

Consumer awareness and acceptability of bambara groundnut as a protein source for use in complementary foods in rural KwaZulu-Natal

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Objectives: To determine the consumer awareness and acceptability of bambara groundnut as a protein source and to assess its potential for use in complementary feeding.

Design: Cross-sectional study using a mixed-methods approach.

Setting: The study took place at Gcumisa Clinic located at Swayimane, uMshwathi Municipality, in the UMgungundlovu District, KwaZulu-Natal province.

Subjects: Black African female outpatients attending the Gcumisa paediatric clinic participated in the consumer-awareness survey ($n = 70$), consumer-acceptability tests ($n = 64$) and focus-group discussion ($n = 16$).

Outcome measures: Consumer awareness of bambara groundnut and consumer acceptability of pureed samples made from bambara groundnut and common dry bean (reference) were assessed using questionnaires. A focus-group discussion was also held with some of the consumer acceptability test participants.

Results: The survey participants were not familiar with bambara groundnut and its preparation methods. The sensory attributes, including overall acceptability, of the brown bambara groundnut puree compared well with that of the reference. Grain colour significantly influenced overall acceptability of the bambara groundnut puree ($p < 0.05$). Fifty caregivers (71%) expressed willingness to use the bambara groundnut in complementary feeding if it was accessible, affordable, and beneficial to health.

Conclusion: Bambara groundnut is not a familiar legume in KwaZulu-Natal and utilisation is seemingly limited due to poor market availability and knowledge of cooking methods. However, there is potential for its use as a protein source in complementary foods. An improvement in the market availability and nutrition education to highlight the nutritional benefits of bambara groundnut are required to increase utilisation.

Keywords: bambara groundnut, complementary foods, consumer awareness

Introduction

Protein energy malnutrition (PEM) has been reported to be a major cause of deaths in children globally¹ and is a concern in most developing countries.^{2,3} PEM results from an inadequate intake of protein and energy and could manifest as either moderate acute malnutrition (MAM) or severe acute malnutrition (SAM). It is rife among children due to their high energy and protein requirements relative to their bodyweight.⁴ PEM appears more frequently during the weaning period, which is usually between the age of 4–6 months, and leads to growth retardation with increased susceptibility to infectious diseases.⁵

Correct feeding practices can prevent malnutrition and early growth retardation.⁶ Breast milk alone is sufficient to meet the nutritional requirements of infants for the first six months of life.⁷ Beyond six months, infants gradually develop the ability to chew, swallow and digest a wide variety of foods.⁸ Also, breastmilk becomes nutritionally insufficient at this age, and hence the need for complementary foods. Complementary foods are expected to be nutrient dense as infants have a small gastric capacity.⁹ However, in most developing countries, these foods are of low nutritional quality and consist mainly of cereal-based porridges.¹⁰ For instance, Allen¹⁰ reported a high dependence on maize, rice, sorghum and millet for preparing complementary foods in developing countries.

In South Africa, soft porridge made from maize meal seems to be the major complementary food.¹¹ The choice of complementary food is subject to cultural acceptance and affordability, thus

foods with low nutrient density consequently influence the nutritional status of infants and children.¹² Animal food sources, which are expensive, are usually excluded, especially in low socio-economic regions.¹³ From the aforementioned, it is imperative to consider alternative protein food sources to combat PEM. Inclusion of affordable plant proteins, especially legumes, in the diets of vulnerable groups may be one way to achieve this.

Bambara groundnut (*Vigna subterranea*) is a legume indigenous to Africa and grown mainly for its edible grains.¹⁴ It is a rich source of protein (15–28%) comparable to those reported for other legumes like cowpea (19.61%) and pea (23.5%).¹⁵ It has a better methionine profile than most legumes, including soybean, and can serve as an affordable source of protein for population groups vulnerable to PEM, particularly the poor rural populations in countries of the sub-Saharan Africa region, including South Africa.¹⁴ However, bambara groundnut is an underutilised crop, grown in some areas of South Africa, especially rural areas,¹⁶ mainly for subsistence. Its underutilisation can be attributed to its hard-to-cook property and strong beany flavour, as well as gas-forming properties.^{14,17}

It is well-known that the acceptance of a crop as a food source by consumers is dependent on their knowledge of the crop, its processing technologies and its nutritional benefits, as well as availability and cultural acceptability.¹⁸ According to Feldmann and Hamm¹⁸ consumer knowledge of local food influences attitudes and translates into purchasing behaviour.

In this study, the consumer awareness of bambara groundnut as a protein source and acceptability of pureed samples made from bambara groundnut and common dry bean (*Phaseolus vulgaris*) were assessed in rural KwaZulu-Natal.

Study design

This was a cross-sectional study.

Plant materials

The most commonly consumed bambara groundnut landraces (red and brown) in Southern Africa were used in this study. A dry bean (*Phaseolus vulgaris*), commonly consumed in South Africa (Ukulinga dry bean variety), was used as a reference.

Ethics approval

Ethical approval was obtained from the University of KwaZulu-Natal, Humanities and Social Science Ethics Committee (HSS/0740/015D). The UMgungundlovu District issued a supporting letter for the research to be conducted and the Department of Health granted permission for the study to be conducted at Gcumisa Clinic, Swayimane (Reference number: HRKM95/12). A research assistant explained the study to the participants in isiZulu. Participants were required to sign a written consent form before participating in the consumer awareness survey, consumer acceptability tests and focus-group discussions. Written consent was also obtained for the recording of the focus-group discussions.

Methodology

A consumer awareness survey of bambara groundnut as a protein source was conducted and caregivers were requested to suggest complementary foods that could be prepared using bambara groundnut. The suggested complementary food (a puree) was prepared and consumer acceptability tests were conducted using it. This was followed by a focus-group discussion on the suggested complementary food.

Consumer awareness of bambara groundnut

African female caregivers who were outpatients of the paediatric unit at Gcumisa Clinic at Swayimane, UMgungundlovu district of uMshwathi Municipality, participated in the study voluntarily. Third-year students from the Department of Dietetics and Human Nutrition, University of KwaZulu-Natal were recruited as research assistants and trained on the objectives of the study and the procedures to follow when conducting the consumer-awareness survey and the consumer-acceptability tests. Research assistants showed the caregivers the bambara groundnut and explained the study to them, after which a total of 70 volunteers completed the consumer-awareness survey. The volunteers were given the survey questionnaire and were requested to fill it in to test their awareness of bambara groundnut as a protein source. Participants were also requested to identify the complementary foods that they would likely prepare using bambara groundnut. The recipes used to prepare the identified complementary food were obtained from the participants during the survey. The survey results indicated that if participants were to use bambara groundnut to make a complementary food it would be in the form of a puree. A bambara groundnut puree was therefore evaluated for its acceptability for use as a complementary food.

Preparation of complementary food (puree)

A total of five recipes were obtained for preparation of the puree. All the participants who provided recipes suggested that the

bambara grains should be boiled until soft and then mashed until they reached a puree consistency. All five recipes were tested by preparing them in the Food Science Laboratory, University of KwaZulu-Natal, Pietermaritzburg. The recipes were prepared by the researcher and an assistant, a black African woman living in a rural area in the UMgungundlovu District with experience in cooking dry bean puree. This ensured that the samples were culturally acceptable to the participants. After testing the recipes, the one that was most acceptable to the researcher and the assistant was chosen for use in this study. Preliminary trials in the laboratory showed that soaking the grains at room temperature reduced cooking time by approximately 30%. Hence, this was used in the puree preparation. Grains of the two bambara groundnut varieties and the reference dry bean were soaked in 750 ml water for 18 h. Thereafter, the soaked grains were drained and boiled in 2.5 L of tap water for about 150 min and 1 mL of salt was added. It was then cooked on low heat for about 15 min and mashed into a puree using a wooden spoon. No fat sources (margarine, oil or butter), salt or seasonings were added to the puree, as suggested by the participants. Once ready, the samples were transported to the research site in air-tight containers.

Consumer acceptability

The consumer-acceptability test was conducted using 64 black African female caregivers of children under 36 months from the paediatric unit of Gcumisa Clinic at Swayimane in the uMshwathi municipality, UMgungundlovu District, KwaZulu-Natal. The panellists were selected on the basis that they were regular users of complementary foods used to feed children in their care. The panellists were seated some distance from each other in a designated room within the clinic premises and were asked not to communicate during the session. The three pureed samples were assigned a unique three-digit code obtained from a Table of Random Numbers and were served in a random order.¹⁹ Each panellist was provided with a spoon and a cup of water to rinse the palate between samples. Research assistants explained the questionnaire to the participants in isiZulu and illiterate participants were assisted where necessary. Participants were served 15 ml of each sample in a polystyrene cup. The samples were warmed for 15 s on medium heat in a microwave oven before they were served to the panellist. The consumer acceptability of the samples was assessed using a five-point facial hedonic scale²⁰ (1 = very bad and 5 = very good) in terms of taste, texture, aroma, colour and overall acceptability. These attributes were explained to the participants prior to tasting.

Focus-group discussions

Focus-group discussions were conducted in a designated room within the clinic premises to further determine the perceptions of caregivers concerning the use of bambara groundnut puree as a complementary food. A focus-group discussion guide was used to facilitate the discussions. The focus-group discussion guide consisted of brief background information on how the samples they had tasted had been prepared and the identities of the samples. As part of the background, it was highlighted to the participants that, since they were familiar with the common dry bean, they would have correctly identified its puree during testing. They were then informed that they were required to discuss their perception of bambara puree samples relative to the common dry bean puree. The other part of the discussion guide was a set of brief questions for initiating and stimulating the discussions. Sixteen participants were randomly selected from the caregivers

who had volunteered to participate in the consumer-acceptability tests. The participants were divided into two groups of eight. The ideal size of a focus group is between 7 and 12 individuals.^{21,22} The focus-group discussions were facilitated by a research assistant fluent in isiZulu using a structured discussion guide. Some of the discussion-guide questions included whether the participants had cooked or tasted bambara groundnut before, whether it was different from other legumes used and how, whether they would prepare a complementary food from bambara groundnut and the identity of the foods that they would prepare. Other discussion points included whether bambara groundnut was available or not and why, whether they would buy it if it was cheaper than dried beans and whether they would buy it if it had positive effects on their infant's health. The discussions were recorded using a digital voice recorder and stored electronically with passwords to protect confidentiality. A verbatim transcript of the entire discussion was translated from isiZulu to English by the focus-group facilitator and compared with handwritten notes taken during the discussion. Another trained focus-group facilitator translated the discussion from English back to isiZulu to check for accuracy in translation. Data were coded and checked by two independent research assistants. They were then analysed by thematic content analysis (TCA), whereby emerging themes and concepts were established from the coded translated verbatim transcript. TCA was deductive as the identification of emerging themes and concepts was guided by well-accepted concepts of acceptance of a crop as a food,¹⁸ referred to earlier.

Statistical analysis

Quantitative data were analysed using the Statistical Package for Social Sciences (SPSS®) version 19.0 (IBM Corp, Armonk, NY, USA). Statistical techniques including one-way analysis of variance (ANOVA), Fisher's least significant difference (LSD) and linear regression were used to analyse data. A *p*-value of < 0.05 was considered significant.

Results

Consumer awareness of bambara groundnut as a protein source

The number and age of the caregivers in the specific age groups are presented in Table 1. Most of the caregivers were younger than 36 years.

The majority of participants (64%) were familiar with bambara groundnut and had consumed it (61%) (Table 2). Unavailability of bambara groundnut, lack of knowledge on preparation methods and unfounded beliefs that it would cause skin reactions were some of the reasons for not using it. The majority of the participants (91%) were willing to purchase bambara groundnut for its nutritional benefits. A large percentage (93%) of the participants

Table 1: Number and age of caregivers who participated in the survey (*n* = 70) and consumer-acceptability testing (*n* = 64)

Age group (years)	Survey, <i>n</i> (%)	Consumer acceptability, <i>n</i> (%)
16–25	14 (20.0)	19 (29.7)
26–35	33 (47.1)	20 (31.3)
36–45	7 (10.0)	7 (10.9)
46–55	8 (11.4)	9 (14.1)
56–65	7 (10.0)	8 (12.5)
66–75	1 (1.4)	1 (1.6)

Table 2: Consumer awareness of bambara groundnut as a food source (*n* = 70)

Survey questions	<i>n</i>	%
Have you seen it before?		
Yes	45	64.3
No	25	35.7
Have you eaten it before?		
Yes	43	61.4
No	27	38.6
Reasons for not eating it:		
The grains are not available	8	11.4
I do not know the plant	10	14.3
Don't know how to use it	8	11.4
It causes acne	1	1.4
Willingness to purchase if it is more nutritious than common dry bean		
Yes	64	91.4
No	6	8.6
Willingness to purchase if it was cheaper than common dry bean		
Yes	65	92.9
No	5	7.1
Willingness to pay more for bambara groundnut than common dry bean		
Yes	43	61.4
No	27	38.6
Willingness to include bambara groundnut in family cooking		
Yes	64	91.4
No	6	8.6
Willingness to include bambara groundnut in infants' meal		
Yes	50	71.4
No	20	28.6
Survey questions	<i>n</i>	%
Have you seen it before?		
Yes	45	64.3
No	25	35.7
Have you eaten it before?		
Yes	43	61.4
No	27	38.6
Reasons for not eating it:		
The grains are not available	8	11.4
I do not know the plant	10	14.3
Don't know how to use it	8	11.4
It causes acne	1	1.4
Willingness to purchase if it is more nutritious than common dry bean		
Yes	64	91.4
No	6	8.6
Willingness to purchase if it was cheaper than common dry bean		
Yes	65	92.9
No	5	7.1

(Continued)

Table 2: (Continued)

Survey questions	n	%
Willingness to pay more for bambara groundnut than common dry bean		
Yes	43	61.4
No	27	38.6
Willingness to include bambara groundnut in family cooking		
Yes	64	91.4
No	6	8.6
Willingness to include bambara groundnut in infants' meal		
Yes	50	71.4
No	20	28.6

would buy bambara if it was cheaper than the common dry bean. Further, a fairly large percentage (61%) of the participants expressed willingness to pay more for bambara compared with the common dry bean. Some 71% of the participants were willing to include bambara groundnut in infant meals.

Consumer acceptability of bambara groundnut puree

The mean acceptability scores recorded for puree made with bambara groundnut were comparable to that of the reference dry bean (Table 3). However, significant differences ($p < 0.05$) were observed between the bambara groundnut samples in terms of aroma, colour and overall acceptability indicating preference for the brown bambara groundnut variety.

Generally, the overall acceptability of the samples increased with the age of the participants (Figure 1). There was a linear relationship between the colour, acceptability and overall acceptability of the brown bambara groundnut and the reference dry bean, while aroma acceptability was linearly related to the overall acceptability of the red bambara groundnut (Table 4).

Focus-group discussion

Unavailability of bambara groundnut is a major factor affecting its utilisation. Older participants were able to easily identify the grain as *izindlubu* and could describe how it is used. Caregivers who participated in the focus-group discussion said 'soil does change as back in the days it was grown here but now it is not'. Changes in soil and climate conditions and lack of proper knowledge on cultivation techniques were some of the factors said to be responsible for its unavailability. Overall, the caregivers had positive perceptions about the sensory characteristics of the bambara groundnut puree as it was mentioned that 'bambara groundnut seeds were very delicious'. They were willing to feed their children the bambara groundnut puree for its nutritional benefits. The caregivers stated that they could prepare bambara groundnut alongside other foods like *uphuthu* (a stiff porridge made from maize meal),

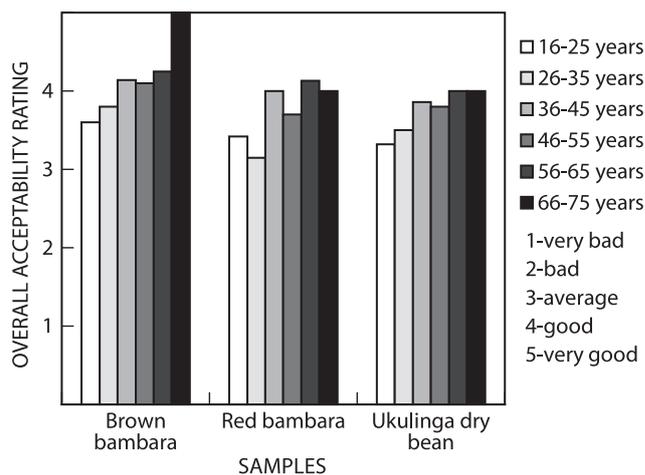


Figure 1: Relationship between age group and overall acceptability of bambara groundnut and dry bean purees (n = 64).

izinkobe (boiled dried mealies) and *samp* (broken maize grain). However, some of the caregivers had concerns about the likelihood that infants could experience gastrointestinal problems if they ate the bambara groundnut puree.

Discussion

In this section the results of the consumer awareness of bambara groundnut as a protein source, consumer-acceptability testing and focus-group discussions are discussed.

Consumer awareness of bambara groundnut as a protein source

This study revealed that bambara groundnut is a less popular legume compared with the dry bean, which is in agreement with previous reports.¹⁴ Unavailability of bambara groundnut and lack of knowledge on nutritional benefits were some of the reasons for its underutilisation. The majority of the survey participants were willing to purchase the grain if it was cheaper and more nutritious than the common dry bean. However, 61% of the participants were willing to pay more for the bambara groundnut than the common dry bean. Neumark-Sztainer²³ also reported that cost, cultural beliefs and health benefits are some of the factors that influence food choices. The participants in this study showed willingness to include the bambara groundnut in infant complementary foods, if it were readily available at grocery stores. Therefore, bambara groundnut could potentially serve as a source of affordable food protein, especially in low socio-economic regions.

Consumer acceptability of bambara groundnut puree

Sensory attributes play a major role in the acceptance of new food products.²⁴ Overall, the sensory attributes of the brown bambara groundnut puree compared well with those of the

Table 3: Sensory acceptability of bambara groundnut and the reference dry bean puree

Puree	Sensory attribute				
	Taste	Texture	Aroma	Colour	Overall acceptability
Brown bambara groundnut	3.80 ^a ± 0.84	3.66 ^a ± 1.02	3.80 ^a ± 0.78	3.73 ^a ± 0.82	3.92 ^a ± 0.80
Red bambara groundnut	3.48 ^a ± 1.02	3.33 ^a ± 1.04	3.39 ^b ± 0.79	3.41 ^b ± 0.83	3.54 ^b ± 1.01
Ukulinga dry bean	3.58 ^a ± 0.85	3.55 ^a ± 0.91	3.59 ^{ab} ± 0.79	3.67 ^{ab} ± 0.67	3.68 ^{ab} ± 0.83

Notes: Mean ± SD. Mean with different superscripts (a or b) along a column are significantly different ($p < 0.05$).

Table 4: Relationship between sensory attributes and the overall acceptability of the bambara groundnut and dry bean puree

Sensory attribute	Standard error	t-stat	p-value*
Brown bambara groundnut puree			
Taste	0.980	6.594	0.000
Texture	0.073	1.268	0.210
Aroma	0.095	2.075	0.042
Colour	0.080	0.168	0.868
Ukulinga dry bean puree			
Taste	0.122	2.600	0.012
Texture	0.122	2.278	0.026
Aroma	0.121	1.963	0.054
Colour	0.121	0.533	0.596
Red bambara groundnut puree			
Taste	0.135	4.201	0.000
Texture	0.134	1.429	0.158
Aroma	0.112	-0.567	0.573
Colour	0.125	0.935	0.353

*Level of significance at $p < 0.05$.

reference bean. This is in agreement with another study in which a highly pigmented bambara groundnut landrace used in making complementary foods also received a lower rating.²⁴ In this study, the reference dry bean was popular among participants and had a colour similar to that of the brown bambara groundnut. The similarity in the colour of the grains may have influenced the preference for brown bambara groundnut over the red bambara groundnut landrace, and is worth investigating further. Age similarly seems to have influenced the overall acceptability of the puree as the preference for the puree increased with increasing age of the participants. This could be due to the fact that the older participants were more familiar with bambara groundnut than the younger participants. Consequently, chances of older caregivers including bambara groundnut in children's diets may be high. It has been reported previously that older caregivers are key determinants of early childhood care patterns, especially in Africa.²⁵ The regression analysis results suggest that the sensory properties of bambara groundnut landraces should be determined, and landraces with more acceptable sensory properties be selected for making bambara groundnut puree.

Perceptions of bambara groundnut as a protein source

Caregivers are important determinants of a child's feeding pattern and may influence the health status of a child. Caregivers who participated in the focus-group discussion identified the changes in soil conditions and unavailability of bambara groundnut as the key factors limiting its utilisation, which is in agreement with previous findings.^{14,17} According to the focus-group discussion participants the use of bambara groundnut in this community had reduced over time due to lack of planting seeds and inadequate knowledge on cultivation practices. Caregivers were willing to include bambara groundnut in their farming system if they had access to viable planting seeds. Caregivers were also willing to include bambara groundnut as an ingredient in the diets of their children. However, they had some reservations with the use of bambara groundnut in complementary feeding as it was stated that 'old people can accept the bambara groundnut but children might have a problem.'

Conclusion

Bambara groundnut is not a popular grain at Swayimane, KwaZulu-Natal province and its utilisation seems to be limited due to poor market availability and lack of knowledge on cooking methods. However, bambara groundnut has the potential to be used as a protein source in infant complementary feeding due to its sensory attributes being comparable to that of the common dry bean. Nutrition education on the nutritional benefits of bambara groundnut and improved market availability may help to improve its overall utilisation.

Recommendations

Agricultural extension programmes are required to encourage cultivation of bambara groundnut. Improved market availability coupled with nutrition programmes to highlight the nutritional benefits of bambara grain are required to improve its utilisation.

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