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VITAMIN A-RELATED POTENTIAL OF WILD EDIBLE PLANTS IN A SCHOOL VEGETABLE GARDEN: A CASE STUDY FROM NORTH-WEST PROVINCE, SOUTH AFRICA

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OPSOMMING

Teen die agtergrond van swak vitamien A-status in Suid-Afrika, die Nasionale Skoolvoedingbeleid en toenemende belangstelling in die rol van eetbare wilde plante in mensvoeding, was die doel van hierdie gevalstudie om die potensiaal van die bevordering van eetbare plante as ‘n bron van vitamien A binne ‘n skoolgroetetuin te verken. Die spesifieke doelwitte was om die volgende in ‘n landelike middelskool (grade 7-9) in Noordwes Provinsie te beskryf: die voedingimplikasies van huidige groetetuinpraktyke van die omliggende gemeenskap; die antropometriese status en inname van vitamien A-ryke voedsels van leerders; faktore wat die inname van Vitamin A-ryke voedsels deur leerders beïnvloed; en die leerders se bewustheid en inname van eetbare wilde plante, sowel as die gewildheid van die plante onder die kinders.

‘n Gemengde metode benadering in vier paralelle sub-studies is gevolg tydens die rëenseisoen van 2007. *Groentetuinpraktyke* in die gemeenskap is bepaal deur middel van woord- en beeld-data wat tydens gestruktureerde onderhoude ter plaatse met toesighouers van elf omliggende tuine verkry is. Die vitamien A-inhoud van gewasse is bereken. In die gemeenskap het geelwortels en spinasie huidig die potensiaal om vitamien A-inname te verbeter. Hoogte, massa en geselekteerde dieetinname-data (aangepaste Helen Keller Vraelys) van 80 sistematies gekose leerders is gemeet ten einde hul *antropometriese status* en *dieet* te beskryf. Veral ondervoeding is aangeteken, en geen voedselbron van Vitamin A is gereeld deur ‘n wesenlike persentasie leerders ingeneem nie. Fokusgroep-besprekings (n=7; agt leerders per groep) het die *faktore wat leerders se inname van geselekteerde vitamien A-ryke voedsels beïnvloed* uitgelig. Dit het interne (newe-effekte, gesondheidsoorwegings, voor- en afkeure) en eksterne (drukgroep- en gesins-invloede, kultuur, bekostigbaarheid en beskikbaarheid) faktore ingesluit. Bewustheid, inname en gewildheid van vier *eetbare wilde plante* (*Amaranthus*, *Cleome*, *Cucurbita* and *Lagenaria)* is vasgestel aan die hand van ‘n studie-spesifieke vraelys en visuele hulpmiddels tydens groeponderhoude met 85 sistematies gekose leerders, wat in ses groepe verdeel was. Baie van die kinders was bewus van die wilde plante, het weeklikse inname gerapporteer, en het oënskynlik daarvan gehou, met tussen-spesie-verskille.

‘n Vitamien A-verwante impak van eetbare wilde plante in ‘n skooltuin kan nie aanvaar word nie. Die konteks, voedingstatus en faktore wat die leerders se inname beïnvloed, moduleer die potensiaal.

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INTRODUCTION

Relatively little is known about the nutritional status of school-aged children worldwide (Best *et al*, 2010) and in South Africa (Wenhold *et al*, 2007). Nationally representative data show that in young children poor growth and micronutrient deficiencies, in particular compromised Vitamin A status, remain a public health concern, especially in rural, resource-limited areas of the country (Labadarios, 2007; Shisana *et al*, 2013). This compromised nutrition has been confirmed by smaller studies focussing on rural school children, e.g. Jinabhai and co-workers (2001). A considerable portion of the South African burden of disease has been attributed to Vitamin A deficiency (Nojilana *et al*, 2007) and low intakes of fruit and vegetables (Schneider *et al,* 2007). Vitamin A deficiency is associated with increased mortality and morbidity, including increased susceptibility to infections, poor growth and xerophthalmia (McLaren & Kraemer, 2012). Supplementation, fortification and the food-based approach are respectively short, medium and long-term options in the fight against micronutrient deficiencies, including Vitamin A. Animal source foods, dark green leafy vegetables and orange-coloured vegetables and non-citrus fruit are good sources of proVitamin A (predominantly β-carotene) (McLaren & Kraemer, 2012).

Since malnutrition in children of school-going age affects their long-term physical wellbeing and their scholastic achievements, school- and food-based nutrition interventions - particularly in developing countries and those in the nutrition transition - appear intuitively important as one way to break the vicious, intergenerational cycle of poverty. Within the National School Nutrition Programme, the South African government promotes a three-component approach - school feeding, nutrition education and sustainable food production - for addressing the nutrition situation of pupils in vulnerable communities (Department of Education, 2004). Sustainable food production includes school food gardens. Studies in the United States of America and Australia showed that, when part of a nutrition education programme or when implemented at a high level within the school, school gardens were associated with improved fruit and vegetable consumption (Parmer *et al*, 2009; Somerset & Markwell, 2009; Christian *et al,* 2014). In a South African study the adoption of healthy eating recommendations by school children appeared to be hampered by poverty and the associated food insecurity at household level (Oosthuizen *et al*, 2011).

Edible wild plants such as African leafy vegetables attract international and local attention, not only from the perspectives of biodiversity conservation, maintaining socio-cultural traditions and income generation, but also in terms of their role in nutritional wellbeing (Johns & Shtapit, 2004; Bharucha & Pretty, 2010; Maroyi, 2011). Uusiku *et al.* (2010) have documented the nutritional value of African leafy vegetables. Local studies suggest that African leafy vegetables have the potential to contribute to Vitamin A requirements, but that access, availability and uses may differ across geographical regions in South Africa (Faber *et al,* 2010; Van Jaarsveld *et al*, 2014). The inclusion of these vegetables in agricultural systems is also a current interest (Bharucha & Pretty, 2010) and is included in the recommendations of the Second International Conference on Nutrition (ICN2, 2014).

This explorative case study was part of a bigger project that investigated the nutritional value and water use of indigenous crops for improved rural livelihoods, of which a large part focused on the cultivation of African leafy vegetables (Oelofse & Van Averbeke, 2012). Cultivation of amaranth is described in the revised manual on a crop-based approach to address Vitamin A deficiency in South Africa (Faber *et al,* 2013), but we are not aware of any studies reporting the successful cultivation of amaranth in home, community or school gardens. The aim of this specific case study was thus to explore the potential of promoting edible wild plants as a dietary source of Vitamin A through a school-based vegetable garden. In particular, the objectives were to describe: nutritional implications of current vegetable-gardening practices in the surrounding community; anthropometric status and dietary intake of Vitamin A rich foods by pupils in the school; the factors influencing the pupils' intake of foods rich in Vitamin A; and the pupils' awareness and consumption of edible wild plants, as well as their popularity with pupils.

Informed by ecological theory, the school and its pupils were viewed as couched within a community (Khoza, 2013), where a food garden would be a systemic intervention (Ozer, 2007) in the school food environment, and pupils' Vitamin A rich food choices are the result of interdependent factors within the individual pupil and factors in the more external environment, including socio-economics, culture and the physical environment (Story *et al,* 2002). The intention was to ultimately tailor the implementation of a school-vegetable garden to the local context and the Vitamin A-related needs of the school, its pupils and the surrounding community. Edible wild plants were loosely defined as indigenous, indigenised, traditional or African (leafy) vegetables.

METHODS

The setting was a rural middle-school (N=247; Number of pupils per grade: grade 7: n=74;

grade 8: n=91; grade 9: n=82; age range 12-18 years) in the Moretele district of North-West province, South Africa. The school principal, citing current school records, indicated that there were in total nine teachers, about 33 pupils per class (in total six classes), and about 56% of the pupils' parents or guardians received social security grants or pensions. Physical facilities included limited piped water, cabled electricity, flush toilets (with many not working), a brick building with cement floors, municipal waste disposal and a community-owned playground with no lawn, shaded area or trees. Overall, the premises appeared sub-optimally maintained. The social relationship between the school and the surrounding community was reportedly strained due to vandalism and burglaries to the school.

Four observational sub-studies were each first piloted and then conducted to address the before-mentioned objectives (Figure 1). Four groups (three groups of three and one group of four) of final-year dietetics students carried out the studies based on the given conceptualisation and as part of academic service learning and a capacity-development initiative of the bigger project (Oelofse & van Averbeke, 2012). Data collection took place in late summer (February 2007, i.e. end of rainy season) during school hours. All children enrolled in the school who were present during the week of data collection were included in the various sub-studies. No pupil participated in more than one sub-study. The four studies were conducted simultaneously to reduce interference in school activities. Permission to conduct the study was obtained from the Department of Basic Education. Ethical clearance for each of the sub-studies was obtained from the Faculty of Health Sciences Research Ethics Committee of the University of Pretoria (Approval numbers: S4/2007; S5/2007; S6/2007; S7/2007). Written informed consent and written assent were obtained from the parents and children respectively. Feedback about the results was given to the authorities (tribal, municipal and provincial departments of health, education and social services, and school) and the community, including the pupils, in writing and during public meetings.

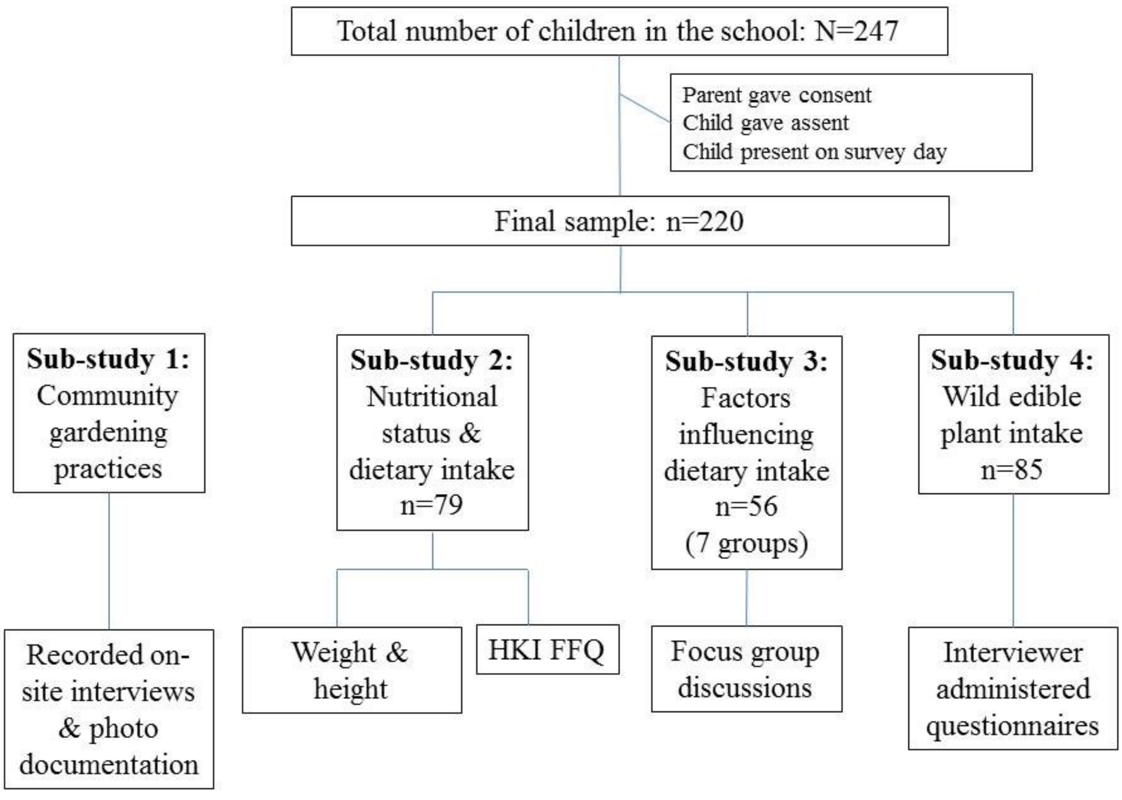

FIGURE 1: OUTLINE OF THE STUDY DESIGN AND SAMPLE

Current gardening practices

Conversational (converted to text)- and image-based (photographs) data were collected during structured on-site interviews with the supervisors of one community garden, one school garden of a neighbouring school and nine home gardens in the vicinity of the school, as identified by a community leader. The interviews were audio-recorded. In addition, field notes were taken at each site to determine what was harvested in each garden. The audio-recordings were transcribed and content analysis was performed. The Vitamin A content of the harvested crops was calculated using the South African food composition tables (Wolmarans *et al,* 2010). The information was summarised in a contingency table.

Nutritional status and dietary intake

Eighty children (38 boys, 42 girls) were systematically sampled from the school register. Their nutritional status was anthropometrically described. Weight and height were measured using a digital Tanita solar scale and a custom-made stadiometer respectively, and following standard techniques (Lee & Nieman, 2013). One fieldworker (final year dietetics student) only took one type of measurement. Each measurement was taken at least twice. If readings differed by more than a pre-determined amount, a third measurement was taken in accordance with good anthropometric practice. For the analysis reference data for children 5-19 years (AnthroPlus software) was used (World Health Organization 2007).

The Helen Keller Institute Food Frequency Questionnaire (HKI FFQ) (Rosen *et al,* 1993) guided the dietary assessment. It was adapted to local habits using the developers' instructions. The HKI FFQ is in essence a single question: *"How many days, in the past seven days, did you eat… [list of food]*?". The questionnaire was fieldworker administered individually in a private setting. Pictures of foods were shown to the pupils to make sure they understood what was meant. In the presentation of the frequency of intake, 1 or 2 days, 3 or 4 days, and 5 or more days were collapsed. Although the HKI FFQ is no longer used as an assessment tool for determining community risk of Vitamin A deficiency (McLaren & Kraemer, 2012), it remains useful for identifying levels of consumption of Vitamin A-rich foods, guiding programme planning and determining changes in intake.

Factors affecting intake of Vitamin A rich foods

For exploring the factors that influence the pupils' intake of Vitamin A-rich foods, this sub-study was guided by the ecological model of Jerome (Story *et al.,* 2008). Since we wanted a generalised sample representing the whole school, probability sampling by stratified random sampling was employed. Eight names were randomly selected from each of the classes. A set of A6 size photographs of six Vitamin A rich foods (milk, liver, hard margarine, spinach, butternut and carrots) was compiled of various forms of the foods (e.g. raw and cooked spinach) so as to aid food identification. Seven focus group discussions were conducted. These started with an ice breaker activity followed by the key questions ("*Which one is your favourite and why? Which one is your least favourite and why? Do you like 'food 1'? Where do you get 'food 1' from? Do you always have 'food 1' at your home? Will you eat 'food 1'at school and why?*") until saturation was reached, where after the next food was discussed. One member of the research team acted as moderator, one as assistant moderator and two were field-note takers. The focus group discussion was audio-taped.

For the data analysis regularities were firstly identified, followed by the data making, according to which two fieldworkers separately each compiled a transcript. These transcripts were combined with the field notes and finalised during a discussion until all four fieldworkers were satisfied (Kruger & Gericke, 2002). The transcribed data were reduced by two pairs of separated fieldworkers coding the data into eight sample units (i.e. the following factors: side effects, health reasons, like, dislike, peer- and family influence, culture, affordability, availability). Consensus was used to finalise the inferred categorisation. Trends were identified using content analysis.

Awareness, consumption and popularity of edible wild plants

Guided by the South African Agricultural Research Council a pilot investigation including ten edible and locally available wild plants was conducted. This was reduced to four crops (*Amaranthus* [amaranth], *Cleome* [spider plant], *Cucurbita* [wild pumpkin] and *Lagenaria* [bottle gourd]) in the final assessment involving a systematically sampled group of 85 pupils (34 girls). A study-specific questionnaire was used in six group sessions (each 12-20 pupils), supplemented by visual aids to determine awareness (photograph recognition and naming according to a list of words provided by the Agricultural Research Council and verified by local informants), popularity (5-point Likert scale with smiley faces; pretested) and consumption (bean bag portion size estimation aids) of each of the plants. Descriptive statistics were used to summarise data. For reporting the consumption, only data from children who had appropriately identified a plant were considered.

RESULTS

From the 247 pupils on the school register a total of 220 (89%) were present during the study, had parental consent, had assented and hence participated.

Gardening practices

Table 1 summarises the vegetables that were harvested in the various gardens visited, as well as the theoretical Vitamin A content of the most commonly reported portion size, ranked from highest to lowest. On the basis of the mode portion size, orange sweet potato, carrots, pumpkin, and spinach were the highest sources of Vitamin A among the vegetables harvested from the gardens.

The most commonly planted vegetable was spinach. It took up most of the space in 55% of the gardens. Spinach was reportedly available throughout the year, grew well, is a relatively small plant with a high harvest index (percentage of plant that is edible), and allows for repeated harvesting, thus increasing the quantity of edible vegetables and nutrients per gardening area. It was preferred by most of the community members and was consumed in portion sizes that provided a fair amount of Vitamin A. The frequency of consumption varied from once a month to daily consumption. It was mostly consumed about one to three times per week.

Carrots were planted in eight of the vegetable gardens, but did not take up large proportions of these gardens. It is a however a whole-year crop. It was consumed at least once a week and done so in portion sizes that provided the second highest amount of Vitamin A from the vegetables harvested.

Taking into consideration the Vitamin A content of the harvested vegetables, frequency of consumption, mode of reported portion size, duration of availability and proportion of garden

TABLE 1: VEGETABLES HARVESTED AND THEIR CALCULATED VITAMIN A CONTENT

Vegetable	Number of gardens planting the vegetable at the time of the survey			Portion (g)[1]	Vitamin A (µg RE)	
	Community garden (n=1)	School garden (n=1)	Home gardens (n=9)		Per 100g[2]	Per portion[3]
Orange sweet potato (cooked)	0	1	3	110	2182	2400
Carrots (cooked)	1	1	6	75	2880	2160
Pumpkin, (cooked)[4]	0	0	3	210	213	447
Spinach (cooked)	1	1	9	90	342	308
Tomato (raw)	1	0	5	100	39	39
“Mielies” i.e. maize (cooked)	0	0	3	135	22	30
Green beans (cooked)	1	0	4	65	25	16
Chillies (raw)	0	0	1	3	228	7
Lettuce (raw)	0	1	1	20	15	3
Cabbage (raw)	0	1	2	40	7	3
Beetroot (cooked)	1	1	6	45	5	2
Green pepper (raw)	1	0	1	3	36	1
Onions (raw)	1	1	1	4	0	0
Butternut (cooked)	0	1	1	-	332	-

[1] based on the mode value
[2] In the South African food composition tables a conversion factor of 1 RE = 6 µg β-carotene is used (Wolmarans *et al*, 2010)
[3] based on the portion size mode
[4] group value for pumpkins (code 4164 in Wolmarans *et al* (2010)

used for planting the vegetable, both locally planted spinach and carrot were judged as having the potential to contribute towards dietary Vitamin A requirements. Lack of reliable water, pests and hard workload were mentioned as barriers to gardening.

Nutritional status and dietary intake

The nutritional assessment was performed on 79 pupils (46.8% girls; aged 12-18 years; mean age: 13.9±1.5 years). Table 2 gives an overview of the anthropometric findings. Among the boys the percentage with low height for age (z-score < -2 denoting stunting) and low body mass index for age (indicative of thinness) was higher than among the girls. While none of the boys had a body mass index for age z-score above +2, this was the case for about 5% of the girls, suggesting the emergence of overweight among the girls.

Table 3 indicates the number of days per week children reported eating the foods listed on the

TABLE 2: ANTHROPOMETRIC STATUS OF GRADE 7 TO 9 PUPILS, AGED 12 TO 18 YEARS

Anthropometric indicator		Boys (n=42)	Girls (n=37)	Total (n=79)
Height for age	Percentage < -2 z-scores[1]	4,8	0,0	3,8
	Mean z-score±SD	-0,27±1.25	-0,04±0.99	-0,16±1.14
Body mass index for age	Percentage < -2 z-scores[2]	21,4	10,8	16,5
	Percentage >2 z-scores[3]	0,0	5,4	2,5
	Mean z-score±SD	-0,94±1.22	-0,25±1.44	-0,62±1.36

[1] stunting
[2] thinness
[3] overweight

TABLE 3: FREQUENCY OF CONSUMPTION OF SELECTED FOODS FOR GRADE 7 TO 9 PUPILS (N=79)

Food	Number of days eaten per week							
	Never		1 or 2		3 or 4		5 or more	
	n	%	n	%	n	%	n	%
Maize meal porridge[1]	4	5,1	7	8,9	7	8,9	61	77,2
Bread[1]	1	1,3	12	15,2	17	21,5	49	62,0
Samp[1]	38	48,1	31	39,2	5	6,3	5	6,3
Milk[1,3]	12	15,2	35	44,3	16	20,2	16	20,2
Eggs[1,3]	21	26,6	27	34,1	16	20,2	15	19,0
Peanut butter[1]	11	13,9	26	32,9	11	13,9	31	39,2
Chicken[1]	2	2,5	35	44,3	19	24,0	23	29,1
Liver[1,3]	47	59,5	21	26,6	7	8,7	4	5,1
Beef or pork[1]	32	40,5	30	38,0	10	12,6	7	8,9
Dry beans[1]	31	39,2	37	46,8	7	8,9	4	5,1
Cooked in/with oil[1]	8	10,1	23	29,1	13	16,4	35	44,3
Margarine[1]	10	12,7	19	24,0	13	16,4	37	46,8
Dark green leafy vegetables[2]	15	19,0	39	49,4	15	19,0	10	12,6
Carrots[2]	22	27,9	46	58,2	1	1,3	10	12,6
Mango[2]	15	19,0	38	48,1	15	19,0	11	13,9
Pumpkin[2]	23	29,1	43	54,4	7	8,9	6	7,6
Paw-paw[2]	61	77,2	12	15,2	3	3,8	3	3,8
Orange sweet potato[2]	54	68,3	19	24,0	2	2,5	4	5,1
Apricots[2]	58	73,4	15	19,0	3	3,8	3	3,8

[1] Energy yielding food
[2] Plant source of (pro)Vitamin A
[3] Animal source of Vitamin A
(Red palm oil, cod liver oil, small fish [liver intact] and butter were not consumed)

TABLE 4: CONSUMPTION OF EDIBLE WILD PLANTS BY GRADE 7 TO 9 PUPILS (N=85) WHO CORRECTLY NAMED THEM

CONSUMPTION	*Cleome* (n=57)		*Amaranthus* (n=30)		*Cucurbita* (n=57)		*Lagenaria* (n=24)	
	n	%	n	%	n	%	n	%
How often?								
Daily	10	17,5	9	30,0	9	16.1	5	20,8
Weekly	29	50,9	15	50,0	30	53,6	8	33,3
Monthly	14	24,6	2	6,7	15	26,8	10	41,7
Never	4	7,0	4	13,3	2	3,6	1	4,2
Total[1]	57	100	30	100	56[1]	100	24	100
How much?								
< ½ cup	25	48,1	11	42,3	15	27,3	11	47,8
½ cup	14	26,9	9	34,6	17	30,9	6	26,1
> ½ cup	13	25,0	6	23,1	23	41,8	6	26,1
Total[1]	52[1]	100	26[1]	100	55[1]	100	23[1]	100
When?								
Breakfast	5	9,1	4	15,4	2	3,5	7	28,0
Lunch	10	18,2	7	26,9	27	47,4	9	36,0
Supper	38	69,1	15	57,7	28	49,1	5	20,0
Snack	2	3,6	0	0,0	0	0,0	4	16,0
Total[1]	55[1]	100	26[1]	100	57	100	25[2]	100
From where?								
Bush + fields	2	3,8	0	0,0	1	1,7	1	4,5
Roadsides	1	1,9	2	7,1	0	0,0	0	0,0
Home gardens	39	73,6	24	85,7	34	58,6	19	86,4
Markets	10	18,9	2	7,1	22	37,9	2	9,1
Other	1	1,9	0	0,0	1	1,7	0	0,0
Total[1]	53[1]	100	28[1]	100	58[2]	100	22[1]	100
How obtained?								
Home environment	37	72,5	21	77,8	34	58,6	18	75,0
Buy	11	21,6	6	22,2	24	41,4	6	25,0
Other	3	5,9	0	0,0	0	0,0	0	0,0
Total[1]	51[1]	100	27[1]	100	58[2]	100	24	100
Form in which eaten								
Cooked	11	20,8	11	42,3	38	70,4	17	73,9
Raw	1	1,9	1	3,8	2	3,7	1	4,4
Mixed dishes	41	77,4	14	53,9	14	25,9	5	21,7
Total[1]	53[1]	100	26[1]	100	54[1]	100	23[1]	100
Part eaten								
Leaves	45	86,5	20	76,9	20	33,9	3	13,6
Stems	2	3,9	1	3,8	3	5,1	0	0,0
Roots	2	3,9	1	3,8	2	3,4	3	13,6
Fruit	2	3,9	0	0,0	30	50,8	16	72,7
Flowers	0	0,0	4	15,4	1	1,7	0	0,0
Seeds	1	1,9	0	0,0	3	5,1	0	0,0
Total[1]	52[1]	100	26[1]	100	59[2]	100	22[1]	100

[1] Totals per plant less than the given n due to missing data.
[2] Total per plant more than the given n due to children marking more than one option

HKI questionnaire. The staple foods, maize meal porridge and bread, were the most frequently consumed items and these were consumed by 77.2% and 62.0%, respectively, on at least 5 days per week. Both maize meal and bread are fortified with Vitamin A in South Africa, as per legislation. Margarine (enriched with Vitamin A), foods cooked in or with oil, and peanut butter were eaten eat least on 5 days by 39.2 – 46.8% of children. Liver and beef/pork were never eaten by 59.5% and 40.5%, respectively. Dark-green leafy vegetables and mango were the only two plant sources of Vitamin A that were eaten on at least three days per week by >30% of children; while 10-20% ate carrots and pumpkin on at least three days per week. More than two-thirds of the children reported that they had not eaten paw-paw, apricots and orange sweet potato in the week preceding the survey.

Factors affecting intake of Vitamin A rich foods

The data analysis of the focus group discussions revealed that intake of foods rich in Vitamin A was influenced by internal and external factors. The internal factors included side effects (physiological consequences - "…*it is not healthy, because it makes me feel sick*" for liver), health reasons (knowledge of food and nutrition verbalised; for example, "*it fights disease*" for spinach) and likes/dislikes (food preferences based on the taste, appearance, texture, seasoning and food combinations – "…*not tasty, but I will eat it in a salad*" for carrots). The external factors were mainly peer- and family influence (social environment, [I eat it] "…*because my mother makes it like that*" for carrots; "*No! Because the children are going to laugh at us*" for butternut); culture (pattern of knowledge, concepts, values, attitudes, beliefs and traditions that are learned and transmitted between individuals, often from generation to generation – "*It is a food for the weekend*" for carrots and for butternut); affordability (economics - "...*no*…[I don't eat it, because]'*, … sometimes we don't have the money"* for milk and for margarine); and availability (natural environment – "W*e eat it here, they make it on our school*" for liver).

Although the children knew about the importance of eating foods that were a rich source of Vitamin A, it was apparent that it did not necessarily translate into the consumption of these Vitamin A rich foods. Many pupils mentioned a nutrition fact about a specific food (e.g. [it is] "…*healthy for my eyes*" for carrots) and later stated that they did not eat it for other reasons (e.g [it is] "*not tasty, but I will eat it in a salad*" or "…*we don't have a garden*"). Another pertinent finding was that the food culture in the community was reportedly such that intake of specific vegetables (e.g. carrots and butternut) is associated with weekends. Thus greater availability would also not necessarily become evident in more frequent intakes of these vegetables.

Awareness, consumption and popularity of edible wild plants

Most of the pupils (97%) said that they knew *Cucurbita* and 67% of the children could name it correctly, at least in their own language. *Lagenaria* was also quite commonly known (88%), yet about 58% of the children were not able to name it. *Cleome* was known by 78% of the pupils, and about two thirds (67%) named it correctly. Fewer children (62%) claimed knowing *Amaranthus* when looking at the photograph showing the plant and only 35% could provide an acceptable name.

Aspects of the consumption of the four plants are summarised in Table 4. The table shows that among those pupils who were able to appropriately name the plants, most ate them weekly, mostly less than half a cup per occasion, typically in the evenings, and sourced from the home environment. The plants were cooked or part of mixed dishes, and in the case of *Cucurbita* and *Lagenaria* the fruits as well as the leaves were eaten. *Cleome* was most popular (90% chose the smiley faces linked to "like a lot" or "like"); for *Cucurbita*, *Amaranthus* and *Lagenaria* these values were 87%, 86% and 74% respectively.

DISCUSSION

The high prevalence of Vitamin A deficiency in South Africa (Labadarios *et al*, 2007; Shisana *et al*, 2013), the nutrient content of traditional leafy vegetables (Van Jaarsveld *et al*, 2014; Uusiku *et a,.* 2010), the emphasis of sustainable food production in school nutrition in South Africa (Department of Education, 2004), and the current interest in traditional crops in human nutrition (ICN2, 2014) prompted this investigation into the potential of promoting edible wild vegetables as a dietary source of Vitamin A in a school garden. With the use of an ecological approach and acknowledging the role of the external environment on children's food choices (Story *et al*, 2002), as well as previous findings that availability may be associated with children's vegetable and fruit intake (Pearson *et al*, 2008), a multi-method approach was used.

The children who were able to name the edible wild plants were reportedly regular consumers of them (about once a week). The survey was conducted in late summer (February) in a summer rainfall area. Seasonal variability in the availability of wild plants has been documented (Faber and Laubscher, 2008), with summer being the period of abundance. Promoting edible plants in combination with a variety of warm weather and cool weather crops could contribute towards year-round availability of affordable vegetables and fruit in rural communities, including Vitamin A rich vegetables. This is particularly relevant in rural areas where Vitamin A-rich vegetables and fruit are not always available in local shops (Faber & Laubscher, 2008). A promotion of this nature could simultaneously have a socio-cultural impact through strengthening indigenous knowledge systems and conserving biodiversity (Bharucha & Pretty, 2010; Johns & Shtapit, 2004).

In terms of the crops that were locally planted, spinach and carrots emerged as currently having the potential to contribute to Vitamin A intake. Pumpkin, butternut and orange sweet potato all are good sources of Vitamin A, but period of availability, portion of garden allocated to the crop and/or frequency of consumption were rather low. In order to meaningfully contribute towards Vitamin A requirements, local production of these crops should be increased through either home-, community- and/or school gardens. In addition, increased consumption should be promoted, for example in the school curriculum. Good planning, management and sustained commitment; applying available knowledge (Faber *et al,* 2013) and taking note of documented challenges, e.g. generational challenges in terms of attitudes towards gardening (Moller, 2005) are important.

Although this study focused on Vitamin A rich crops, other locally produced crops should not be disregarded as these crops can contribute towards dietary intake of nutrients such as fibre and vitamin C. They will also favourably affect dietary diversity, which was shown to be associated with nutritional adequacy of the diet (Steyn *et al,* 2006) and contribute towards achieving the minimum daily consumption of 400g of vegetables and fruit, as recommended by the World Health Organization (1990). The role of the school garden in addressing food and nutrition insecurity in the school and community should be emphasised through a broad nutrition and wellness promotion. This promotion should focus on strengthening existing health-promoting knowledge, attitudes and practices about Vitamin A intake and healthy nutrition and, at the same time, take cognisance of dietary variety and balance. The school feeding component of the National School Nutrition Programme and the inclusion of fortified foods in these meals are pertinent in this regard. On the other hand, the prevention of dietary risk for the development of non-communicable diseases should also be kept in mind, against the backdrop of the emergence of childhood obesity in South Africa (Armstrong *et al*, 2006) and the observation that about 5% of the girls in the school were already affected. The primary problem was, however, undernutrition, as evidenced by low body mass indices for age, particularly among boys, even though the statistical significant hereof was not tested.. Contrary to national trends among younger children (Labadarios et al, 2007; Shisana et al, 2013), not a major portion of pupils in this school were stunted. The co-existence of considerable under- and emerging overnutrition, as well as differences across the sexes emphasises that one intervention would not be appropriate for all children. This has been noted previously (Jinabhai *et al*, 2007). Food-based approaches are one of numerous strategies to address sub-clinical Vitamin A deficiency. In this setting this could be guided by the observed infrequent intakes of foods rich in Vitamin A.

Children were aware of edible wild plants, and Vitamin A rich vegetables and fruit were planted locally to some extent. Promoting production and/or consumption of these foods through a school garden would therefore build on and strengthen existing practices. It should be kept in mind, however, that Van der Hoeven *et al* (2015) were unable to demonstrate improved serum retinol among 6-12 years old school children when they included an African leafy vegetable dish - consisting mainly of *Amaranthus* - in the school menu. School vegetable gardens can be considered to be part of the food and nutrition environment of a school. In a study including 90 schools, Faber and co-workers (2014) concluded that South African school food environments have much scope for improvement when healthy eating and good nutrition are the outcomes of interest. School gardens as ecological interventions have the potential to strengthen the school environment as a whole and yield long-term benefits, well beyond the individual pupil and his/her health (Ozer, 2007). Guitart *et al*. (2014) argue that school gardens that have high agro-biodiversity expose children to a healthy range of vegetables and fruit. Garden-based interventions have the potential to promote increased vegetable and fruit intake among children (*Christian et al*, 2014; Davis *et al,* 2015; Robinson-O'Brien *et al*, 2009). Opportunities that exist for garden-based learning (Hazard *et al*, 2011) appear to be largely unexplored and under-researched in South Africa.

Schools provide a setting where healthy eating habits in the youth can be fostered, because schools are natural learning environments where the children regularly convene, are exposed to teachers with pedagogical expertise, and have ample opportunities for peer interaction. The pupils were socially concerned with the opinions of their peers regarding the intake of certain foods. Peer influence as a factor was noted in the pupils' responses where they spoke about "we" and "us" when answering the questions. Some of the factors influencing fruit and vegetable intake as identified in this study were similar to those highlighted by Kroner and co-workers (2011), yet many were unique to the local setting. Garden-based, experiential learning and the use of garden produce – including edible wild plants – in school feeding would be a pedagogically meaningful opportunity unique to school gardening. School food service policies in this regard, including supporting local farmers can enhance the fruit and vegetable environment of school children (Bundy *et al*, 2012; Ganann *et al,* 2014).

From a research perspective there is a need for well-documented, objective analyses of what works, specifically in terms of school food gardens as part of multi-component school-based interventions for good nutrition (van Cuawenberghe *et al,* 2010; McCormack *et al*, 2010; Christian *et al,* 2014;). Even though the data reported here are not recent, the findings may contribute to local understanding of the factors playing a role when linking a school garden to nutrition, including Vitamin A-status. A social ecological-transactional perspective of human development places the school child in specific environments (the school, family, community), all of which interact with each other, thereby shaping not only the child, but also these environments. In the conceptualisation by Ozer (2007) of school food garden programmes, the various components of school gardens (i.e. the garden site and gardening activities, the formal curriculum, and the parent and community involvement) each have more immediate (proximal) and longer-term (distal) effects on the pupil and the school. Unless food gardening projects are viewed and studied holistically and over a longer time, evidence of their full impact will continue to elude us.

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