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SCHOLARLY, PEER REVIEWED
AFRICAN JOURNAL OF FOOD, AGRICULTURE, NUTRITION AND DEVELOPMENT
Volume 23 No. 2
February 2023
PUBLISHED BY AFRICAN SCHOLARLY SCIENCE COMMUNICATIONS TRUST
ISSN 1684 5374

Afr. J. Food Agric. Nutr. Dev. 2023; 23(2): 22602-22623 https://doi.org/10.18697/ajfand.117.21615

SMALLHOLDER FARMERS' WILLINGNESS TO ADOPT, CULTIVATE AND CONSUME PROVITAMIN A BIOFORTIFIED MAIZE IN KWAZULU NATAL, SOUTH AFRICA

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ajfand SCHOLARLY, PEER REVIEWED
AFRICAN JOURNAL OF FOOD, AGRICULTURE, NUTRITION AND DEVELOPMENT
Volume 23 No. 2
February 2023
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ABSTRACT

Vitamin A deficiency (VAD) is one of the significant hidden hunger challenges in sub-Saharan Africa (SSA), and children are the most vulnerable group. Therefore, there is a need for interventions to reduce this deficiency. Provitamin A biofortified maize (PVABM) has the potential to reduce VAD for the vulnerable groups of SSA. The study investigated the possibility of incorporating provitamin A biofortified maize into smallholder farming systems and assessed the acceptability of typical PVABM meals for household consumption. Using a quantitative approach, a cross-sectional study design was conducted in Bulwer local municipality of Sisonke district and Mhlathuze local municipality of uThungulu district, KwaZulu-Natal province, South Africa. A total of 233 smallholder farmers were interviewed using semi-structured interviews and focus group discussions. The sensory evaluation was done with 72 smallholder farmers assessing the sensory attributes of typical meals such as steamed mealies (*ifutho*) and crumbled maize meal (*uphuthu*) produced by PVABM and common maize. Knowledge about PVABM and the average household income highly influenced ($p < 0.05$) the farmers' likeliness to accept and incorporate PVABM into their farming systems. About 82% (Bulwer) and 83% (Mhlathuze) of farmers from the areas were willing to incorporate PVABM in their farming systems, and they had positive perceptions about the success of the varieties in their systems. Farmers already growing yellow maize were more willing to integrate PVABM. Sensory evaluation showed that PVABM foods (*uphuthu* and *ifutho*) were accepted for consumption and the farmers expressed the willingness to consume PVABM in their diets for nutrient improvement. The response showed that the taste of *ifutho* was acceptable for both PVABM (52.8%) and white maize (52.8%). The colour of PVABM *ifutho* was acceptable (50%) and white maize (44.4%), and the aroma was good for PVABM (58.3%) and very good for white maize (44.4%). Overall, both maize sensory attributes were rated as acceptable. The study indicated that farmers could accept PVABM into farming systems and it can be consumed at the household level.

Key words: Sensory evaluation, vitamin A deficiency, biofortification, Bulwer, Mhlathuze, malnutrition, micronutrient

INTRODUCTION

Malnutrition remains a significant problem in South Africa [1] and the most affected are rural communities, where the most vulnerable groups are women and children. Ntila *et al.* [2] added that dietary surveys on the South African population from 2000 to 2015 showed that most rural households received limited dietary diversity. Malnutrition in rural communities can be caused by various factors such as low income, unemployment and too much dependence on staple foods such as maize (*Zea mays*) [3]. Subsequently, micronutrient deficiency grows steadily as a challenge in South Africa.

One of the concerning nutrition deficiencies is vitamin A deficiency (VAD), which has been on the rise over the past decade [4]. The vulnerable groups are children younger than nine years, with children aged 0 - 4 years most likely to die of VAD in low-income communities. The South African government has tried different strategies to combat VAD and other micronutrient deficiencies for vulnerable groups [5]. These strategies include supplementation with medical interventions and food fortification. Other strategies are consumption of animal sources and food diversification for improved intake of micronutrients [6]. Notable is that maize is the main staple crop highly consumed in low-income areas with a high existence of VAD.

In South African communities, maize is used for human consumption and animal feed [7]. The major challenge with maize consumption is that, beyond food energy, it is largely devoid of nutritional value, which is problematic if there is no dietary diversity, as observed in most households of low-income communities [8]. This could predispose micronutrient deficiency in rural communities where maize is a staple crop [7]. According to Odunitan-Wayas *et al*. [9], high consumption of white maize promotes hidden hunger, such as vitamin A deficiency (VAD), especially among children under five years. The prevalence of VAD remains a challenge and public health issue for South Africa [10]. However, farmers or consumers still prefer white maize over yellow maize [8]. Previous studies have shown that cultural preference and lack of knowledge can result in the consumption of white rather than yellow maize [11].

Different strategies have been implemented to reduce the impact of VAD in South Africa, including supplementation with vitamin A [12]. Biofortification is a newly introduced strategy to increase micronutrients such as zinc, iron and vitamin A in staple crops. Targeted crops through this programme are maize, rice, cassava, sweet potato, beans, wheat and millet [12]. Provitamin A biofortified maize

https://doi.org/10.18697/ajfand.117.21615

(PVABM) is a product of biofortification with provitamin A carotenoids and has a yellow-orange colour.

Studies in southern and eastern Africa showed potential for provitamin A biofortified maize consumption and acceptance by different targeted participants [13]. However, there is less evidence on farmers' perceptions and the willingness to integrate PVABM into their maize production system in South Africa. The study investigated the potential of incorporating provitamin A biofortified maize into smallholder farming systems and assessed the acceptability of typical PVABM meals (*ifutho* and *uphuthu*) for household consumption.

MATERIALS AND METHODS

Study sites

A quantitative-based cross-sectional design approach was utilised in the study conducted in Bulwer local municipality of Sisonke district and Mhlathuze local municipality of uThungulu district, KwaZulu-Natal Province, South Africa. Bulwer falls under Bioresource Group 11, defined as Moist Transitional Tall Grassveld and represents Bioresource Unit (BRU) Wc26 [14]. The altitude varies from 964 - 1555 meters above sea level, with a mean annual rainfall of 848 mm. Subsistence farming is still in practice by many residents in the communal areas of Bulwer. Maize is their dominant crop which is produced every year. Mhlathuze municipality consists of many villages under thirty administrative wards and the study was conducted in KwaDlangezwa. KwaDlangezwa falls under Za4 BRU with greater than 450 m coast altitude and less than 1100 mm mean annual rainfall [14]. The Bioresource Group of the area is Moist Zululand Coastal Thornveld (BRG 1), dominated by shallow soils. The common crops produced in the area are sugarcane, maize and vegetables suitable to the local environment.

Sampling technique

A cross-sectional study was conducted among rural smallholder farmers from Bulwer and Mhlathuze local municipalities. A total of 233 farmers were randomly selected, 124 in Bulwer and 109 in Mhlathuze local municipality. The selection of the households was characterised by the involvement in smallholder farming and the willingness to participate in the study. Semi-structured interviews were administered by six trained enumerators from the local community to promote cooperation. Participants gave consent and were allowed to answer in the language of their choice.

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A sample of 72 rural smallholder farmers was recruited from the initial survey for sensory evaluation. The participants responded positively to the recruitment invitation for sensory evaluation. A five-point hedonic scale (1 = very bad, 2= bad, 3= neutral, 4= good and 5 = very good) was used to test the acceptability of different maize foods (steamed mealies (*ifutho*) and crumbled maize meal (*uphuthu*)). Each food combination was assigned a unique three-digit code obtained from a table of random numbers [15]. The researcher knew the three-digit codes, but not the panellist, to prevent bias. Each sample was carefully dished out, so there was uniformity in portion size and appearance. The sensory evaluation was limited to Bulwer due to financial implications and logistic challenges.

Data collection

Participatory research tools such as critical informant discussions were held with four extension officers working with areas of focus, prominent farmers in the communities, officials from active non-governmental organisations and the tribal authorities of the villages. This research exercise was complemented by a transect walk to explore and observe farming systems and maize production in the villages. For triangulation of data, a survey was done through the questionnaires. The data captured farmers' demographics, socio-economic status, farming practices, challenges with maize production, perceptions on maize production, maize variety preferences and perceptions of PVABM and willingness to incorporate it into their farming systems.

Maize used for sensory evaluation and preparation of maize dishes

Maize used for the sensory evaluation was harvested in Bulwer's on-farm trials, which consisted of different PVABM and common local varieties. Maize was harvested during the growing season using local practices (August to December). Green mealies were boiled using the local methods of preparing *ifutho* (steamed mealies in the IsiZulu language). Local women (not part of the study) prepared the mealies as it was recommended that they are consumed while warm and no salt was used during the preparation. Maize for *uphuthu* was harvested, dried and milled for maize meal. *Uphuthu* was prepared by boiling with water only and no salt was added to avoid contamination of taste during the sensory evaluation. The method used for preparing meals was the typical procedure for its preparation in the community.

Seating and serving order

Twelve table-chair pairs were set back-to-back, spaced at an arm's length distance in-between and cubicles were placed on the tables to prevent participants from talking and influencing each other. Before serving the samples, they were all

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labelled using three-digit codes using random permutation and the food was served hot. Four trained (Zulu speaking) administrators were assigned to administer the sensory evaluation and focus group sessions. One administrator was a facilitator for focus group discussions, and the other was a scriber. A tape recorder was used to supplement the scribed notes.

Ethical consideration
The study was granted ethical approval by the University of KwaZulu Natal (HSS/0184/016D). Both the extension government sector and the tribal authority granted written and verbal permission. The consent form was given to participants in the local language (IsiZulu) and was read to the participants to ensure that the content was understood. All participants we able to sign and keep a copy of the consent form should there be any queries.

Statistical analysis
Descriptive statistical analysis was performed on the household demographics and socio-economic status using the Statistical Package for the social sciences (SPSS for Windows version 21, SPSS Inc. Chicago, IL, USA). Ordinal logistic regression (PROC LOGISTIC) of SAS (2018) was used to predict the odds ratio of farmers' knowledge of PVABM and their perceptions of incorporating PVABM in their farming systems. Content analysis was done to gain interpretation of the transact walk and key informant data.

RESULTS AND DISCUSSION

Household demographic and socio-economic status
A total of 233 (124 Bulwer and 109 Mhlathuze) smallholder farmers were interviewed for the study. Balanced participation (50.81% males and 49.19% females) was observed in Bulwer while, in Mhlathuze, there were 56.18% (n = 62) female and 43.12% (n = 47) male participants. Overall, 122 female and 111 male participants were interviewed at both study sites (Figure 1). The distribution in Bulwer could be justified by the fact that maize is a cash crop in the area and both genders are actively involved in farming. Yet, in Mhlathuze, the smallholder farmers were predominantly female and were mainly involved in subsistence farming and selling some surplus. Youth involvement in smallholder farming was low (n = 5, Bulwer and n = 9, Mhlathuze), and high participation was observed between the ages of 35 - 60 (n = 66, Bulwer and n = 62, Mhlathuze). The elderly group also participated in the study as smallholder farmers (Figure 2).

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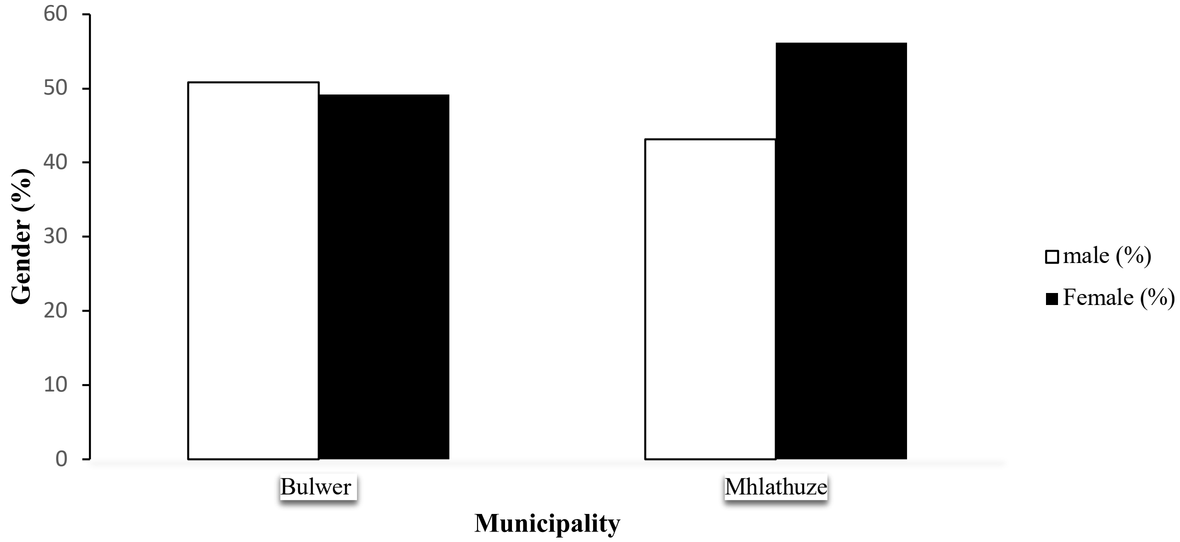

Figure 1: Percentage of male and female respondents at Bulwer and Mhlathuze municipality

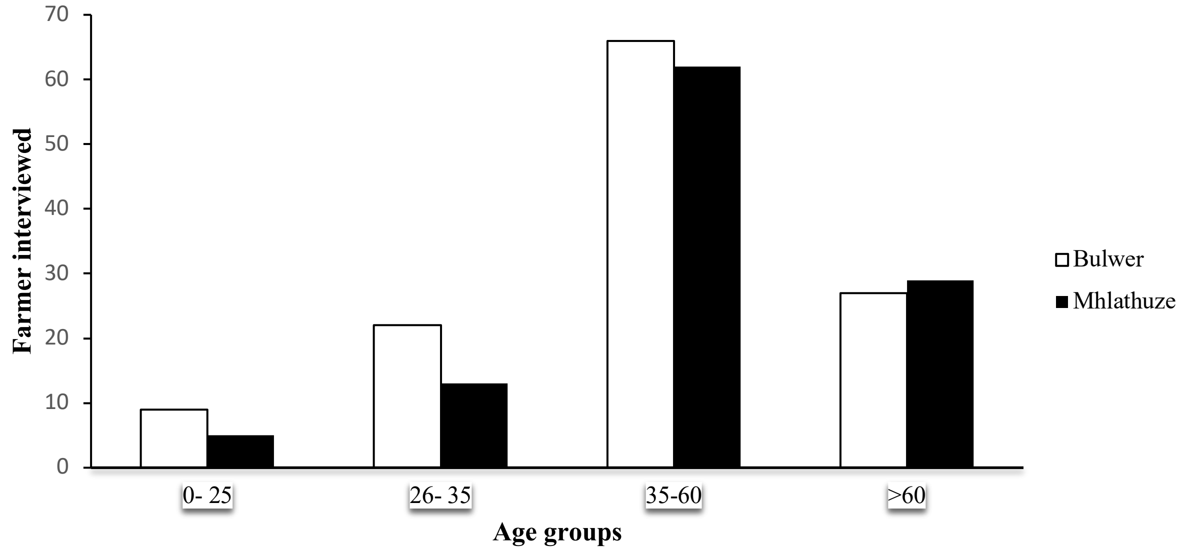

Figure 2: Age groups of farmers interviewed in Bulwer and Mhlathuze municipality

Table 1 shows that most of the respondents were married (46% Bulwer and 51% Mhlathuze)). In Bulwer, there was a high dependence on pension grants (old age) which was ZAR 1,500 per month (ZAR 18,000 per annum), while in Mhlathuze, they showed more dependence on child grants which was ZAR 350 and old age pension grant ZAR 1,520. Most of the respondents were unemployed (60.48%) in Bulwer and this was similar to Mhlathuze municipality (Table 1). Mhlathuze had

https://doi.org/10.18697/ajfand.117.21615

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higher (32.11 %) respondents who went to high school and this was similar to Bulwer's educational status, where most had gone to high school (Grade 11 - 12).

Farming practices

Land available to respondents for production ranged from 250 m^2 to 25 hectares in Bulwer and 200 m^2 to 20 hectares in Mhlathuze. In Bulwer average land owned was 0.5 hectares, while Mhlathuze's average was two hectares. Respondents showed different farming experiences: in Bulwer, the experience ranged from 1 - 52 years, compared to Mhlathuze, which ranged from 1 - 60 years. Most farmers (nearly 70%) depended on rain for crop production in both municipalities (Figure 3). Different crops were produced. The most common in Bulwer were maize, potatoes, beans and leafy vegetables, while in Mhlathuze, sugarcane, maize, *amadumbe* and sweet potatoes dominated.

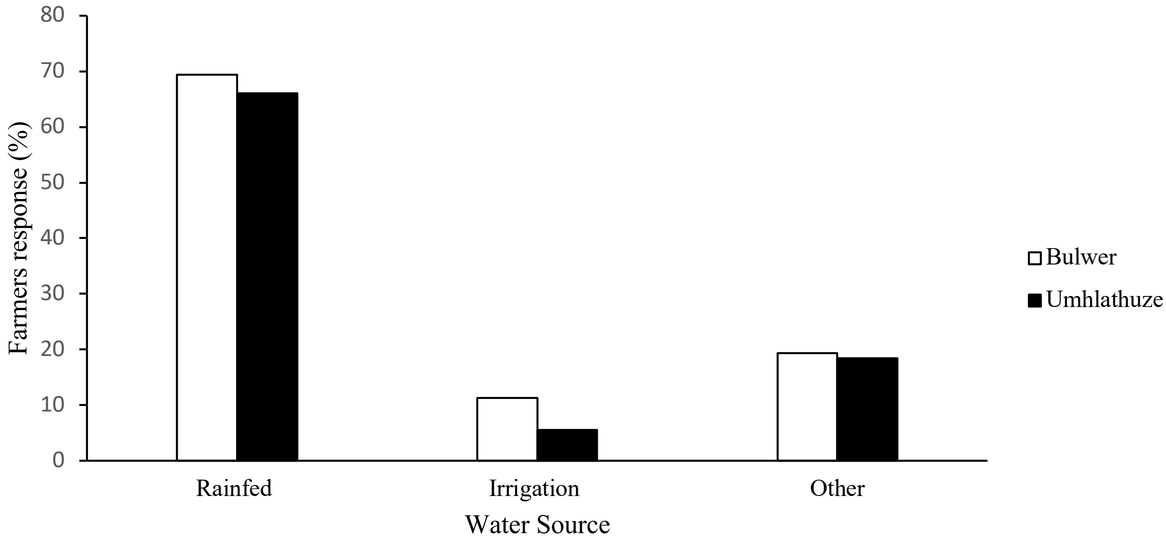

Figure 3: Major water sources for farming practices in Bulwer and Mhlathuze

Farmers preferred to select early maturing varieties in their crop production systems (Table 2). Furthermore, during dry seasons or seasons when water was limited, these farmers grew drought resistant (21%) and short season (21%) crops in Bulwer, while in Mhlathuze, they preferred drought-resistant crops (45%) such as *amadumbe* (*Colocasia esculenta*) and local maize landraces and practised crop rotation (22%) {Table 2}. Most did not plant in their fields during prolonged droughts, while others selected crops based on their low water requirements.

About 96% of farmers applied fertiliser to their crops in Bulwer compared to 89% in Mhlathuze municipality. These farmers preferred to use organic and inorganic fertilisers in their gardens rather than specialising in organic or inorganic fertilisers.

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Inorganic fertilisers are mostly bought from local suppliers, while organic manures such as cow dung, chicken litter and food waste are self-made/collected. Weeds were mainly managed through manual weeding (hand weeding) for both municipalities, 91% (Bulwer) and 86% (Mhlathuze). Furthermore, 85% of farmers in Bulwer used family labour to minimise weeding costs, while in Mhlathuze, 58% preferred family labour for weeding their fields.

Maize preference and impact of maize colour on production systems

Most farmers planted white maize in both municipalities (Bulwer 45%, Mhlathuze 72%), while a few cultivated yellow maize only at Mhlathuze (8%) compared to Bulwer (23%). Bulwer farmers produced more local landraces than Mhlathuze farmers (Table 3). Farmers considered cheapness (Bulwer) and maize colour (Mhlathuze) as their main reasons for maize selection in their maize production systems. Most farmers preferred high-yielding maize varieties when they chose their maize for growing in both municipalities. Disease resistance and type of variety are less considered when farmers purchase or choose maize attributes.

Maize consumption

Maize is the major crop produced in Bulwer, while in Mhlathuze, maize falls behind sugarcane. However, maize is consumed in both study areas in different forms and meals depending on the colour variety. In Bulwer, for example, white maize was commonly consumed as green steamed or roasted (55%), crumbled maize meal (40%) and soft porridge; yellow maize varieties were mostly consumed as *izinkobe* (mixture of cooked maize grains with legumes) (39%), corn bread (33%) and samp (28%). On the contrary, in Mhlathuze both colour varieties were consumed for the same purposes and meals; they were highly consumed as green steamed or roasted, *izinkobe* and corn bread.

The study showed that women still participate in smallholder farming systems in rural communities of South Africa. Females play a significant role in agricultural production in rural livelihoods [16] and are the most vulnerable to malnutrition and food insecurity in low-income communities. Most females in rural areas are deprived of education as they get married at an early age (teenage ages) to perform many tasks (farm operation, cooking, running a family, artisan work and many others) when their husbands migrate to cities for jobs. Current findings showed that most females operate subsistence farming systems. The recent findings also showed that social grants and old age pensions are primary income sources for rural households, which agrees with findings by Gwala [17].

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Maize is consumed in various meals in a rural household [18]; however, the nutritional balance remains a problem. White maize is used for animal and human consumption rather than yellow maize. Positively, yellow maize was used for foods such as *mahewu*, *samp*, *inkobe* and steamed bread, while white maize was used in all foods (*phuthu*, *pap*, *mahewu*, *samp*, *inkobe* and *green mealies*). The current study showed that maize is consumed in various meals or dishes in these communities, hence the call for improved breeding through biofortification for improved nutritional intake. This can aid in dietary diversification with improved nutrient supply for many low-income households. Chawafambira *et al*. [19] also suggested that diversification with biofortified maize can improve micronutrient intake, reduce hidden hunger and reduce vitamin A deficiency in low-income communities.

Biofortification was new for most participants; however, some understood the breeding process and the varieties. Farmers in these areas introduced different maize varieties in their farming systems. Most introduced had been a success and had been an improvement in terms of yield and other characteristics. Some challenges with adopting new varieties were observed in other varieties. These include low yields, inability to adapt well in the areas, and easy crossbreeding with locally grown varieties. However, most farmers in both areas said they were willing to produce PVABM under their crop production systems. Regardless of the colour, most farmers were optimistic about the production of PVABM in the future. Similar findings have been observed in previous studies [9, 20]. However, as those studies reported, education training and workshops must be implemented for information on the improvement and breeding strategies for PVABM. *"Some farmers reported during the study to have seen the orange colour in sweet potato and commended that they are sweet and have become common in the local market, and they are already propagated in some farming plots. Some farmers knew that mixed colour corn was usually a product of natural crossbreeding, especially when different maize crops are planted near each other. Some suggest that mixed corn colour (navy-yellow-white) was caused by planting maize in a monocropping system for an extended period".*

This calls for breeding training for improved knowledge of varieties and breeding systems in these communities. Dutta *et al*. [21] indicated that breeding training is essential for farmers to understand the process of biofortification. When farmers better understand the breeding processes, they can easily be recruited to grow new varieties such as PVABM.

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Potential and willingness for provitamin A biofortified maize (PVABM) production under smallholder farming systems

Most farmers reported that they were willing to incorporate PVABM into their maize farming systems (Bulwer 82% and Mhlathuze 83%). Furthermore, 90% of the farmers (Mhlathuze) were optimistic about the success of PVABM varieties in their crop planting system. In comparison, less than 70% of Bulwer were confident about the success of these PVABM varieties. Maize type dominantly grown highly influenced ($p < 0.05$) the likelihood of farmers' better knowledge about PVABM (Table 4). Farmers producing yellow maize were most likely to understand PVABM better. Furthermore, gender had less influence on the knowledge of PVABM by farmers. Knowledge of PVABM was the strongest predictor (5.2) for farmers' stated willingness to produce PVABM in their crop production system (Table 5). Farmers with knowledge of PVABM were more likely ($p < 0.05$) to be willing to plant PVABM varieties. Furthermore, farmers with successful experience producing hybrids were also likely ($p < 0.05$) to produce PVABM. In addition, farmers in Bulwer were less likely to incorporate PVABM in their farming systems. Yellow maize producers were more likely to produce PVABM than white maize producers (Table 5).

Sensory evaluation

Sensory attributes of steamed maize (*ifutho*) showed that both PVABM and white maize were acceptable for consumption during the study. The response showed that the taste of *ifutho* was acceptable for both PVABM (52.8%) and white maize (52.8%). The colour of PVABM *ifutho* (50%) and white maize (44.4%) was acceptable; the aroma was good for PVABM (58.3%) and very good for white maize (44.4%). The texture for both maize samples was comparably acceptable (good). Overall, both maize sensory attributes were acceptable (Table 6). A different response was noted concerning PVABM *uPhuthu*; the evaluation was neutral (41.7%) for PVABM and good (50%) for white maize (Table 6). Also notable was the colour attribute, where PVABM was considered neutral (44.4%) while white maize was very good (58.3%). The texture was also neutral for PVABM (50%) while good (44.4%) for white maize. A similar trend was recorded for aroma, where PVABM was neutral (52.8%), and white was good (44.4%).

Sensory attributes for *ifutho* showed less difference between the maize types as it was observed that both PVABM and white maize were ranked as suitable by the farmers for all attributes (aroma, taste, texture, colour) measured. These findings suggest that farmers had no challenges with the consumption of PVABM prepared as *ifutho* meal. Meenakshi *et al*. [22] observed similar findings that farmers had no challenge with PVABM in the rural areas of Zambia. These findings agree with Bechoff *et al*. [23], who suggested that farmers in their study accepted the

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biofortified products and even themed them as *"yellow is good for you."* These authors further explained that farmers were willing to incorporate these foods into their farming system because of their nutrient composition.

Farmers' response to *uphuthu* sensory attributes showed an excellent rating for white and yellow maize meals. These findings were similar to those of Pillay [24], who found that caregivers accepted and rated provitamin A biofortified food as good as white maize food. The current findings are contrary to suggestions that biofortification affects sensory attributes in a way that can affect its acceptability. In their conclusions, Stevens and Winter-Nelson [10] noted that existing preferences for white maize did not preclude the acceptance of PVABM (orange) varieties in Maputo. Similar to their findings, the current results showed that farmers accepted and positively perceived the PVABM meals (*ifutho* and green mealies).

Overall, farmers had positive sensory responses to PVABM food during the current study, and there was no impact of food colour on the reaction. In the present study, farmers accepted PVABM for consumption, animal feeding and trading. The recent findings were similar to those of Odunitan-Wayas *et al*. [9] and Amod *et al*. [25], who found acceptability and willingness to consume and produce PVABM in their studies. The colour and maize type had less impact on the acceptability of the PVABM meals during the current study; hence, there was a good rating of PVABM food and white maize. Nuss *et al*. [26] suggested that to improve the rating of flavour and the acceptability of provitamin A maize, is to use relish such as a chicken stew with meals. Beswa *et al*. [13] stated that adding amaranths as relish can also improve the nutritional content of the everyday dishes prepared in rural households.

As expected, white maize remains the most preferred maize for consumption, but the farmers showed willingness to consume the PVABM maize due to the nutrient content and the potential to adapt to drought conditions. Furthermore, if the opportunity arises to market the products in South Africa, the farmers would be willing to produce for the market. The study findings align with various other studies [27, 28, 29] that PVABM has the potential to be integrated into farming systems, food production and marketing by the low-income people of South Africa.

CONCLUSION

The study investigated the potential of incorporating provitamin A biofortified maize into smallholder farming systems, and assessed the acceptability of everyday PVABM meals for household consumption. Farmers accept the idea of growing

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PVABM, and they are willing, in principle, to incorporate it in their maize production systems regardless of its orange/yellow colour. Farmers are also optimistic about provitamin A biofortified maize. There is willingness to incorporate these varieties into smallholder farming systems to improve nutrition and as a new business strategy. Provitamin A biofortified maize is accepted just like white maize during the sensory study; however, this may lead to further studies on different foods prepared by PVABM tested for sensory. Nevertheless, farmers are willing to consume PVABM and complement their diets for improved nutrition in their households. Therefore, this would need to be addressed for future studies and breeding purposes to improve PVABM acceptability.

STUDY LIMITATIONS

The study limitation was that only one area was assessed for sensory evaluation due to limited financial resources to replicate the review in both districts.

CONFLICT OF INTEREST

The authors declare no conflict.

ACKNOWLEDGEMENTS

National Research Foundation (NRF) is acknowledged for funding this work. Smallholder farmers are recognised for their contribution and willingness to share information during the study. The tribal authorities of Kwa Mkhwanazi and KwaGwala are also acknowledged for granting permission to assess their communities and, lastly, the University of KwaZulu-Natal.

AUTHORS' CONTRIBUTIONS

M.K. Zuma was the field researcher and designed the study, U. Kolanisi supervised the research and assisted in communicating with key stakeholders, while A. Modi designed, managed and analysed some of the data. X. Mbhenyane contributed to the writing of the article.

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Table 1: Socio economic status of farmers in Bulwer and Mhlathuze

	Bulwer (%), (n = 124)	Mhlathuze (%), (n = 109)
Marital status (%)		
Single	43	44
Married	46	51
Divorced	1	3
Widow/widower	9	2
Education (%)		
No formal education	9	19
Lower primary	12	5
Higher primary	19	13
Grade 8 - 10	26	19
Grade 11 - 12	27	32
Tertiary education	6	12
Income source (%)		
Wages	17	13
Salary	13	17
Pension	30	26
Grant	23	25
Other	17	19
Average income (%)		
Below R800 (ZAR)	28	31
R800 - R 1500 (ZAR)	49	31
R1501 - R3500 (ZAR)	20	18
Above R3500 (ZAR)	3	19
Employment status (%)		
Full time	10	13
Part time	21	13
Unemployed	61	60
Self employed	8	15

https://doi.org/10.18697/ajfand.117.21615

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Table 2: Criteria used by smallholder farmers in Bulwer and Mhlathuze to select maize varieties and coping strategies applied during dry seasons

		Bulwer (%), (n = 124)	Mhlathuze (%), (n = 109)
Variety (%)	Early maturity	47	32
	Resistance to diseases	11	17
	Resistance to drought	3	16
	High yield potential	11	6
	Easy market access	1	6
	Easily manageable crop	2	8
	Human consumption	15	14
	Other	10	2
The coping strategy applied during drought season (%)			
	Drought resistant	21	46
	Short season	21	10
	Crop rotation	19	22
	Mixed cropping	11	6
	Revised planting date	15	5
	Change plant density	0	3
	Other	14	7

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February 2023
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ISSN 1684 5374

Table 3: Maize selection criteria and preference for production by smallholder farmers in Bulwer and Mhlathuze

	Bulwer (%), (n = 124)	Mhlathuze (%), (n = 109)
Maize colour		
Yellow	23	8
White	45	72
Both	32	19
Reason for choice		
Cheaper	37	15
Colour	7	20
Drought tolerance	17	9
Taste	13	19
Product quality	6	16
Availability	14	17
Other	8	5
Type of maize breeds		
Local landrace	52	42
Varieties	39	43
Both	9	15

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AFRICAN JOURNAL OF FOOD, AGRICULTURE, NUTRITION AND DEVELOPMENT
Volume 23 No. 2
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ISSN 1684 5374

Table 4: Odds ratios for respondents knowing provitamin A biofortified maize

Predictor	Odds Ratio	Lower	Upper	Significance
District (Bulwer vs. Mhlathuze)	0.2	0.3	1.6	NS
Age (< 35 vs. > 35)	1.3	0.6	2.7	NS
Gender (male vs. female)	0.5	0.2	1.3	NS
Marital Status (single vs. married)	1.7	0.8	3.5	NS
Education (< Grade 7 vs. > Grade 7)	1.1	0.5	2.3	NS
Employment status (unemployed vs. employed)	1.5	0.7	3.1	NS
Average household income (< 800 ZAR vs. > 800 ZAR)	0.8	0.9	2	NS
Maize type mainly grown (yellow vs. white)	2.7	1.2	6	*

https://doi.org/10.18697/ajfand.117.21615

Table 5: Willingness and acceptance to plant provitamin A maize in their garden by smallholder farmers in Bulwer and Mhlathuze

Predictor	Odds Ratio	Lower	Upper	Significance
District (Bulwer vs. Mhlathuze)	0.8	0.4	1.8	NS
Age (< 35 vs. > 35)	0.8	0.4	1.6	NS
Gender (male vs. female)	0.8	0.3	1.9	NS
Marital status (single vs. married)	1.2	0.6	2.6	NS
Education (< Grade 7 vs. > Grade 7)	1.3	0.6	2.9	NS
Employment status (unemployed vs. employed)	2.1	0.9	5.1	NS
Average Household Income (< 800ZAR vs. > 800ZAR)	2.2	0.9	5.3	*
Maize type (yellow vs. white)	1.6	0.6	3.9	*
Heard of PVABM (yes vs. no)	5.2	1.2	23.2	*
Hybrid experience (success vs. failure)	1.7	0.8	3.5	NS

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Table 6: Farmers' sensory acceptability of PVABM food (*ifutho* and *uPhuthu*) in Bulwer

		PVABM					White				
		VB	B	N	G	VG	VB	B	N	G	VG
Ifutho	Taste	0	8.3	16.7	52.8	22.2	0	2.8	11.1	52.8	33.3
	Colour	8.3	2.8	16.7	50	22.2	8.3	5.6	13.9	44.4	27.8
	Aroma	2.8	0	19.4	58.3	19.4	2.8	19.4	2.8	30.6	44.4
	Texture	2.8	11.1	22.2	47.2	16.7	5.6	0	22.2	55.6	16.7
uPhuthu	Taste	0	2.8	41.7	38.9	16.7	8.3	2.8	16.7	50	22.2
	Colour	0	0	44.4	36.1	19.4	2.8	11.1	2.8	25	58.3
	Aroma	0	8.3	52.8	22.2	16.7	2.8	0	19.4	55.6	22.2
	Texture	8.3	2.8	50	22.2	16.7	2.8	8.3	19.4	44.4	25

VB = very bad, B = bad, N = Neutral, G = good and VG = Very Good

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