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Acceptance of a Complementary Food based on Provitamin A-Biofortified Maize and Chicken Stew

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ABSTRACT This study aimed to determine the acceptance of a composite complementary food prepared with provitamin A-biofortified maize and chicken stew by caregivers (n=59) in rural KwaZulu-Natal. Grains of two provitamin A-biofortified maize varieties and a white variety (control) were used as the major ingredient in the composite complementary foods. The sensory acceptability of the complementary foods was rated using a five-point facial hedonic scale. Focus group discussions were conducted in order to assess the perceptions of the selected participants about the composite complementary foods. Sensory evaluation results showed that the acceptability of the complementary foods containing the biofortified maize was similar to that of the control. The subjects had positive perceptions about the taste, texture, aroma and colour of the composite complementary food prepared with the two varieties of biofortified maize. The results suggest that provitamin A-biofortified maize has the potential to replace white maize in complementary feeding.

INTRODUCTION

Malnutrition during infancy and childhood is a global problem and accounts for one third of childhood deaths (UNICEF 2013). Micronutrient deficiencies are on the increase with vitamin A deficiency (VAD) being one of the four micronutrient deficiencies affecting most of the world's population (WHO 2011). The South African National Health and Nutrition Examination Survey (SANHANES-1) of 2013 showed that the national prevalence of VAD was 43.6 percent for children under the age of five years, indicating a severe public health problem with the highest prevalence being amongst the Black African children (45.4%) (Shisana et al. 2013). Some of the strategies implemented to address VAD in South African children are food fortification, vitamin A supplementation and dietary diversity (Van Jaarsveld et al. 2005). Despite the introduction of these interventions, they have not been successful for various reasons (Labadarios et al. 2008; DOH 2012).

Biofortification, which involves increasing the concentrations of target nutrients by conventional breeding, is currently being evaluated as a complementary strategy to address VAD (Hotz and McClafferty 2007; Mayer et al. 2008; Saltzman et al. 2013). Although white maize grain is a leading staple in sub-Saharan Africa (SSA) and is consumed widely, it does not contain vitamin A. Biofortification of maize with provitamin A carotenoids changes the colour of the grain from white to yellow/orange as well as the aroma and flavour of the maize (De Groote et al. 2011). The sensory properties of provitamin A-biofortified maize are unfamiliar to consumers in the sub-Saharan African region who are accustomed to white maize (West and Darnton-Hill 2001). Several studies conducted in SSA have shown that white maize is generally preferred over the provitamin A-biofortified maize (De Groote and Kimenju 2008; Muzhingi et al. 2008; Stevens and Winter-Nelson 2008; Pillay et al. 2011). Recent studies have explored the potential of using provitamin A-biofortified maize to prepare other food items. Beswa et al. (2016a) found that healthy, nutritious extruded snacks could be prepared using provitamin A-biofortified maize and added amaranth. *Amahewu*, a fermented non-alcoholic maize-based beverage

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popular in Southern Africa is usually prepared with white maize. Awobusuyi et al. (2016) tested the consumers' acceptance of *amahewu* prepared from provitamin A-biofortified maize compared to white maize. The consumer acceptance of the biofortified maize *amahewu* was slightly higher than the *amahewu* made with white maize.

There are no published studies testing the consumer acceptance of a composite complementary food based on provitamin A-biofortified maize and an accompanying traditionally accepted food item. Complementary feeding refers to the introduction of safe and nutritious foods, other than breast milk, to infants from six months, up to 18-24 months of age (WHO 2013). A survey conducted amongst caregivers in rural KwaZulu-Natal revealed that chicken stew was the most common complementary food that caregivers introduce to infants after porridge, other starches, vegetables and meat, at around eight months of age. The sensory properties of a complementary food play a crucial role in determining whether or not caregivers will give that food to their infants (Stone and Sidel 2004; Blisset and Fogel 2013). Children are also strongly influenced by their caregivers' acceptance of novel foods, and caregivers are more likely to try new foods on children if they perceive the foods as nutritious and healthy (Mennella and Ventura 2011; Mennella and Trabulsi 2012; UNICEF 2012). This investigation aimed to determine the acceptance of a complementary food based on provitamin A-biofortified maize and chicken stew by caregivers in rural KwaZulu-Natal province of South Africa.

METHODOLOGY

This was a cross-sectional study. Two varieties of provitamin A-biofortified maize and one variety of white maize were bred for the purpose of this research. A survey was conducted to identify the most commonly fed composite complementary foods introduced to infants after porridge at around eight months of age. The identified composite complementary food was prepared and the sensory acceptability of that food was assessed by caregivers of infants. Focus group discussions were used to determine perceptions about the composite complementary food.

Breeding of the Provitamin A-biofortified Maize

Two yellow provitamin A-biofortified maize hybrids, PVA pool A and PVA pool H, were used as the experiments in this study. The provitamin A content of the PVA pool A and PVA pool H was 5.23 µg/g. These hybrids were developed using conventional breeding methods at the Makhathini Research Station near Jozini in KwaZulu-Natal. A standard white maize hybrid was used as the control. The maize was harvested manually and left to dry under ambient conditions (about 25 °C). The maize was then threshed by hand and the grain obtained stored in a cold room (5 °C) until it was needed for experimentation. Grain of each maize hybrid was cleaned with a machine by aspiration and then milled using a pilot plant roller mill (Model MK 150, Roff Industries, Kroonstad, South Africa). The maize meal fractions that passed through a 459µm aperture screen were collected for the experiments.

Survey to Determine the Most Common Composite Complementary Food

A survey was conducted at the Paediatric Out-Patient Department (POPD) of Edendale Hospital to determine the most common composite complementary food that the caregivers introduced to infants after porridge, other starches, vegetables and meat, at around eight months of age. The hospital was chosen on the basis that it is located in the peri-rural area of uMgungundlovu District of KwaZulu-Natal. A total of 60 caregivers, both male and female, were recruited to participate in the survey. The survey showed that the most common composite complementary food fed to infants at around eight months of age was *phutu* (crumbly maize meal porridge) served with chicken stew. In order to determine the most common recipe used by the caregivers to prepare the *phutu* and chicken stew, on a separate day 32 caregivers from POPD were recruited to provide their recipes. The most common ingredients and methods were used to develop a standardised recipe for the *phutu* and chicken stew. A standardised recipe was developed after three cooking trials.

Preparation of the Composite Complementary Foods

A Black African woman from a rural area of uMgungundlovu district with experience in preparing local dishes was recruited to prepare the *phutu* and chicken stew complementary foods.

The ingredients for the chicken stew were boneless chicken pieces, onion, green pepper, mixed vegetables (corn, carrots, green beans and peas), stock cubes, soup powder, curry powder, oil and water. A minimum amount of soup powder and stock cubes were added to ensure that the stew was culturally acceptable. The *phutu* was made with maize meal, water and salt using each of the maize hybrids (Pools A and H) as well as the control. The *phutu* was combined with the chicken stew to produce three samples of the complementary food. Both the *phutu* and chicken stew were prepared on the day of data collection in the food-processing laboratory at the University of KwaZulu-Natal. Thereafter, the samples were transported to the study site in air-tight containers and temperature controlled. Twenty-five millilitres of *phutu* and 25ml of chicken stew (consisting of three chicken pieces) were served to the panellists in a 250ml polystyrene cup.

Sensory Evaluation

Fifty-nine black African male and female caregivers whose infants attended POPD at Edendale Hospital were selected to participate in the study, using simple random selection. Subjects who had participated in the pilot study were not allowed to participate in the main study. The accepted consumer sample size for acceptance/preference tests is 50 or more subjects (Stone and Sidel 2004). Three research assistants (who were trained prior to the sensory evaluation) assisted the panellists. Each of the three composite complementary food samples was assigned a unique three-digit code obtained from The Table of Random Numbers. The samples were served in a random order using The Table of Random Permutations of Nine (Heymann 1995). All panellists (59) received 25 ml of *phutu* and 25 ml of the chicken stew in a 250 ml polystyrene cup. The samples were warmed for eight seconds to ± 65ºC in a microwave oven before serving. Each panellist was provided with a cup of water to cleanse the palate between samples. The panelists evaluated the acceptability of the composite complementary foods by rating selected sensory attributes, including overall acceptability, using a five-point facial hedonic scale. The facial scale corresponded with: 1=very bad (most frowning), 2=bad, 3=maybe good or maybe bad, 4=good and 5=very good (most smiling). The questionnaire was developed in English and translated into *isiZulu*, the predominant vernacular language in KwaZulu-Natal. A facial hedonic scale has been found to be appropriate for use by semi- and illiterate people (Stone and Sidel 2004). The questionnaire as well as the sensory attributes were explained to the panellists by research assistants before they evaluated the samples. The panellists were asked not to communicate with each other during the sensory evaluation session so as not to influence each other's responses.

Focus Group Discussions

Focus group discussions (FGDs) were conducted to determine the perceptions of the caregivers about provitamin A-biofortified maize and its use in complementary foods. Three FGDs were conducted using eight participants in each group. There were two males and six females in each group. The focus group discussion participants were recruited from the sensory evaluation panel. The ideal number of participants for a focus group discussion is 6 to 10 participants who are strangers to each other (Powell and Single 1996). The FGDs were conducted by a trained facilitator in *isiZulu*. The facilitator used Discussion Guide Questions, which were formulated by the researchers. The FGDs were recorded using a digital voice recorder and a camera to capture relevant visuals. Furthermore, a scribe took notes of the discussions which were later transcribed into themes and concepts whilst the facilitator also captured the discussion points on a flip chart. The information from the field notes, the flip chart and the recorded information were transcribed immediately after each session. The transcripts were translated into English by an *isiZulu*-speaking person. The English translations were then compared with the *isiZulu* recordings and checked for accuracy by another *isiZulu* speaking person. In order to ensure validity, all fieldworkers were trained by the facilitator before the focus group discussions. The facilitator spoke the vernacular language and was also conversant in English. After each focus group discussion, the facilitator and the scribe presented the discussions to the participants for verification.

Statistical Analysis

Data was entered into the Statistical Package for Social Science® (SPSS) version 15. The statistical tests used to analyse the data includ-

ed analysis of variance (ANOVA), Dunnet and Tukey tests. A p-value of <0.05 was considered significant. FGDs recordings were transcribed and then translated into English immediately after each session. The transcripts were then subjected to Content Analysis to identify and interpret key themes of the FGDs. For each theme identified, supporting verbatim quotes were included.

Ethical Approval

Ethical approval was granted by the University of KwaZulu-Natal (UKZN), Humanities and Social Sciences Research Ethics Committee (HSS/0534/013M). A letter of support was obtained from the Medical Manager of Edendale Hospital and the KwaZulu-Natal Health Research Committee (HRKM 238/13). Prior to participation, a written consent was obtained from all the caregivers after the study was explained to them. Illiterate participants were assisted in placing an 'X' next to their names to indicate that consent was given.

Pilot Study

A pilot study of the sensory evaluation and the focus group discussions was conducted before the main study to test the methods proposed for the study. All the participants in the pilot study were recruited from POPD at Edendale Hospital. Ten caregivers participated in the pilot study. The pilot study participants were volunteers recruited by two *isiZulu*-speaking research assistants. Focus group discussions (FGDs) were conducted with eight participants recruited from the sensory evaluation panel. The pilot study showed that the proposed sensory evaluation and FGDs methods required minor modification. In order to reduce bias, subjects who participated in the pilot study were not permitted to participate in the main study.

RESULTS

Sensory Acceptability of the Composite Complementary Foods

The largest number of participants were between the ages of 16-25 years old. There were more female participants (n=53) than male participants (n=6). Table 1 shows that the appearance, aroma and flavour of PVA pool A were rated as "good" (four on the facial hedonic scale) and texture and overall acceptability were rated as "very good' (five on the facial hedonic scale) by the highest percentage of panellists (55.9%). The appearance, aroma, texture and flavour of PVA pool H were rated as "good" and overall acceptability was rated as "very good" by the highest percentage of panellists (47.5%). The control was rated as "good" by the highest percentage of panellists for aroma and flavour. An equal number of participants rated the control as "good" and "very good" for appearance.

Table 1: Acceptability of the composite complementary foods as indicated by the number and percentage of panellists who gave the different ratings for the sensory attributes evaluated (n=59)

Composite complementary food	*Acceptability rating*	*Appearance*	*Aroma*	*Texture*	*Flavour*	*OA*
PVA pool A	Very bad	2[a] (3.4)[b]	1 (1.7)	0 (0)	1 (1.7)	2 (3.4)
	Bad	1 (1.7)	2 (3.4)	4 (6.8)	2 (3.4)	1 (1.7)
	Neutral	9 (15.3)	8 (13.6)	6 (10.2)	8 (13.6)	3 (5.1)
	Good	31 (52.5)	36 (61.0)	23 (40.0)	28 (47.5)	20 (33.9)
	Very good	16 (27.1)	12 (20.3)	26 (44.1)	20 (33.9)	33 (55.9)
PVA pool H	Very bad	1 (1.7)	0 (0)	1 (1.7)	1 (1.7)	2 (3.4)
	Bad	4 (6.8)	6 (10.2)	9 (15.3)	3 (5.1)	5 (8.5)
	Neutral	14 (23.7)	7 (11.9)	2 (3.4)	7 (11.9)	1 (1.7)
	Good	24 (40.7)	28 (47.5)	28 (47.5)	31 (52.5)	23 (40.0)
	Very good	16 (27.1)	18 (30.5)	19 (32.2)	17 (28.8)	28 (47.5)
Control	Very bad	1 (1.7)	0 (0)	0 (0)	0 (0)	1 (1.7)
	Bad	2 (3.4)	0 (0)	3 (5.1)	3 (5.1)	2 (3.4)
	Neutral	14 (23.7)	6 (10.2)	6 (10.2)	6 (10.2)	6 (10.2)
	Good	21 (35.6)	34 (57.6)	24 (40.7)	32 (54.2)	21 (35.6)
	Very good	21 (35.6)	19 (32.2)	26 (44.1)	18 (30.5)	29 (49.2)

OA=Overall acceptability, [a]Number of subjects, [b]Percentage of the total number of panelists
Acceptability rating 1-5: 1=very bad; 2=bad; 3=neutral; 4=good; 5=very good

Overall acceptability and texture were rated as "very good" by the highest number of panellists (49.2%). Overall acceptability was rated as "very good" for all the three samples.

Perceptions about Provitamin A-biofortified Maize and its Complementary Foods

Caregivers had positive perceptions about the taste, texture, aroma and colour of both of the experimental composite complementary foods (Table 2). There were some negative perceptions with regard to the provitamin A-biofortified maize grain, for example the yellow maize was perceived as animal feed as well as being for food aid: '*I remember this maize we ate it long time ago, there was drought*; *we were not familiar with this maize as human food as we used to give it to livestock'.* There were observed reactions among the generation groups. The younger caregivers (16-25 years old) were impressed with the yellow-orange colour: *'I think that children would love it because they love colourful food.'* However, they also showed concern about the colour as they thought there was a colourant added: *'Have you added a colourant here?'* The younger caregivers did not approve of the addition of colourants to infant foods as they were perceived as chemicals. On the other hand, the yellow colour of the maize triggered memories of past experiences among older generations (46-55 years): *'We used to call it ubhokide, you could even buy it in the stores but that was a long time ago.'* Caregivers were willing to give their infants the provitamin A-biofortified maize if it was readily available for purchase; if the nutritional value was higher than that of the white maize; and if it was beneficial for their infants' health: *'There was little difference between the three meals that we tasted and the food had a nice smell; the mealie meal that we tasted was alright and all three that we tasted were almost the same.'* Surprisingly, taste was not the top priority as the caregivers believed that children learn taste from the food prepared by their mothers.

DISCUSSION

Sensory Acceptability of the Composite Complementary Foods

Sensory evaluation results indicated that the acceptability of the composite complementary foods made with the biofortified maize was similar to that made with white maize (control). This is clearly demonstrated by the ratings for the overall acceptability of the samples as the two samples containing biofortified maize and the control were all rated "very good" for overall acceptability. The stew which was colourful due to the addition of the vegetables made the provitamin A-biofortified composite complementary foods more visually appealing, thereby increasing its acceptance. This suggests that the acceptance of provitamin A-biofortified maize may be increased when it is eaten together with another food item that is visually appealing. The results of this study differ to those of initial studies conducted to assess the consumer acceptance of provitamin A-biofortified maize which showed that the white maize was preferred over the yellow/orange, biofortified maize (De Groote and Kimenju 2008; Muzhingi et al. 2008; Stevens and Winter-Nelson 2008). An earlier study conducted in rural KwaZulu-Natal on the consumer acceptance of yellow maize found that preschool children showed a higher preference for yellow maize food products such as samp (broken maize kernels), thin porridge and *phutu* (Pillay et al. 2011). A study by Govender et al. (2014) tested the consumer acceptance of an infant porridge made from provitamin A-biofortified maize on Black African female infant caregivers. The porridge made from biofortified maize was found to be as acceptable as the white maize porridge (Govender et al. 2014). Researchers have attempted to prepare and test the consumer acceptance of other food items using provitamin A-biofortified maize. Beswa et al. (2016b) found that the provitamin A-biofortified maize with added amaranth leaf powder has the potential to produce nutritious and healthy snacks, however, the sensory acceptability of the snacks needs to be improved. Awobusuyi et al. (2016) found that *amahewu* prepared with provitamin A-biofortified maize had a slightly higher acceptance compared to the *amahewu* prepared with white maize. The findings of the current paper suggest that a composite complementary food prepared with provitamin A-biofortified maize has the potential to be used as a complementary food by rural caregivers in the uMgungundlovu district of KZN.

Perceptions about Provitamin A-biofortified Maize and its Complementary Foods

One of the findings of this paper was that the older generation associated the yellow maize

Table 2: Caregivers' perceptions towards the consumption of a composite complementary food made with provitamin A-biofortified maize

Question	*Theme/s*	*Concept/s*	*Quotes*	*Discussion*
Consumer familiarity towards yellow maize food products	Consumer opinions and perceptions of yellow maize among different generations	• Yellow maize was unfamiliar to the younger generation who found it captivating. • Yellow maize had been consumed by the older generation previously, during times of drought, but the older generation had different views about liking or disliking it.	*Have you added a ' colourant here?'*	The younger study subjects were not familiar with the yellow maize and associated the yellow colour of the maize with the use of additives. The older study subjects had consumed yellow maize before and had a negative attitude towards it. It was perceived as drought food/food aid, as it was available during the drought of 2004. The yellow maize that was provided at that time was thought to have caused diarrhoea. Consumers perceived yellow maize as animal feed as it is only available in animal feed stores. However, the yellow maize which came as food aid was not provitamin A-biofortified maize. Explanations need to be given to consumers that not all yellow maize has a high provitamin A content.
		• Previous experience	*'We used to call it ubho kide, you could even buy it in the stores but that was a long time ago.'*	There was a willingness by consumers to purchase the yellow maize and to prepare it for their families. Availability is important to the consumers and it could increase the probability of the yellow maize being purchased if it was available in the local stores and supermarkets. Another factor that would be attractive to the consumers is the taste. Consumers also perceived the yellow maize as being easier for their infants to digest. It can be deduced that availability and knowledge of the product will create demand. Therefore a reasonable quantity of the product should be produced before the educational campaigns are launched.
Consumers' willingness to use yellow maize to prepare complementary foods	Benefit perception	• Awareness about nutritional value and health benefits • Availability in stores • Taste panels to sensitise consumers	*'It should be provided in stores so that we can also be able to cook it for our families* *'Customers should be given cooked samples in stores so that they know how it tastes.'* *'People who have used it before and know it would buy it.''We would buy it because it tastes so much better than some of the mealie meals that are being sold in the stores.'* *'The yellow phutu looks like it is easier to digest.'*	

with animal feed. The findings of the yellow maize being associated with animal feed were consistent with those reported in other studies (Muzhingi et al. 2008; Meenakshi et al. 2010; Pillay et al. 2011; Govender et al. 2014). Another finding from the FGDs was that the nutritional value of the maize was important to the caregivers. This increased their willingness to use provitamin A-biofortified maize as a base for a composite complementary food. A study conducted by Muzhingi et al. (2008) in Zimbabwe found that only 2 percent of consumers had some knowledge of yellow maize. Nutrition education was cited as an important factor in influencing a consumer to purchase yellow maize. Another study conducted by Meenakshi et al. (2012) in rural Zambia found that consumers who received nutrition education were more willing to accept and purchase orange maize than those consumers who did not know about the nutritional value of the maize. Educational campaigns are required to change the perceptions of consumers towards provitamin A-biofortified based complementary foods. Focus group discussions found that the texture of the *phutu* made with provitamin A-biofortified maize was more appealing to the caregivers, as they associated it with being easier for their infants to digest.

The results of this paper are limited to a small sample of caregivers in one district of one of the nine provinces of South Africa. There is a need to expand the study to cover a larger sample of caregivers who represent the population of caregivers whose infants are vulnerable to VAD. The results of the current paper indicate that a complementary food based on provitamin A-biofortified maize and chicken stew was popular among the rural population in uMgungundlovu District, KwaZulu-Natal. However, this may not be the most popular complementary food amongst caregivers in other provinces of South Africa. There is a need to assess the consumer acceptance of several alternative types of complementary foods made from the provitamin A-biofortified maize.

CONCLUSION

A complementary food based on provitamin A-biofortified maize and chicken stew was as acceptable as a complementary food based on white maize and chicken stew among the rural population in uMgungundlovu District, KwaZulu-Natal. Caregivers of infants from rural areas of uMgungundlovu District of KwaZulu-Natal were willing to use provitamin A-biofortified maize to prepare complementary foods if it was nutritionally superior to white maize, available at the local stores and if it had a positive impact on the health of their infants. A complementary food based on provitamin A-biofortified maize and a traditionally accepted food item has the potential for use in infant feeding.

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