

Acceptability of a moringa-added complementary soft porridge to caregivers in Hammanskraal, Gauteng province and Lebowakgomo, Limpopo province, South Africa

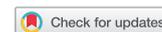
Sithandiwe Ntila^{ab}, Ashwell R. Ndhkala^b, Unathi Kolanisi^c, Hafiz Abdelgadir^b and Muthulisi Siwela^{ab*}

^aSchool of Agricultural, Earth and Environmental Sciences, University of KwaZulu-Natal, Pietermaritzburg, South Africa

^bAgricultural Research Council, Vegetable and Ornamental Plants, Roodeplaat, Pretoria, South Africa

^cDepartment of Consumer Science, University of Zululand, Durban, South Africa

*Corresponding author, email: siwelam@ukzn.ac.za



Objectives: This study determined caregivers' (mothers') acceptability and perceptions of a soft, white maize porridge (traditional complementary food (TCF)) that was modified by substituting maize meal with *Moringa oleifera* Lam. leaf powder at different levels, 1%, 2% and 3% weight for weight (w/w).

Design: A cross-sectional study was conducted.

Setting: The study was conducted in Stinkwater, Hammanskraal, Gauteng province (25° 23' 59.99" S: 28° 16' 60.00" E) and G-Mphahlele village, Lebowakgomo, Limpopo province (24°18'0.83"S: 29°32'33.61"E), South Africa.

Subjects: Sixty mothers were sampled, separately, from Hammanskraal and Lebowakgomo communities.

Outcome measures: The sensory acceptability of the complementary soft porridges was evaluated by caregivers from Hammanskraal and Lebowakgomo communities using a five-point facial hedonic scale ($n = 60$ per study area). A series of three focus-group discussions were conducted per study area ($n = 12$ persons per group) to assess caregivers' perceptions on the inclusion of moringa in complementary foods.

Results: Sensory evaluation results showed that the acceptability of the two traditional complementary foods decreased as the level of moringa leaf powder increased. Caregivers indicated in the focus-group discussions that moringa-based soft porridges had a bitter taste, which would not be suitable for children. Only the Lebowakgomo modified traditional complementary food (MTCF) containing 1% of moringa was rated similar in overall acceptability to the corresponding TCF (control). Nevertheless, all caregivers expressed willingness to use moringa in complementary foods provided they would be trained on how to process it.

Conclusions: Varying product formulation and processing methods may contribute to increased acceptability of moringa-based foods. Overall, moringa appears to have the potential for use in complementary foods.

Keywords: Caregivers, Complementary soft porridge, Moringa leaf powder, Sensory evaluation,

Introduction

The World Health Organization (WHO) recommends that children be fed nutritious and safe complementary foods after six months of life to achieve optimal growth and development.¹ Unfortunately, a review of dietary surveys of the South African population from 2000 to 2015 revealed that most rural households had limited dietary diversity.² Caregivers have been reported as relying on white maize, together with energy-rich ingredients, such as sugar and margarine, when preparing complementary foods.^{3–5} This is primarily due to the fact that most families, especially in rural areas, cannot afford diversified diets.⁶ Unfortunately, cereal grains are limited in several nutrients, including protein and micronutrients; hence the high rates of child malnutrition in rural areas of South Africa.⁷ The consumption of cheaper complementary foods with a longer stomach-filling effect such as white maize meal and sugar resulted in severely food insecure and underweight children in Limpopo and Gauteng provinces.⁸ Children in Limpopo province, Lebowakgomo (87%) and Gauteng province, Hammanskraal (78%) were reported to be severely food insecure. Additionally, Lebowakgomo children (23.6%) and Hammanskraal children (17.9%) were severely underweight.

In South Africa, interventions aimed at improving food and nutrition security, such as the supplementation programme and dietary diversification, among low economic status populations are not sustainable, as they tend to promote dependency on

government institutions. The Department of Health provides routine and therapeutic doses of vitamin A to children who present clinical signs of vitamin A deficiency and the Department of Agriculture provides agricultural inputs such as seeds to rural communities.⁹ Utilisation of nutrient dense foods that are locally available, affordable and culturally acceptable would be a more sustainable strategy for addressing child malnutrition among low-income, rural communities.¹⁰ The sub-Saharan African region is well endowed with wild and domesticated food plants that have several beneficial properties, including good nutritional and medicinal properties.¹¹

Moringa (*Moringa oleifera* L.) is a plant from the Moringaceae family, which is native to sub-Himalayan tracks of India, Pakistan, Bangladesh and Afghanistan; however, it is now distributed all over the world.¹² Moringa leaves are the most nutritious and have a higher health benefiting potential than other organs of the plant.^{13,14} The leaves are a rich source of minerals, amino acids and proteins, and vitamins, including vitamin A precursors, especially beta-carotene, and various phenolics and alkaloids.^{13–16} Thus, moringa leaves seem a good candidate for incorporation in complementary foods to enhance their nutritional quality. Complementary foods containing moringa could contribute to improving the nutritional status of children in Lebowakgomo and Hammanskraal, especially with regard to alleviation of protein and micronutrient deficiencies. While there are a number

of publications on the origin, morphology and chemical composition of moringa,^{12,14,16} there are scanty published data on the utilisation of moringa to enhance the nutritional value of complementary foods. Similarly, there is scarcity of data on caregivers' perceptions of the use of moringa in complementary foods. The aim of the current study was to assess the acceptability of a soft, white maize porridge (traditional complementary food (TCF)) which was modified by partially substituting maize meal with *Moringa oleifera* Lam. leaf powder.

Methodology

Setting

The acceptability of moringa-added soft porridge samples was tested in two separate communities that are both of *Pedi* ethnic culture; this was found appropriate as environmental factors (agro-climatic conditions and availability of resources, including food resources) and psychological factors (past experiences, attitude, values and beliefs) also play a major role in determining the acceptability of a food product by consumers regardless of its sensory attributes. The communities are located in Stinkwater, Hammanskraal, Gauteng province (25° 23' 59.99" S; 28° 16' 60.00" E) and Ga-Mphahlele village, Lebowakgomo, Limpopo province (24° 18' 0.83" S; 29° 32' 33.61" E), South Africa. In order to gain entry into the communities, the researcher was assigned a community leader who acted as a gatekeeper and assisted with organising of study participants and venues for the meeting. The criteria for including participants in the study was that they were caregivers of children aged 7–12 months, were easily accessible and willing to participate in the study. Caregivers from the communities participated in the focus-group discussions (FGDs) and sensory evaluation as they were responsible for preparing complementary food in the household. The procedures for FGDs and sensory evaluation are described below.

Focus group discussions

A series of three FGDs were conducted per study area to establish the most commonly used complementary food recipes. The other objective of the FGDs was to assess whether or not the participants knew and utilised moringa and to evaluate their perceptions of the inclusion of moringa in complementary foods. The sensory evaluation sessions described below were used to recruit FGDs participants on a voluntary basis and each group was made up of 12 persons. The discussions were facilitated by field workers who were trained in conducting FGDs and fluent in *Sepedi*, the local vernacular language in the study areas. The field workers facilitated the FGDs following a discussion guide consisting of mainly open-ended questions. A digital video camera was used to record the discussion sessions. The recorded data were transcribed into text and main discussion points were translated as verbatim into English by FGDs facilitators, and were then cross-checked by a person who was proficient in both English and *Sepedi*. The discussions revealed that the most common complementary food fed the 7–12-month-old children was soft porridge, which consists of maize meal and water. The most common method of preparation was then used to develop a standardised soft porridge recipe (after two cooking trials). This recipe was used to prepare samples for sensory evaluation.

Preparation of soft porridge samples

Hammanskraal moringa-added soft porridge samples were prepared using white maize meal (Super-sun, Premier manufacturer, South Africa) purchased from local commercial markets around Hammanskraal and moringa leaf powder was

sourced from Phedisanang Moringa project in Hammanskraal. Similarly, Lebowakgomo moringa-added soft porridge samples were prepared using white maize meal (Magnifisan super, VKB milling manufacturer, South Africa), purchased from local commercial markets around Lebowakgomo and moringa leaf powder sourced from Sedikong Sa Lerato Moringa Farm, Limpopo province, South Africa. The two moringa-producing projects were funded by the South Africa Department of Science and Technology (DST) and mentored by the Agricultural Research Council (ARC-South Africa) to comply with the South African Government for Good Agricultural Practices (GAPs).

Fresh moringa leaves were processed into powder at an agro-processing facility at ARC, Roodeplaat, South Africa. Fresh leaves were harvested from 12-week-old plants, uniformly dried in the shade (25 ± 2 °C) for 72 h and then processed into powder. A standard recipe for preparing traditional complementary soft porridge (which did not contain moringa) was sourced from Hammanskraal and Lebowakgomo community and used as a control. The recipe is as follows: 500 ml of water was heated to boiling point and 120 g of white maize meal was combined with 250 ml of water in a bowl to make a smooth paste. The paste was then added to the boiling water and stirred until smooth. The mixture was left to cook for 20 min. To prepare test samples (moringa-added porridges [MAPs]), maize meal was mixed with moringa leaf powder at 1%, 2% and 3% w/w substitution levels. The porridges were prepared on site on the day of the survey by caregivers (mothers) from the study areas. This ensured that the porridges were prepared in the same manner as the study participants (caregivers) normally prepared traditional soft porridges for their children. The women who assisted with processing the soft porridges were excluded from the study investigations related to the porridges they had prepared.

Sensory evaluation

Sixty volunteer black female caregivers (mothers) were recruited from each of the selected communities (communities of Hammanskraal and Lebowakgomo, respectively). The caregivers provided their basic sociodemographic data and evaluated the sensory attributes of soft porridges prepared using ingredients from their respective communities. Prior to the sensory evaluation sessions, a pilot study was conducted using 10 caregivers; these caregivers were excluded from the main study. To reduce bias associated with the labelling of samples, each sample was assigned a unique three-digit code obtained from a table of random numbers. The serving order of the porridge samples was randomised using a table of random permutations of nine. To prevent panellists from influencing each other's responses, the panellists were seated a few metres away from each other and were asked not to communicate during the sessions. Trained research assistants were available throughout the sensory evaluation sessions to assist the study participants when required. All participants were provided with a glass of water, four plastic teaspoons, a serviette, four small dishes containing approximately 12.5 ml of each soft porridge sample (three tests and a control) and five questionnaires (four sensory evaluation questionnaires and one paired preference test questionnaire) written in *Pedi*. The sensory evaluation questionnaires were in the form of a five-point facial hedonic scale (1 = very bad; 5 = very good), to accommodate illiterate individuals and the paired preference test questionnaire required participants to mark with an 'X' the preferred porridge sample.

Data analysis

The Statistical Package for the Social Sciences (IBM SPSS®), version 21 (IBM Corp, Armonk, NY, USA), was used to analyse quantitative data. The data were analysed using descriptive statistics and the Dunnett test ($p < 0.05$). FGD recordings were transcribed and translated into English immediately after each session. The transcripts were then subjected to content analysis, to identify key themes from the discussions. For each theme, supporting verbatim quotes were included.

Results

Sociodemographic data of caregivers

Sociodemographic data indicated that 66% of caregivers from Hammanskraal were in the 17–25 years age category whilst 73.6% of Lebowakgomo mothers were in the 26–35 years age category. In both study areas, only a small proportion of caregivers had acquired employable skills from tertiary education. Consequently, 91.5% of Hammanskraal caregivers and 92.5% of Lebowakgomo caregivers were unemployed. The majority of caregivers from both study areas reported that they received household income of less than R800 per month, which was in the form of government child grants. The FGDs participants did not mention obtaining money from other sources.

Caregivers' perceptions of the use of moringa in complementary foods

Hammanskraal caregivers had limited knowledge on how to use moringa as they had only heard about its benefits from locals in the community (Table 1). On the other hand, caregivers from Lebowakgomo were well informed about moringa and had used it for its various benefits before the current study. Nevertheless, because of the known benefits, caregivers from both study communities expressed willingness to use moringa in complementary foods provided they were well trained on how to process and incorporate it in complementary foods.

Sensory evaluation

Figure 1 shows soft porridge samples prepared at different levels of moringa as an additive to the usual white maize meal and the control. Hammanskraal moringa-supplemented porridges were noticeably greener than those from Lebowakgomo, because moringa leaf powder sourced from Hammanskraal had a strong green colour.

The taste, texture, aroma and colour acceptability of all Hammanskraal moringa-based soft porridges were significantly different ($p < 0.05$) from the control (Table 2), and moringa-based porridges were less acceptable compared with plain porridge. Nevertheless, in Lebowakgomo, taste, texture, aroma and colour acceptability of 1% inclusion of moringa did not significantly affect the overall acceptability of the soft porridge, as it was high and similar to the control.

Discussion

Caregivers from Hammanskraal had limited knowledge on how to use moringa as they had only heard about its benefits from locals in the community (see Table 1). This limited knowledge of the potential benefits of moringa seems to have contributed to the preference for the traditional white maize soft porridge (control) over the moringa-added porridge by these caregivers.

These findings suggest the need for raising awareness and provision of information regarding the nutritional and potential health-promoting properties of moringa as well as training the target communities on how to process and use moringa in foods. Indeed, during the focus-group discussions, the caregivers from Hammanskraal as well as the caregivers from Lebowakgomo indicated willingness to use moringa in foods, including the complementary soft porridges, if they were trained on how to process moringa into suitable foods for children. Further, the caregivers from Lebowakgomo liked the moringa-added porridge more than the caregivers from Hammanskraal, probably because they had become more familiar with moringa, as they had been in the past (before the current study) well informed about the plant and utilised it for its various benefits.

The Lebowakgomo community used moringa leaves as a relish and seasoning in foods for adults; moringa tea was consumed by both adults and babies (aged 1 year or less). However, the tea was diluted with lots of water to decrease the bitterness as that taste was considered unsuitable for children. The study communities believed moringa had healing properties. Due to the perceived healing properties, moringa was used in the purported treatment of several health conditions as indicated in Table 1. Similarly, in Uganda and Nigeria, respectively, moringa leaves were consumed as tea and vegetable relish.^{17,18} In addition, the leaves were used to treat skin diseases, HIV-related symptoms and flu and to boost the immune system.¹⁷ However, these authors did not report on the use of moringa to increase food appetite, revive menstruation after menopause, heal sore feet, boost women's sexual drive and neutralise bile as was reported by caregivers from Lebowakgomo in the current study.

The significantly lower taste acceptability of all moringa soft porridges may be attributed to the bitter taste of moringa, as indicated by the caregivers in the FGDs (Table 1). The use of different ingredients (maize meal and moringa leaf powder) in each study area could have also affected the recipe, hence the different sensory attributes' ratings (Tables 3 and 4). The results suggest that the bitter taste of moringa is retained irrespective of the fact that other ingredients were included in the soft porridge. In addition, it was observed that incorporation of moringa in the soft porridges resulted in unfamiliar odours. Therefore, there is a need to mask the bitter taste and unfamiliar odour of moringa-added soft porridge. This could be achieved through recipe modification, for example by adding fruit extracts or by substituting moringa powder with moringa extracts in the porridges.

The findings indicate that the overall acceptability of soft porridges decreased as the levels of moringa were increased. Only the overall acceptability of 1% Lebowakgomo soft porridge was high and similar to the control. Similarly, other studies have found that samples with the low moringa levels were most acceptable. For instance, rice crackers with up to 2% moringa were as acceptable as the control.¹⁹ Flat noodles with the lowest substitution level (5%) were found to be most acceptable, compared with a higher moringa substitution level.²⁰ A similar case was reported for cookies.²¹ Additionally, high amounts of moringa extracts negatively affected the sensory acceptability of pineapple and carrot juice.²² The decrease in overall acceptability with increasing levels of moringa seemed to be associated with a

Table 1: Caregivers' knowledge, current utilisation and perceptions of incorporating moringa in complementary foods

Question	Study area	Theme	Concept	Quotes
Have you heard about moringa?	Hammankraal	Medicinal benefits	Beliefs	'Yes, we have heard that people use moringa to lose weight, controls high blood pressure and helps children with sores in the chest and children who pee at night'
	Lebowakgomo	Medicinal benefits	Beliefs	'Moringa is well known and widely used in this community' 'Moringa is used when children have rash, it is also good for ringworms' 'Moringa can remove stomach cramps, clean the womb to improve fertility, stops menstruation pains, helps stop kids from urinating at night, boost immune system of HIV patients, helps cure flu, energy booster, increases appetite for food, revives menstruation after menopause, neutralise bile, heals sore feet, boost sexual activity of women'
How do you utilize moringa?	Hammankraal	Social aspect	Beverage	'We have never used moringa before as we do not have knowledge of how to use it. We have heard that some mothers add it to water for their children to drink'
	Lebowakgomo	Utilisation	Vegetable	'Moringa is cooked as morogo and consumed as a relish with pap by old people' 'We use moringa when cooking spinach for children aged 6–12 years'
			Beverage	'Consumed as tea by old people and children (1 year or less). We make it to be weak if it is to be consumed by children as moringa has a bitter taste which is not suitable for children'
			Seasoning	'Moringa acts as a unique spice in foods'
Would you use moringa in complementary foods for children?	Hammankraal	Nutrition campaign knowledge and information	Education and training	'If we are well informed about measurements, we can use it for our children as moringa is said to have many benefits'
	Lebowakgomo	Nutrition education	Education and training	'We would love to, but we do not know how to process food with moringa in a way that is suitable for children less than a year old, as these kids do not consume lots of food that we incorporate moringa with'

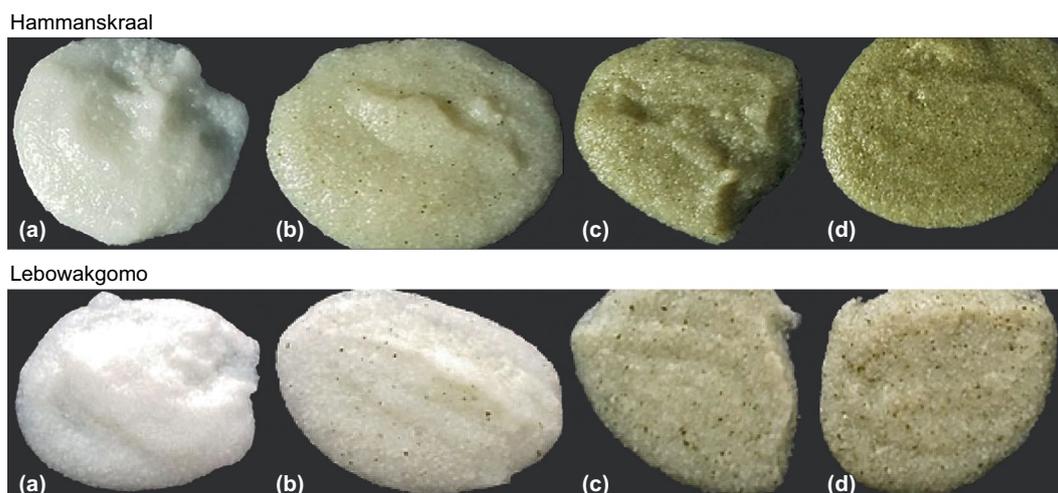


Figure 1: Hammanskraal (A) and (B) Lebowakgomo soft porridges with different levels of moringa leaf powder. Levels: (a) control without moringa –0, (b) 1%, (c) 2% and (d) 3% moringa as an additive to the normal white maize meal.

Table 2: Sensory acceptability of moringa-added soft porridges, compared with soft porridge without moringa (control)

Soft porridge type	Taste	Texture	Aroma	Colour	Overall
<i>Hammanskraal</i>					
Control	3.9 (1.1)	3.8 (1.1)	3.7 (1.1)	3.8 (1.0)	3.9 (1.1)
1% moringa	2.6 (1.2)	2.5 (1.2)	2.8 (1.2)	2.8 (1.3)	2.7 (1.2)
2% moringa	2.5 (1.4)	2.6 (1.4)	2.7 (1.3)	2.8 (1.3)	2.9 (1.4)
3% moringa	3.0 (1.0)	3.1 (1.1)	2.9 (1.0)	3.2 (1.1)	3.0 (1.1)
<i>Lebowakgomo</i>					
Control	3.8 (1.1)	3.7 (1.1)	3.9 (1.0)	4.1 (1.0)	4.1 (1.1)
1% moringa	3.2 (1.1)	3.5 (1.2)	3.7 (1.1)	3.8 (0.8)	3.8 (1.0)
2% moringa	3.1 (1.2)	3.5 (1.2)	3.4 (1.1)	3.6 (1.3)	3.6 (1.1)
3% moringa	3.0 (1.4)	3.1 (1.3)	2.9 (1.2)	3.0 (1.2)	3.2 (1.2)

Notes: Values = mean and standard deviation (in parentheses).

Values in bold are significantly different from the control ($p < 0.05$).

The results from the preference test showed that plain porridge was the most preferred in Hammanskraal while 2% moringa soft porridge was the most preferred in Lebowakgomo (see Tables 3 and 4).

decrease in taste, texture, and aroma and colour acceptability. It is likely that the bitter taste in the moringa-added porridges contributed most to the decrease in the overall acceptability of the moringa-added porridges. Nevertheless, the caregivers in this study indicated their willingness to use moringa in complementary foods provided they were trained on how to process it into foods suitable for children. These findings indicating willingness of the caregivers to use moringa leaf powder in complementary foods suggest that moringa leaf powder could contribute to combating nutrient deficiencies among the children of these communities. Considering the recommended average daily nutrient intake for children, it seems that the nutrients in moringa leaf powder have potential to contribute to the nutritional requirements of children aged 7–12 months. Additionally, a study conducted in Burkina Faso revealed that the use of moringa leaf powder as a dietary supplement was successful in rehabilitating severely malnourished children.²³

Table 3: Percentage of Hammanskraal panellists who gave the different ratings for the sensory attributes evaluated ($n = 60$)

Attribute	Rating	Control	1% Moringa	2% Moringa	3% Moringa
Taste	Very bad	6.7	20.0	30.0	10.0
	Bad	6.7	33.3	33.3	16.7
	Neutral	10.0	23.3	6.7	43.3
	Good	46.7	16.7	16.7	23.3
	Very good	30.0	6.7	13.3	6.7
Texture	Very bad	3.3	23.3	26.7	3.3
	Bad	10.0	30.0	33.3	23.3
	Neutral	16.7	23.3	10.0	43.3
	Good	43.3	20.0	16.7	16.7
	Very good	26.7	3.3	13.3	13.3
Aroma	Very bad	3.3	16.7	20.0	13.3
	Bad	13.3	23.3	26.7	16.7
	Neutral	16.7	33.3	26.7	5.0
	Good	43.3	20.0	16.7	10.0
	Very good	23.3	6.7	10.0	10.0
Colour	Very bad	3.3	13.3	13.3	6.7
	Bad	10.0	36.7	40.0	16.7
	Neutral	10.0	16.7	10.0	40.0
	Good	53.3	20.0	23.3	23.3
	Very good	23.3	13.3	13.3	13.3
Overall	Very bad	6.7	20.0	16.7	6.7
	Bad	3.3	23.3	36.7	26.7
	Neutral	10.0	30.0	6.7	36.7
	Good	53.3	20.0	20.0	20.0
	Very good	26.7	6.7	20.0	10.0
Preference test		60.0	3.3	20.0	16.7

Table 4: Percentage of Lebowakgomo panellists who gave the different ratings for the sensory attributes evaluated ($n = 60$)

Attribute	Rating	Control	1%	2%	3%
			Moringa	Moringa	Moringa
Taste	Very bad	5.0	10.0	8.3	18.3
	Bad	6.7	11.7	31.7	23.3
	Neutral	25	28.3	15.0	18.3
	Good	28.3	41.7	33.3	20.0
	Very good	35	8.3	11.7	20.0
Texture	Very bad	5	5.0	8.3	10.0
	Bad	6.7	8.3	11.7	25.0
	Neutral	25	33.3	20	20.0
	Good	36.7	41.7	43.3	26.7
	Very good	26.7	11.7	16.7	18.3
Aroma	Very bad	1.7	5.0	5	11.7
	Bad	8.3	5.0	13.3	28.3
	Neutral	23.3	30.0	30.0	30.0
	Good	31.7	33.3	33.3	20.0
	Very good	35.0	26.7	18.3	10.0
Colour	Very bad	1.7	3.3	10.0	13.3
	Bad	6.7	1.7	10.0	23.3
	Neutral	11.7	20	13.3	26.7
	Good	38.3	60	40	28.3
	Very good	41.7	15	26.7	8.3
Overall	Very bad	3.3	3.3	5.0	5.0
	Bad	6.7	6.7	8.3	25.0
	Neutral	11.7	18.3	30.0	31.7
	Good	26.7	41.7	26.7	18.3
	Very good	51.7	30	30.0	20.0
Preference test		35	16.7	36.7	7

Conclusion

The findings of the present study indicated that soft porridge containing 1% (w/w) of moringa was as acceptable as the traditional soft porridge (control) to caregivers from Lebowakgomo. The low acceptability of porridge samples containing higher levels (2% and 3%) of moringa was mainly due to their unfamiliar taste and aroma. In Hammanskraal, the control was more acceptable than moringa-added porridges. Unlike caregivers from Hammanskraal, Lebowakgomo caregivers knew moringa and utilised it for its various benefits before this study was conducted. Nevertheless, caregivers from both communities demonstrated willingness to use moringa in complementary foods if they were trained on how to process it into foods that are suitable for children aged 7–12-months; the bitter taste was considered not suitable for children. These findings suggest that moringa soft porridge could be used as a complementary food in the areas of South Africa selected for the current study. The optimisation of product formulation and processing methods may contribute to increased acceptability of moringa-added complementary foods. Further studies should be conducted to evaluate the nutritional quality of moringa-added porridges and their potential for contributing to the nutritional requirements of children. Additionally, the safety of using moringa in complementary foods should be assessed.

Ethical considerations – Ethical approval to conduct the study was obtained from the University of KwaZulu-Natal, Humanities and Social Science Research Ethics Committee (HSS/1244/015D). Approval to conduct the study in Hammanskraal and Lebowakgomo was obtained from Tshwane Municipality and Lebowakgomo Municipality respectively. Written consent was obtained from panellists before their participation in the study; the consent form was read and explained in the preferred language before being signed by the participants. Participants were requested to sign a non-disclosure statement, agreeing to maintain the confidentiality of the information discussed during the FGDs.

Disclosure statement – No potential conflict of interest was reported by the authors.

Funding – This work was funded by Will Keith Kellogg Foundation, University of KwaZulu-Natal, Agricultural Research Council Professional Development Programme, and the Department of Science and Technology-National Research Foundation (South Africa).

References

- World Health Organization. Global database on child growth and malnutrition. 2013. Available from <http://www.who.int/nutgrowthdb.about/introduction/en/index5.html>
- Mchiza Z, Steyn NP, Hill J, et al. A review of dietary surveys in the adult South African population from 2000 to 2015. *Nutrients*. 2015;7:8227–50. <https://doi.org/10.3390/nu7095389>
- Faber M, Benadé AJS. Breastfeeding, complementary feeding and nutritional Status of 6-12-month-old infants in rural Kwazulu-Natal. *SAJCN*. 2007;20(1): 16–24.
- Nuss ET, Tanumihardjo SA. Maize: a paramount staple crop in the context of global nutrition. *CRFSFS*. 2010;9: 417–36.
- Goosen C, McLachlan MH, Schubl C. 2014. Infant feeding practices during the first 6 months of life in a low-income area of the western cape province. *SAJCH*. 2014; 8(2):50–54. <https://doi.org/10.7196/sajch.675>
- Tshabalala ZP. An Assessment of the Impact of Food Access on Children on the Nutrition Supplementation Programme to Combat Protein-Energy Malnutrition [Master's thesis]. University of KwaZulu-Natal; 2014.
- Tathiah N, Moodley I, Mubaiwa V, et al. South Africa's Nutritional transition: overweight, obesity, underweight & stunting in female primary schools in rural Kwazulu-Natal. *S Afr Med J*. 2013;103(10): 718–22. <https://doi.org/10.7196/SAMJ.6922>
- Ntla S, Siwela M, Kolanisi U, et al. An assessment of the food and nutrition security status of weaned 7–12 months old children in rural and peri-urban communities of Gauteng and Limpopo Provinces, South Africa. *Int. J. Environ. Res. Public Health*. 1004;2017: 1–11. doi:10.3390/ijerph14091004.
- Iversen PO, Du Plessis L, Marais D, et al. Nutritional health of young children in South Africa over the first 16 years of democracy. *SAJCH*. 2012a; 5(3):72–77.
- Adedodun MO, Oladoye AO, Olawumi AT, et al. Economic contribution of moringa oleifera (Lam.) plantation of rural livelihoods in monoidi local government area of Niger Republic. *Obeche J*. 2010; 28(2):142–6.
- Mahajan SG, Mali RG, Mehta AA. Protective effect of ethanolic extract of seeds of *Moringa Oleifera* Lam. against inflammation associated with development of arthritis in rats. *J Immunot*. 2007;4(1):39–47. <https://doi.org/10.1080/15476910601115184>
- Fahey JW. *Moringa Oleifera*: a review of the medical evidence for its nutritional, therapeutic, and prophylactic properties. *Trees Life J*. 2005;1: 5.
- Lako J, Trenerry VC, Wahlqvist M, et al. Phytochemical flavonols, carotenoids and the antioxidant properties of a wide selection of Fijian Fruit, Vegetables and Other Readily Available Foods. *Food Chem*. 2007;101(4): 1727–41. <https://doi.org/10.1016/j.foodchem.2006.01.031>

14. Siddhuraju P, Becker K. Antioxidant properties of various solvent extracts of total phenolic constituents from three different agroclimatic origins of drumstick tree (*Moringa Oleifera* Lam.) leaves. *J Agric Food Chem.* 2003;51: 2144–55. <https://doi.org/10.1021/jf020444+>
15. Anwar F, Lotir S, Ashraf M, et al. *Moringa oleifera* a food plant with multiple medical uses. *Phytother Res.* 2007;21: 17–25. [https://doi.org/10.1002/\(ISSN\)1099-1573](https://doi.org/10.1002/(ISSN)1099-1573)
16. Arabshahi-D S, Devi DV, Urooj A. Evaluation of antioxidant activity of some plant extracts and their heat. PH and Storage Stability. *Food Chem.* 2007;100: 1100–5.
17. Kasolo JN, Bimenya GD, Ojok L, et al. Phytochemicals and uses of *moringa oleifera* leaves in Ugandan rural communities. *J Med Plants Res.* 2010;4(9): 753–7.
18. Oyewole MF, Adetoro FT, Meludu NT. Level of acceptability of *moringa oleifera* diversifies products among rural and urban dwellers in Nigeria. *Int J Biol Biomol Agr Food and Biotech Eng.* 2014;8(12): 1341–7.
19. Manaois RV, Morales AV, Abilgos-Ramos RG. Acceptability, shelf life and nutritional quality of *Moringa*-supplemented rice crackers. *Philipp J Crop Sci.* 2013;38(2): 1–8.
20. Abilgos RG, Barba CVC. Utilization of malunggay (*Moringa Oleifera* Lam.) leaves in rice (*Oryza sativa* L.) flat noodle production. *Philipp J Sci.* 1999;128:79–84.
21. De la Mar RA. Polvoron with malunggay: a tickle to taste. *Int J Math Eng Technol.* 2012;2012(2): 109–29.
22. Otu PNY, Saalia FK, Amankwah EA. Optimizing acceptability of fresh *Moringa oleifera* beverage. *FSQM.* 2013;21: 26–33.
23. Zongo U, Zoungrana SL, Savadogo A, et al. Nutritional and clinical rehabilitation of severely malnourished children with *moringa oleifera* Lam leaf powder in Ouagadougou (Burkina Faso). *FNS* 2013;4: 991–7. <https://doi.org/10.4236/fns.2013.49128>

Received: 19-04-2017 Accepted: 04-03-2018