000 mg 100 $g^{-1}$) was observed in all varieties. With respect to sequential harvesting, concentration of nutrients was observed to fluctuate with relative higher amounts of nutrients found in the early stages of growth. Both landraces were shown to be excellent sources of potassium (> 1000 mg 100 $g^{-1}$) (Table 1). A vast range of 583 mg 100 $g^{-1}$ was observed between the landraces and hybrids and with respect to sequential harvesting, K was observed to be lower with small fluctuations. Magnesium ranged from 451 mg 100 $g^{-1}$ in landraces to 1902 mg 100 $g^{-1}$ in hybrids varieties. Magnesium was shown to be relatively constant when leaves were sequentially harvested. All varieties were shown to contain low levels (< 0.6 mg 100 $g^{-1}$) of copper and in both hybrid varieties and landraces the level was, on average, equal. Iron (Fe) concentration between landraces ranged between 6.5 to 26.1 mg 100 g-1 and 6.9 to 29.3 mg 100 $g^{-1}$ in sequentially harvested plants. For both landraces and hybrids, leaf Fe content was observed to fluctuate in response to sequential harvesting. Similar trends were observed in protein with significant lower values. Landrace M01 had higher protein content at 26 and 39 days after transplanting, respectively, than all other varieties. The protein content of hybrid varieties was observed to drop significantly at 54 days after transplanting, while landraces in that period were observed to increase in protein content.

Nutrient retention factors were used to calculate the nutrients retained after cooking 100 g raw leaves (Tables 2 and 3). The retention fac-

**Table 1: Concentration of selected minerals and protein in raw leaves of bottle gourd landraces and commercial cultivars of pumpkin in response to sequential harvesting.**

| *Variety* | *DAT*[1] | *N* g | *P* mg | *K* mg | *Ca* mg | *Mg* mg | *Na* mg | *Zn* mg | *Cu* µg | *Mn* mg | *Fe* mg | *Protein* mg |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Landrace M01* | 26 | 2.03 | 533 | 2010 | 2713 | 688 | 10.5 | 4.9 | 200 | 8.0 | 21.5 | 0.92 |
| | 39 | 1.46 | 193 | 1450 | 3140 | 782 | 6.2 | 5.6 | 300 | 10.8 | 9.1 | 0.95 |
| | 54 | 1.02 | 244 | 871 | 2922 | 721 | 8.2 | 4.5 | 300 | 9.42 | 9.7 | 0.86 |
| | 65 | 1.62 | 486 | 1339 | 3140 | 743 | 9.2 | 5.3 | 500 | 8.14 | 13.1 | 0.86 |
| | 73 | 1.90 | 226 | 1692 | 2622 | 578 | 6.1 | 4.3 | 700 | 8.8 | 7.6 | 0.92 |
| *Landrace M03* | 26 | 1.90 | 496 | 2144 | 3467 | 736 | 10.6 | 5.7 | 300 | 9.7 | 26.1 | 0.74 |
| | 39 | 1.46 | 222 | 1592 | 2077 | 577 | 6.2 | 5.5 | 400 | 8.9 | 9.2 | 0.89 |
| | 54 | 1.09 | 289 | 1118 | 2051 | 483 | 4.1 | 4.1 | 300 | 7.8 | 16.9 | 0.86 |
| | 65 | 1.44 | 218 | 1655 | 2566 | 678 | 5.7 | 5.1 | 600 | 7.4 | 10.8 | 0.96 |
| | 73 | 1.63 | 214 | 1690 | 2300 | 515 | 6.3 | 4.0 | 600 | 8.7 | 6.5 | 0.84 |
| *Landrace mean* | | 1.56 | 340 | 1556 | 2652 | 650 | 7.0 | 5.0 | 400 | 9.1 | 13 | 0.88 |
| *Hybrid GRH* | 26 | 1.72 | 381 | 2495 | 5976 | 2500 | 30.0 | 10.1 | 300 | 12.6 | 29.3 | 0.76 |
| | 39 | 1.60 | 425 | 2411 | 6619 | 1926 | 18.6 | 8.9 | 400 | 13 | 10.7 | 0.87 |
| | 54 | 1.53 | 354 | 1838 | 5769 | 1958 | 22.7 | 8.7 | 300 | 15 | 25.1 | 0.94 |
| | 65 | 1.49 | 375 | 2046 | 5713 | 1722 | 23.3 | 6.1 | 400 | 26 | 12.6 | 0.88 |
| | 73 | 1.53 | 493 | 1766 | 4505 | 1840 | 10.5 | 6.5 | 500 | 14.4 | 13.0 | 0.84 |
| *Hybrid GOH* | 26 | 1.81 | 322 | 2325 | 5598 | 2449 | 26.8 | 9.3 | 300 | 10.1 | 28.0 | 0.73 |
| | 39 | 1.60 | 475 | 2560 | 5912 | 2127 | 25.0 | 6.9 | 400 | 18.7 | 9.8 | 0.92 |
| | 54 | 1.66 | 387 | 2093 | 6504 | 2341 | 33.1 | 6.6 | 400 | 20.9 | 17.2 | 0.94 |
| | 65 | 1.59 | 370 | 1839 | 6305 | 1577 | 20.3 | 9.7 | 400 | 19.1 | 22.1 | 0.80 |
| | 73 | 1.58 | 546 | 2015 | 4698 | 1784 | 10.5 | 5.7 | 500 | 18.3 | 6.9 | 0.74 |
| *Hybrids mean* | | 1.61 | 413 | 2139 | 5760 | 2022 | 22 | 8.0 | 400 | 16.8 | 17 | 0.84 |

*100 g of leaf sample is equal to approximately 3 cups.
[1]DAT= days after transplanting

**Table 2: Nutrient content and protein per 100 g edible portion of bottle gourd landraces leaves and hybrids of pumpkin.**

| *Variety* | *N* | *P* | *K* | *Ca* | *Mg* | *Na* | *Zn* | *Cu* | *Mn* | *Fe* | *Proteins* |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | *mg* | | | | | | |
| Landrace M01 | 1609 | 336 | 1472 | 2813 | 702 | 8 | 4.9 | 0.401 | 9.4 | 12.17 | 0.90 |
| | (1011) | (340) | (1139) | (518) | (204) | (4.4) | (0.6) | (0.5) | (2.8) | (13.9) | (0.09) |
| Landrace M03 | 1508 | 344 | 1640 | 2492 | 598 | 6.6 | 4.91 | 0.46 | 8.7 | 13.92 | 0.86 |
| | (808) | (278) | (1026) | (1416) | (253) | (6.5) | (1.7) | (0.4) | (1.9) | (10.4) | (0.22) |
| Hybrid GRH | 1576 | 406 | 2111 | 5716 | 1989 | 21 | 8.03 | 0.389 | 16.2 | 18.15 | 0.86 |
| | (106) | (139) | (729) | (2114) | (778) | (19.5) | (4.0) | (0.2) | (1.8) | (18.6) | (0.18) |
| Hybrid GOH | 1650 | 420 | 2166 | 5803 | 2056 | 23.1 | 7.62 | 0.389 | 17.4 | 16.8 | 0.83 |
| | (230) | (224) | (721) | (1806) | (872) | (22.6) | (4.0) | (0.2) | (10.8) | (21) | (0.21) |

Values are mean and (range) of five samples analysed individually.

**Table 3: Estimated[1] amount of nutrient retained after cooking 100g leaves of bottle gourd landraces and hybrids of pumpkin**

| *Variety* | *P* | *K* | *Ca* | *Mg* | *Na* | *Zn* | *Cu* | *Mn* | *Fe* | *Proteins* |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | *mg* | | | | | | |
| Landrace M01 | 302 | 1325 | 2672 | 667 | 8 | 5 | 0.4 | 9.4 | 12 | 0.90 |
| Landrace M03 | 310 | 1476 | 2367 | 568 | 6 | 5 | 0.4 | 8.7 | 13 | 0.86 |
| Hybrid GRH | 365 | 1900 | 5430 | 1890 | 20 | 8 | 0.4 | 16.2 | 17 | 0.86 |
| Hybrid GOH | 378 | 1949 | 5513 | 1953 | 22 | 7 | 0.4 | 17.4 | 16 | 0.83 |

[1]The nutrient content of cooked leaves was calculated from the mean nutrient value in raw leaves using the following retention factors: calcium, sodium, magnesium, copper, iron zinc, copper and manganese = 0.95; phosphorus and potassium = 0.90 (USDA Table of nutrient (USDA Table of nutrient retention factors 2007).

tors used to account for the amount of nutrients retained after cooking are estimates, as different cooking methods (temperature and time) are known to affect retention (Greenfield and Southgate 2003). To estimate the potential contribution to the DRIs, two age groups were selected in this study (Table 4). Children of 4-8 years old and 19-30 year old non-pregnant, non-breastfeeding females were used because young children and women of child-bearing age are most vulnerable to malnutrition (van Jaarsveld et al. 2014). The results from the estimated nutrient contribution of an average cooked portion size of both landrace and pumpkin cultivar leaves (90 g) for a 4-8-year-old child showed that they provide less than two percent of the RDA for protein. However, when comparing other nutrients, both landraces and pumpkin cultivars were shown to be good sources of calcium, iron, magnesium, zinc, copper and manganese for this group. Specifically calcium, magnesium and manganese provided more than a hundred percent of the RDA. Phosphorus and potassium were found to contribute a reasonable amount (> 30 and < 50%) to the RDA. Similar trends were observed for percentage contribution to the RDA for 19-30 year old women when using an average cooked portion size of both landraces and pumpkin cultivar leaves (130 g). In both life stage groups, sodium was found to meet less than one percent and two percent of the RDA in both landraces and hybrid varieties of pumpkins, respectively.

## DISCUSSION

Bottle gourd, as a leafy vegetable, can be harvested at any time during the stage of crop growth and development; however, data on nutritional value with plant age is limited for landraces. The objective of this study was to determine the nutritional changes in the crop at different time intervals and in doing so, determine the optimum harvest time.

The results found higher levels of nutrients in commercially produced varieties when compared with landraces. These results were similar to the observations made by Modi (2009) that introduced species generally contain more nutrients compared to their native counterparts.

**Table 4: Estimated nutrient contribution of an average portion size[1] of leaves of bottle gourd landraces and two commercial cultivars of pumpkin to the RDA for children aged 4-8 years and women aged 19-30 years**

| | *Unit* | *Landrace M01* | *Landrace M02* | *Hybrid GRH* | *Hybrid GOH* |
|---|---|---|---|---|---|
| Proteins | % RDA 4-8y[2] | 0.85 | 0.85 | 0.85 | 0.76 |
| | % RDA 19-30y | 1.5 | 1.5 | 1.5 | 1.3 |
| Phosphorus | % RDA 4-8y | 42 | 43 | 50 | 52 |
| | % RDA 19-30y | 43 | 44 | 52 | 54 |
| Potassium | % Al 4-8y[3] | 31 | 35 | 45 | 46 |
| | % Al 19-30y | 37 | 41 | 52 | 54 |
| Calcium | % RDA 4-8y | 301 | 266 | 470 | 477 |
| | % RDA 19-30y | 347 | 308 | 406 | 716 |
| Magnesium | % RDA 4-8y | 355 | 302 | 1006 | 1040 |
| | % RDA 19-30y | 217 | 184 | 614 | 635 |
| Sodium | % Al 4-8y | 0.6 | 0.45 | 1.5 | 1.6 |
| | % Al 19-30y | 0.7 | 0.52 | 1.7 | 1.9 |
| Zinc | % RDA 4-8y | 69 | 69 | 111 | 97 |
| | % RDA 19-30y | 89 | 89 | 95 | 82 |
| Copper | % RDA 4-8y | 67 | 67 | 67 | 67 |
| | % RDA 19-30y | 58 | 58 | 58 | 58 |
| Manganese | % Al 4-8y | 546 | 520 | 973 | 1047 |
| | % Al 19-30y | 679 | 628 | 1172 | 1255 |
| Iron | % RDA 4-8y | 85 | 92 | 115 | 108 |
| | % RDA 19-30y | 200 | 212 | 275 | 262 |

[1] 90g cooked leaves of bottle gourd and pumpkin for young children and 130g cooked bottle gourd leaves and pumpkin using a yield factor of 1.3 from raw to cooked.
[2] RDA= recommended dietary allowance – average daily dietary intake level that is sufficient to meet the nutrient requirement of nearly all (97-98%) health individuals in a particular life stage and gender group. (Institute of Medicine 1997)
[3] Al= adequate intake used when there is inadequate evidence to set and EAR and calculate an RDA. Al is a recommended intake value that is assumed to be adequate (Otten et al. 2006; Ross et al. 2011).
[4] ND= not determined

This may also be due to the fact that hybrid varieties have been bred to produce higher amounts of nutrients and differences may also be attributed to species differences. For example, Aluru et al. (2008) observed the production of high levels of provitamin A carotenoids to combat vitamin A deficiency in rice as a result of several years of intensive research. A study by Pillay et al. (2014) to compare provitamin A-biofortified maize varieties with unfortified white maize observed similar trends. In this paper, provitamin A carotenoid content ranged from 7.3-8.3 μg/g dry weight (DW), with total β-carotene ranging from 3.5-3.6 μg/g DW, and β-cryptoxanthin from 3.7- 4.8 μg/g DW, whereas no carotenoids were detected in the white maize variety. With respect to sequential harvesting of the leaves, the analysis of the results found variations in nutrient content over time depending on the type of nutrient in question. Although notable inconsistences were observed for different nutrients over time, it was evident that high nutrient content can be attained 39 days after transplanting and before flowering, because the crop flowers around 50 DAP. These results were similar to those obtained by Modi (2007) where the amaranthus species in the early stage of crop development was observed to contain appreciable amounts of plant nutrients. In the early stages of plant growth and development, leaves are more of sinks than sources of nutrients. However, other phenological stages like flowering and fruit development may affect the source-sink relationship. Older leaves may act as a source of nutrients for the developing of floral structures and fruits (Venkateswarlu and Visperas 1987). From a human and animal nutrition perspective (Tanumihardjo 2015; Ayusoa et al. 2015), these results could mean that bottle gourd should be harvested during the early stage of crop development before the onset of the flowering period to attain highest nutrients in the leaves. However, since the leaves of the crop are mixed with young immature fruits, this stage is usually compromised and leaves are consumed after flowering and fruit development.

Lower protein content observed in this paper was contrary to that observed by Schönfeldt and Pretorius (2011) in Cucurbita maxima. This was also in disagreement to the findings by Langenhoven et al. (1991), Kruger et al. (1998), and Njume et al (2014) who observed higher amounts of protein in locally grown leafy vegetables compared to their commercially produced counterparts. Differences observed in protein and other nutrients could be attributed to natural variations in growth factors, growth development stages and redistribution between new, developing and developed leaves. The variation of nutrients observed in different studies may also be associated with handling and processing after harvesting and different methods used in nutrient quantification (Gupta et al. 2005). As such, van Jaarsveld et al. (2014) advised that nutrient comparison should be interpreted with caution. In addition, higher amounts of certain nutrients do not imply that they are bioavailable, especially in older leaves because they may be associated with anti-nutrients such as oxalates and phytates, which reduce their bioavailability (Fincham et al. 1986; Njume et al 2014).

Furthermore, the crop (bottle gourd) was shown to contribute an appreciable amount of the RDA for most nutrients. This suggests that bottle gourd has the potential to contribute in meeting the RDA for nutrients in vulnerable populations such as children and women, especially those living in rural areas with access to the crop. Contrary to this study, van Jaarsveld et al. (2014) reported a lower contribution to the RDA for iron in both life stage groups (children 4-8 years old and adult females 19-30 years old) in pumpkin leaves. According to van Jaarsveld et al. (2014), a large variation of iron content in leaves could be due to soil contamination and this should be interpreted with caution. In their study, the leaves were meticulously soaked and washed with several changes of water before the samples were homogenized, while in the current study leaves were freeze-dried after harvest without washing.

## CONCLUSION

Bottle gourd contains most of the nutrients required for human health. Bottle gourd was found to contain high amounts of iron, zinc and calcium, which are known to be associated with deficiency in the rural populations of South Africa and Africa. Since the nutrient content in the crop did not decrease with time, it may have the potential to be a valuable crop to achieve food security throughout the growing season. The crop was also shown to meet the RDA for most nutrients that are poorly consumed by individuals living in rural areas.

## RECOMMENDATIONS

The findings of this study suggest a need to recognise bottle gourd as a vegetable crop with nutritional composition required for human health. It is recommended that further studies should be undertaken to obtain more detailed nutritional composition data, including vitamin A and antioxidants.

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