ajfand SCHOLARLY, PEER REVIEWED
AFRICAN JOURNAL OF FOOD, AGRICULTURE, NUTRITION AND DEVELOPMENT
Volume 22 No. 9
November 2022
PUBLISHED BY AFRICAN SCHOLARLY SCIENCE COMMUNICATIONS TRUST
ISSN 1684 5374

Afr. J. Food Agric. Nutr. Dev. 2022; 22(9): 21454-21475 https://doi.org/10.18697/ajfand.114.22305

SUCCESSFUL REINTRODUCTION OF LANDRACE ORANGE MAIZE IN RURAL MALAWI IS NOT RELATED TO THE NUTRITIONAL KNOWLEDGE OF WOMEN IN FARMING FAMILIES

Katola AA[1,2], Katundu MC[1], Ndolo VC[1], Tembo DT[3] and AH Stark[2]*

Alex Arves Katola

*Corresponding author email: aliza.stark@mail.huji.ac.il

[1]The University of Malawi, Zomba, Malawi

[2]The International School of Agricultural Sciences, The Hebrew University of Jerusalem, Rehovot, Israel

[3]Malawi University of Business and Applied Sciences (MUBAS)

ajfand SCHOLARLY, PEER REVIEWED AFRICAN JOURNAL OF FOOD, AGRICULTURE, NUTRITION AND DEVELOPMENT Volume 22 No. 9 November 2022 PUBLISHED BY AFRICAN SCHOLARLY SCIENCE COMMUNICATIONS TRUST ISSN 1684 5374

ABSTRACT

Vitamin A deficiency is a global health challenge, particularly in the developing world. Diet based approaches, using locally available foods, are recommended for providing long term, sustainable solutions. The ProFarmer project, initiated in Malawi, encouraged local farmers to re-adopt landrace crop varieties. Orange maize was used as a case study. Over time, reintroducing this carotenoid-rich crop is predicted to increase provitamin A content in the Malawian diet. Furthermore, it is considered a relatively simple, cost-effective approach that has the potential to reduce dependence on food fortification. This study was aimed at evaluating the impact of the reintroduction of landrace orange maize on nutrition knowledge, attitudes and behaviours (KAB) in women of farming families that currently cultivate the crop. Women were selected, as they are largely responsible for food preparation and providing healthy foods for their families. Additionally, the overall diet adequacy in women living in rural Malawi was assessed. A total of 336 females took part in the cross-sectional study. Before the study, the participating farming families underwent a training program run by local Agriculture Extension workers prior to receiving seeds for cultivation. The training included an explanation of the rationale behind reintroducing landrace maize and nutrition education regarding the health aspects of providing provitamin A through locally grown foods. Families that had recently joined the project and families that had already harvested the crop in previous years were included in the study sample. A semi-structured questionnaire was used to determine KAB regarding orange maize. Diet quality was also assessed using the FAO Minimum Dietary Diversity questionnaire (MDD-W) designed for women. Independent t-tests and Chi-square tests were performed where appropriate. Positive attitudes towards growing and consuming landrace orange maize were recorded. However, only 32% of the women understood the nutritional benefits. Dietary Diversity scores, a proxy for nutrient adequacy, were low with only 34% of women consuming a sufficiently diverse diet. Despite low levels of nutritional knowledge, landrace orange maize was well accepted by families in rural Malawi and presents an affordable, sustainable option for increasing dietary sources of provitamin A. Nutrition education emphasizing the advantages of eating orange maize and expanding diet diversity is recommended in Malawi.

Key words: landrace orange maize, Vitamin A, nutrition knowledge, Malawi, carotenoids, diet diversity, women, sustainability

ajfand SCHOLARLY, PEER REVIEWED AFRICAN JOURNAL OF FOOD, AGRICULTURE, NUTRITION AND DEVELOPMENT Volume 22 No. 9 November 2022 PUBLISHED BY AFRICAN SCHOLARLY SCIENCE COMMUNICATIONS TRUST ISSN 1684 5374

INTRODUCTION

Maize as a staple food provides numerous compounds and nutrients which are important for human health. These include carbohydrates, proteins, fats, dietary fibre, folate, thiamin, phosphorus, magnesium and pro-vitamin A carotenoids (yellow and orange maize) [1]. However, developing countries that depend primarily on maize tend to have high levels of micronutrient deficiencies [2]. These deficiencies, characterized by a lack of specific minerals and vitamins, can have an enormous negative impact on health, particularly in women and children. This is due primarily to the higher nutrient requirements for growth and development in children, and pregnancy and lactation in women. Deficiencies can lead to impaired physical and mental development [3,4] and anaemia [5]. Suboptimal birth outcomes [6], poor bone health [7] and severe situations, can result in premature death [8].

Micronutrient deficiencies, in particular vitamin A, are a major problem in many developing countries [9]. In Malawi, vitamin A deficiency has been dramatically reduced and currently has relatively low prevalence rates of 4% in preschool children, 1% in school-age children and less than 1% in non-pregnant women and men. Successful reduction of Vitamin A deficiency (VAD) over the years is attributed to vitamin A supplementation and fortification of cooking oil and sugar [10].

It is important to note that supplementation is costly and not considered sustainable over the long term [11]. Fortification of industrial food products that are commonly eaten by urban populations is less accessible to individuals that live in rural areas, as is the case in Malawi [12]. However, leading nutritionists argue that dietary based approaches, such as the use of crops that are high in carotenoids, that are locally available, are a sustainable and effective way of reducing and preventing vitamin A deficiency [13]. Several edible crops have been promoted to control and prevent vitamin A deficiency including orange-fleshed sweet potatoes and biofortified maize [14,15]. These crops are not direct sources of vitamin A but contain carotenoids which can be precursors of Vitamin A for example beta-cryptoxanthin and beta carotene, and are easily converted by the human body [16]. Currently, the population in Malawi, similar to other sub-Saharan countries consumes white maize as a staple food that does not have significant levels of vitamin A precursors [17].

In Malawi, landrace orange maize was once cultivated in the districts of Dedza and Ntcheu. However, most farmers abandoned its production due to limited

https://doi.org/10.18697/ajfand.114.22305

knowledge of its nutritive value and unavailability of seeds due to the promotion of hybrid maize varieties by extension workers. Recently, the ProFarmer project successfully reintroduced the landrace orange maize to 2000 famers. This project was initiated in 2014 and was built on the work of the Malawi Farmer to Farmer Agroecology (MAFFA) and Farmer-led Climate Smart Agriculture projects, which sought to explore the nutritive value and farmers' re-adoption of landrace crop varieties with the additional value of maintaining indigenous vegetables and grains. Using landrace orange maize as a case study, the project advocated for inclusion of farmers' rights and support for the use, propagation, saving and exchange or sale of landrace seeds among small scale farmers in Malawi. This project was also a means of increasing the intake of provitamin A among the population. Murayama *et al.* [18] reported that the landrace orange maize was early maturing, high yielding, required less flour to make nsima (thick porridge) of the desired consistency and stored better in comparison to hybrid white maize. The maize has ~12% protein and its provitamin A content meets the target level of 15 µg/g of biofortification and in some cases even higher levels are reached (avg=18 µg/g). One hundred grams of the maize provides 10% of Vitamin A (retinol equivalents) needed for the day [19].

The cultivation of orange maize is currently underway by farmers in Dedza district (central region) and Thyolo district (southern region) in Malawi. The farmers were provided with 5 kg of seeds for free on the condition that at the end of the growing season, they return 10 kg to be redistributed in the following planting season. In addition, before receiving the seeds, participating farmers underwent a training program run by local Agriculture Extension workers. The training included an explanation of the rationale behind reintroducing landrace maize and nutrition education regarding the health aspects of providing provitamin A through locally grown foods.

Nutrition education is considered a low cost, practicable and sustainable intervention to improve food security, community nutrition and health interventions [20]. It is also a reliable means of improving dietary behaviour and nutritional status. Nutrition education has the potential to improve nutritional knowledge, attitudes and practices towards the adoption of healthy dietary practices and wise food choices. An action-oriented nutrition model is an effective way of achieving effective nutrition education. This model emphasizes the consideration of motivation and practice as a way of increasing understanding and adoption [20]. Nutrition education has also been reported to have a significant effect on improved knowledge for making decisions regarding foods that are considered healthy as opposed to foods that are not thought to promote health [21]. This study was

designed to investigate the link between nutritional knowledge in rural Malawian women on farms that produce orange maize, with attitudes and practices towards the importance of growing foods with vitamin A, in particular, landrace orange maize.

MATERIALS AND METHODS

This study was a cross-sectional, quantitative study that took place in Dedza (central Malawi) and Thyolo (southern Malawi). The study targeted farmers and their families that had been cultivating orange maize for 3 years (primary farms/farmers) and others who were in their first year of production (secondary farm/farmers). Farmers and their families who were currently part of the ProFarmer Project were eligible to participate in this study. Women from selected families were invited to participate. The choice was made to target women as they are the ones who are actively involved in food preparation and taking care of the home. In some cases, women were also family farmers.

The project lies in two different livelihood zones in Malawi (Thyolo and Dedza districts).

Dedza district is situated in the central part of Malawi at an altitude of 1581 meters above sea level and has a tropical wet and dry climate. The district's average annual temperature is 22.5°C. Average rainfall is 119 mm of precipitation per year, with 144 rainy days. Thyolo district is located in the southern part of Malawi at an elevation of 910 meters above sea level and also has a tropical wet and dry climate. The yearly temperature in the district is 25^{o}C. Thyolo has an average yearly precipitation of 101 mm and 123 rainy days [22]. Both districts have favorable conditions for farming of maize and other crops.

To accommodate for two different study locations, a cluster sampling technique formula was used to determine the sample size, as shown in Figure 1. At each district level, a purposive sampling technique was used to choose farmers from a pool of 2000 farmers who were already in the project. The selection criteria for this purposive sampling was based on those women from farms that had been in the project for the past three years and those that were in their first year of orange maize cultivation. The women were chosen from the records kept by the ProFarmer extension workers using the farmer's family names. The questionnaire was administered at the household level.

ajfand SCHOLARLY, PEER REVIEWED AFRICAN JOURNAL OF FOOD, AGRICULTURE, NUTRITION AND DEVELOPMENT Volume 22 No. 9 November 2022 PUBLISHED BY AFRICAN SCHOLARLY SCIENCE COMMUNICATIONS TRUST ISSN 1684 5374

$$n = \frac{Z^2 \cdot p \cdot (1-p) \cdot f \cdot k}{d^2}$$

Z = Confidence interval of 95%
k = non-response rate of 5%
p = Estimated Prevalence of 50%
n = Sample size
d = Desired precision of 7.5%

Figure 1: Formula for calculating sample size using cluster sampling [23]

With the help of ProFarmer extension workers and based on the inclusion criteria, a list of eligible women was created. One week before data collection, messages were sent to the eligible women about the survey and that they had been shortlisted. This was done by the ProFarmer extension workers with the support of the local leaders, and each participant was told of the exact day that she would be interviewed. On the day of the interview, research staff were escorted by extension workers to each participant's home for the completion of study questionnaires.

The survey involved executing a standardized pretested questionnaire. Trained research staff carried out interviews in the home setting of the farmers. All data were collected orally because of low literacy rates. The questionnaire was pilot tested among women in ProFarmer families from the Zomba district (not included in the study areas), who were also growing landrace maize. The choice of location for questionnaire validation prevented corruption of the research sample. Modifications were made to the questionnaire to improve clarity, ease of administration and time needed for completion.

The questionnaire had five sections which included questions concerning: demographics, knowledge regarding the nutritional value of orange maize, attitudes towards the use and consumption of orange maize, consumption practices and levels of intake of orange maize. In the questionnaire, a Likert scale of 1-5 (1 being the least liked and 5 the most liked) was used to rate different attributes of orange maize at the household level and how the mothers felt regarding their children.

A standard validated questionnaire of the FAO, the Minimum Dietary Diversity for Women of Reproductive age (MDD-W) was also administered in this study [24]. Participants were asked if they had consumed foods from a specific food group the previous day. A list of examples from the group was read. The ten food groups were: 1) grains, white roots and tubers and plantains, 2) pulses (beans, peas and lentils), 3) nuts and seeds, 4) dairy products, 5) meat, poultry and fish, 6) eggs, 7) dark green leafy vegetables, 8) other vitamin A-rich fruits and vegetables, 9) other vegetables and 10) other fruits. If a woman consumed any food from the food group, she received a score of 1. Otherwise, she was not awarded points. Women who consumed foods from at least 5 different food groups were more likely to meet

their micronutrient needs as compared to those who did not. Daily consumption of 5 or more food groups was considered a diverse diet. There was no attempt to quantify amounts of foods eaten, rather just establish if the individual had consumed foods from one of ten food groups. The food group diversity indicator is a proxy used to assess micronutrient adequacy of the diet in women of reproductive age. It gives a general score for diet quality. All surveys were completed in the local Chichewa language.

The ProFarmer project was a 5-year project which ran from 2014 to 2019. Before the implementation of activities, the project extension workers provided a training program with a nutrition education element to the project beneficiaries. The project beneficiaries were categorized into two groups: primary farmers and secondary farmers. The primary farmers were trained three years before the time of the study. Secondary farmers had just received their training and nutrition education and were in their first year of cultivation.

The nutrition education element of the training took place in the farmers' respective communities and was facilitated by the ProFarmer project extension workers who had undergone a session for training the trainers. The nutrition education focused on improving nutrition knowledge regarding the health benefits of orange maize, building positive attitudes towards the orange maize and encouraging consumption of orange maize products among rural farmers.

Data Analysis

Analyses were carried out using IBM SPSS Statistics for Windows, version 25.0 (Armonk, Secondary York, 2017). Descriptive statistics were expressed as Mean ± Standard Deviation or percentages. Independent T-test was used to compare the outcomes of the primary farmers and the secondary farmers regarding attitudes, knowledge and consumption practices of white and orange maize. Chi-square test was used to analyze categorical data and discontinuous data. Significance was achieved at levels of $P< 0.05$.

Research Ethics and Approval

This research involved interviewing human subjects, as such approval was sought and given by the Malawi National Committee on Research Ethics in Social Sciences and Humanities (NCRSH). Protocol number was P.01/19/345 (Approval letter attached). Informed consent was provided either orally (for those who could not write) or by signing a consent form before conducting the interview. The study investigators made sure that individuals who were invited to participate in the research study were given an adequate description of the study that was clear and

complete enough for the individual to judge whether they wanted to participate. Consent was obtained only from participants who were legally, mentally and physically able. An emphasis on voluntary participation in the study was made to the participants. To ensure confidentiality and privacy of the collected information, the participants were assigned random numbers for identification.

RESULTS AND DISCUSSION

From a pool of 2000 farmers, 336 women of reproductive age were recruited and completed the survey representing a 17% recruitment. Table 1 describes the demographics of the study population. Few differences were observed between districts or between women from primary or secondary farms. Overall, interviewees had lived in the same village their entire life, while a few were born elsewhere and had come to live in the village for different reasons such as marriage or farming. Monogamous marriages were common and participants had a mean of 4.7±2.0 children with about half having at least one child under the age of 5.

Some primary school education or no formal education was reported by most of the women and many of them were illiterate. Farming was the most common occupation in both districts while a few women described themselves as housewives. Family income was largely provided through the sale of agricultural produce.

Overall, positive attitudes towards orange maize did not significantly differ between women from primary farms and secondary farms in both Dedza and Thyolo districts. However, women from Thyolo district secondary farms had higher scores on each attribute measured when compared to women from primary farms of the same district as shown in Table 2. Unlike Thyolo district, in Dedza district, more women from primary farms had higher scores than women from secondary farms on each attribute. High positive scores were reported by women from both primary farms and secondary farms from Dedza believing that orange maize is good for Nsima (thick porridge). A greater number of women who had been in the project for a longer period held this belief. Positive attitudes towards orange maize were, at least in part, attributed to the work of the nutrition education provided by Agriculture Extension workers. This is in line with the work carried out in Zimbabwe by Muzhingi *et al.* [25], who reported that nutrition education on orange coloured maize (yellow maize) having vitamin A precursors influenced the choice and acceptance of coloured maize over white maize.

ajfand SCHOLARLY, PEER REVIEWED AFRICAN JOURNAL OF FOOD, AGRICULTURE, NUTRITION AND DEVELOPMENT Volume 22 No. 9 November 2022 PUBLISHED BY AFRICAN SCHOLARLY SCIENCE COMMUNICATIONS TRUST ISSN 1684 5374

Although overall knowledge was limited, on a scale of 5, women from primary farms in both Dedza and Thyolo districts (3.82±1.7 and 4.14±1.1 respectively) demonstrated a greater understanding of the nutritional value of orange maize when compared to women from secondary farms in their respective districts (3.57±1.9 and 3.59±1.8, respectively). However, significance was only reached in Thyolo district. Most likely, over the three years working with ProFarmer, the nutritional advantages of orange maize were repeatedly discussed. It is critical for women, who do the majority of cooking in the homes, to be willing to prepare foods from orange maize. This seemingly small change in the family diet can positively impact health. Potential health benefits of orange maize have been documented in Sub Saharan Africa. Work in Zambia indicated that after only two months of consumption of the product, beta-cryptoxanthin (provitamin A carotenoid), lutein and zeaxanthin levels increased in the serum of three and five-year-old children [26].

It is encouraging to note that among the women from the farming families, there was a high preference for orange maize over white maize (85% of the primary farmers and 75% of the secondary farmers). This was because orange maize was considered to be sweeter and its flour was perceived to last longer in comparison to white maize because it gels fast. However, there was an effect of product familiarity in the preference of white maize to orange maize. Some women reported a preference for white maize because they have been eating it for a longer period. An additional effect of product familiarity was seen in women from primary farms from both Thyolo and Dedza district where they showed higher preference scores for orange maize's colour and taste when compared to women from secondary farms. These results mirror the findings of Pilly *et al.* [15] in South Africa where older children and adults liked and preferred products from white maize over yellow-orange maize products because they had been using the white maize products for a long period. Another study in New Zealand also indicated that consumers were likely to use previous exposure and familiarity to food and beverages in deciding the use of a product and its preference [27].

The landrace orange maize is known to be high in provitamin A carotenoids, protein and carbohydrates [19]. The nutrition education that was offered to the farmers covered this topic and emphasized that orange maize was a good source of these nutrients. Results were not consistent between districts. Both women from primary farms in Dedza district and Thyolo districts demonstrated more knowledge regarding the orange maize nutritional topics than the women from secondary farms. Regardless of why one set of farmers did better or worse on the survey, overall results showed that the majority of the farmers in both districts (68.3%) did

https://doi.org/10.18697/ajfand.114.22305

not have sufficient knowledge regarding the nutritional value of orange maize. Table 3 shows the number of women from both primary farms and secondary farms in Thyolo district that did not know that orange maize was a source of protein.

It is unclear why the women in the survey did not have higher levels of knowledge. Possibilities are that their spouses were at the training done by the extension workers, overall low literacy levels or lack of understanding of the importance of nutritional factors on health and well-being. It is unfortunate because knowledge of health benefits appears to be an important motivator for adapting food products. This was the case in one study on orange-fleshed sweet potatoes as a replacement for white potatoes. The study carried out in Kenya noted that prior nutrition knowledge on the presence of vitamin A precursors was one of the factors that led to increased production and adoption [28].

Results from this study also showed that women from farms who had been growing maize for several years had perception that their children liked foods made from orange maize to a significantly greater extent than women from secondary farms. This was true for both primary farmers from Dedza (4.4±1.2) and Thyolo (4.3±1.0) districts versus secondary farmers from Dedza (3.5±2.1) and Thyolo (3.8±1.7). The majority of participants from both Dedza and Thyolo district (89.3%) indicated that they already prepared orange maize products for their children. In contrast, 10.1% women from secondary farms who were not feeding their children orange maize products at the time of the survey, showed an interest in adopting the practice in the future. Only two farmers (0.6%) responded that they would not feed their children orange maize.

Maize in Malawi is processed into different products for household consumption such as green maize, nsima and porridge [2]. The findings of this study also show that orange maize was consumed in many forms by ProFarmer families. Consumption of boiled green maize, porridge and nsima at the household level was common in both adults and children. Proportionally, children from primary farmers from both Dedza and Thyolo district were higher consumers of orange maize products than the children from secondary farmers with significant differences measured for consumption of porridge (82% of children from Dedza primary farmers versus 38% of children from Dedza secondary farmers) and nsima (80% of children from Dedza primary farmers versus 62% of children from Dedza secondary farmers). There were significant consumption differences of porridge for children from primary farmers and secondary farmers from Thyolo district as shown in Table 4. This could be because the primary farm families have been eating the

orange maize products for a longer period than those living on secondary farms. It was presumed that the secondary farms had not yet harvested their first crop and therefore would not be as familiar with the orange maize. In reality, many of the women from secondary farms reported consuming orange maize products such as nsima. Orange maize flour for nsima could have been provided by friends or relatives from the previous year's harvest. This scenario is possible because people in rural communities in Malawi share foods and materials with others who are in need. These results are in line with the findings of an American study in rural low-income families who reported that food sharing is one of the mechanisms for maximizing food resources and also as a strategy of meeting food needs [29]. Overall, the provision of free seeds, agricultural advice through extension services, nutrition education and community support for the intervention led to a high level of acceptability and consumption of the orange maize in Dedza and Thyolo districts. It is impossible to isolate the specific impact of the nutrition intervention in this study. However, in Uganda, nutrition education and other extension programs led to increased adoption and use of orange-fleshed sweet potatoes [30].

Results from the Dietary Diversity questionnaire indicated that the majority of rural women in both districts surveyed were not meeting the daily minimum dietary diversity recommendations of more than 5 food groups out of 10. Only 32% of the women in Dedza and 36% in Thyolo met the minimal criteria for dietary diversity. This puts the women at a greater risk of nutrient deficiencies which have negative effects on their health and pregnancy outcomes [31]. The majority of the foods that the farmers reported to be consuming were cereals (maize), green leafy vegetables (pumpkin leaves) and other vegetables such as cabbage as shown in Table 5. There was a high level of consumption of pumpkin leaves because the survey was conducted during March and April. The time of year of the survey may have contributed to the low diet diversity as it was the end of the growing season and families had not yet harvested their crops. Thus, pumpkin leaves were a commonly eaten vegetable.

There was a low intake of legumes in Thyolo, along with limited consumption of nuts, milk and milk products, meat, poultry and fish, eggs, other vitamin A rich fruits, vegetables and roots and other fruits such as bananas and oranges. It is not surprising that fruit consumption was low because most of the fruits were not yet in season. Mangoes, commonly eaten in rural Malawi, are not harvested until the summer months (October/November). Fruits were available in the marketplace at the time of the survey, but most of the subsistence farmers could not afford to buy them. These results are consistent with that reported by Chakona [32] who found low dietary diversity in women from the rural areas of South Africa compared to

those from the urban areas. Diets were based on starchy foods, especially maize. Another study in Mali also demonstrated that rural women from food-insecure households had low dietary diversity and were likely not to meet the dietary diversity requirements [33].

CONCLUSION

Despite low levels of nutrition knowledge, both children and adults in rural Malawi accepted landrace orange maize. Reintroduction of local varieties of grain provides a sustainable, cost-effective option for increasing dietary sources of provitamin A. Nutrition education emphasizing the advantages of eating orange maize and other carotenoid-rich foods is of extreme importance. Expanding overall diet diversity is also imperative for improving food consumption patterns of families in the ProFarmer project and throughout Malawi. This will only happen if interventions have the ability to reach women, as they must be willing to prepare and serve these foods. Knowledge is key to changing farming practices like upscaling orange maize production, and consumers should be well informed and understand the nutritional importance of reintroducing this crop. Furthermore, farmers can share their know-how within their communities. This study demonstrates the need for widespread nutrition education to ensure optimal food choices for the people of Malawi.

ACKNOWLEDGEMENTS

The authors would like to thank the Pears Foundation and the International School of the Agriculture Sciences- The Hebrew University of Jerusalem for the scholarship that enabled carrying out this research (AAK). We appreciate the Open Society Initiative for Southern Africa (OSISA) for providing support for the fieldwork through the Pro-Farmer Project. We also want to thank all the field staff from Dedza and Thyolo districts who supported the project with community mobilization during the study. Finally, we would like to thank the women who took part in this study.

ajfand SCHOLARLY, PEER REVIEWED AFRICAN JOURNAL OF FOOD, AGRICULTURE, NUTRITION AND DEVELOPMENT Volume 22 No. 9 November 2022 PUBLISHED BY AFRICAN SCHOLARLY SCIENCE COMMUNICATIONS TRUST ISSN 1684 5374

Table 1: Demographic data of survey respondents from two districts in rural Malawi

	Characteristics	N	Dedza		Thyolo	
			Primary farmers n=106	Secondary Farmers n=65	Primary farmers n=70	Secondary Farmers n=95
Period lived in the village	less than 5 years	N (%)	0 (0)	0 (0)	1 (1.4)	0 (0)
	5 to 10 years	N (%)	0 (0)	3 (4.6)	2 (2.9)	1 (1.1)
	Beyond 10 years	N (%)	7 (6.6)	12 (18.5)	4 (5.7)	14 (14.7)
	Born in the village	N (%)	99 (93.4)	50 (76.9)	63 (90)	80 (84.2)
Marital status	Married monogamous	N (%)	74 (69.8)	45 (69.2)	48 (68.6)	57 (60)
	Married polygamous	N (%)	3 (2.8)	1 (1.5)	3 (4.3)	2 (2.1)
	Never married	N (%)	1 (0.9)	3 (4.6)	2 (2.9)	1 (1.1)
	Divorced/Separated	N (%)	14 (13.2)	2 (3.1)	10 (14.3)	16 (16.8)
	Widowed	N (%)	14 (13.2)	14 (21.5)	7 (10)	19 (20)
Under-five children	0 Children	N (%)	52 (49.1)	37 (56.9)	47 (67.1)	65 (68.4)
	1 Child	N (%)	41 (38.7)	20 (30.8)	17 (24.3)	22 (23.2)
	2 Children	N (%)	11 (10.4)	7 (10.8)	5 (7.1)	7 (7.4)
	3 Children	N (%)	2 (1.9)	0 (0)	1 (1.4)	1 (1.1)
	4 Children	N (%)	0 (0)	1 (1.5)	0(0)	0(0)
Education Level	No schooling	N (%)	21 (19.8)	12 (18.5)	12 (17.2)	14 (14.7)
	Some primary school	N (%)	66 (62.3)	32 (49.2)	38 (54.3)	59 (62.1)
	Completed primary school	N (%)	12 (11.3)	8 (12.3)	13 (18.6)	13 (13.7)
	Some secondary school	N (%)	2 (1.9)	8 (12.3)	5 (7.1)	7 (7.4)
	Completed secondary school	N (%)	4 (3.8)	5 (7.7)	2 (2.9)	1 (1.1)
	Adult education	N (%)	1 (0.9)	0 (0)	0 (0)	1 (1.1)
Profession	Farmer	N (%)	90 (84.9)	59 (90.8)	55 (78.6)	74 (77.9)
	Housewife	N (%)	6 (5.7)	2 (3.1)	5 (7.1)	14 (14.7)
	Employed	N (%)	4 (3.8)	1 (1.5)	5 (7.1)	5 (5.3)
	Business	N (%)	6 9(5.7)	3 (4.6)	5 (7.1)	2 (2.1)
Income source	Sells cash crop	N (%)	4 (3.8)	0 (0)	1 (1.4)	4 (4.2)
	Sells food crops	N (%)	79 (74.5)	54 (83.1)	44 (62.9)	51 (53.7)
	Sells livestock	N (%)	2 (1.9)	0 (0)	2 (2.9)	4 (4.2)
	Resale of goods	N (%)	0 (0)	0 (0)	0 (0)	1 (1.1)
	Casual labour	N (%)	8 (7.5)	3 (4.6)	8 (11.4)	4 (4.2)

ajfand SCHOLARLY, PEER REVIEWED AFRICAN JOURNAL OF FOOD, AGRICULTURE, NUTRITION AND DEVELOPMENT Volume 22 No. 9 November 2022 PUBLISHED BY AFRICAN SCHOLARLY SCIENCE COMMUNICATIONS TRUST ISSN 1684 5374

Owns a shop	N (%)	10 (9.4)	8 (12.3)	7 (10)	20 (21.1)
Sells firewood	N (%)	3 (2.8)	0 (0)	2 (2.9)	1 (1.1)
Formal Employment	N (%)	0 (0)	0 (0)	2 (2.9)	2 (2.1)
Brewing local beer	N (%)	0 (0)	0 (0)	2 (2.9)	1 (1.1)
Relative support	N (%)	0 (0)	0 (0)	2 (2.9)	7 (7.4)

Primary farmers = Women living on farms who have been cultivating orange maize for 3 years. Secondary farmers= Women living on farms in their first year of cultivating orange maize

ajfand SCHOLARLY, PEER REVIEWED AFRICAN JOURNAL OF FOOD, AGRICULTURE, NUTRITION AND DEVELOPMENT Volume 22 No. 9 November 2022 PUBLISHED BY AFRICAN SCHOLARLY SCIENCE COMMUNICATIONS TRUST ISSN 1684 5374

Table 2: Attitudes of women living on primary and secondary farms in two districts of rural Malawi towards orange maize

Attitude			Dedza		Thyolo	
	No/ Yes	N (%)	Primary Farmers n=106	Secondary Farmers n=65	Primary farmers n=70	Secondary Farmer n=95
Orange maize is good food	No	N (%)	2 (1.9)	2 (3.1)	1 (1.4)	1 (1.1)
	Yes	N (%)	104 (98.1)	63 (96.9)	69 (98.6)	94 (98.9)
		P	0.6		0.8	
Orange maize is for relief aid	No	N (%)	87 (82.1)	57 (87.7)	69 (98.6)	90 (94.7)
	Yes	N (%)	19 (17.9)	8 (12.3)	1 (1.4)	5 (5.3)
		P	0.3		0.2	
Orange maize is good for the family	No	N (%)	2 (1.9)	3(4.6)	0 (0)	0 (0)
	Yes	N (%)	104 (98.1)	62 (95.4)	70 (100)	95(100)
		P	0.3		.a	
Orange maize is for the poor	No	N (%)	93 (87.7)	57 (87.7)	69 (98.6)	94 (98.9)
	Yes	N (%)	13 (12.3)	7 (10.8)	1 (1.4)	1 (1.1)
		P	0.4		0.8	
I would grow orange maize if I had access to seeds	No	N (%)	2 (1.9)	2 (3.1)	0 (0)	0 (0)
	Yes	N (%)	104 (98.1)	63 (96.9)	70 (100)	95(100)
		P	0.6		.a	
Orange maize is used as a main preparatory flour	No	N (%)	93 (87.7)	55 (84.6)	68 (97.1)	93 (97.9)
	Yes	N (%)	13 (12.3)	10 (15.4)	2 (2.9)	2 (2.1)
		P	0.4		0.4	
Orange maize is good for children	No	N (%)	4 (3.8)	1 (1.5)	0 (0)	1 (1.1)
	Yes	N (%)	102 (96.2)	64 (98.5)	70 (100)	94 (98.9)
		P	0.6		0.741	
Orange maize is not good for Nsima	No	N (%)	99 (93.4)	65 (100)	70 (100)	95 (100)
	Yes	N (%)	7 (6.6)	0 (0)	0 (0)	0 (0)
		P	0.03		.a	
Nutrition information would make people grow orange maize	No	N (%)	3 (2.8)	1 (1.5)	0 (0)	0 (0)
	Yes	N (%)	103 (97.2)	64 (98.5)	70 (100)	95 (100)
		P	0.294		.a	
Orange maize tastes bad	No	N (%)	102 (96.2)	64 (98.5)	70 (100)	95 (100)
	Yes	N (%)	4 (3.8)	1 (1.5)	0(0)	0(0)
		P	0.6		.a	

P<0.05. a= No statistics are computed because there were no significant differences between the groups as both groups gave 100% responses

ajfand SCHOLARLY, PEER REVIEWED AFRICAN JOURNAL OF FOOD, AGRICULTURE, NUTRITION AND DEVELOPMENT Volume 22 No. 9 November 2022 PUBLISHED BY AFRICAN SCHOLARLY SCIENCE COMMUNICATIONS TRUST ISSN 1684 5374

Table 3: Nutrition knowledge of orange maize by farmers in two districts of rural Malawi

			Dedza		Thyolo	
Nutrition message	**Yes/No**	**N (%)**	**Primary farmer n=106**	**Secondary farmer n=65**	**Primary farmer n=70**	**Secondary farmers n=95**
Orange maize is a source of vitamin A	No	N (%)	0 (0)	1 (1.5)	0 (0)	0 (0)
	Yes	N (%)	42 (39.6)	16 (24.6)	27 (38.6)	30 (31.6)
	Don't know	N (%)	64 (60.4)	48 (73.8)	43 (61.4)	65 (68.4)
		P	0.07		0.4	
Orange maize is a source of protein	Yes	N (%)	39 (36.8)	19 (29.2)	34 (48.6)	26 (27.4)
	Don't know	N (%)	67 (63.2)	46 (70.8)	36 (51.4)	69 (72.6)
		P	0.3		0.005	
Orange maize is a source of carbohydrates	No	N (%)	2 (1.9%)	0 (0)	1 (1.4)	1 (1.1)
	Yes	N (%)	25 (23.6)	16 (24.6)	22 (31.4)	16 (16.8)
	Don't know	N (%)	79 (74.5)	49 (75.4)	47 (67.1)	78 (81.1)
		P	0.5		0.08	

P<0.05 Primary farmers= Famers who have been cultivating orange maize for 3 years. Secondary farmers= Famers who were in their first year of cultivating

ajfand SCHOLARLY, PEER REVIEWED AFRICAN JOURNAL OF FOOD, AGRICULTURE, NUTRITION AND DEVELOPMENT Volume 22 No. 9 November 2022 PUBLISHED BY AFRICAN SCHOLARLY SCIENCE COMMUNICATIONS TRUST ISSN 1684 5374

Table 4: Orange maize products consumed by primary and secondary farmers' children in Malawi

			Dedza district		Thyolo district	
Orange maize products	**Yes/No**	**N (%)**	**Primary farmer**	**Secondary farmer**	**Primary farmer**	**Secondary farmer**
Boiled green maize	No	N (%)	55 (51.9)	30 (46.2)	19 (27.1)	35 (36.8)
	Yes	N (%)	51 (48.1)	35 (53.8)	51 (72.9)	60 (63.2)
		CSV	0.530		1.722	
Nsima (thick porridge)	No	N (%)	21 (19.8)	25 (38.5)	4 (5.7)	13 (13.7)
	Yes	N (%)	85 (80.2)	40 (61.5)	66 (94.3)	82 (86.3)
		CSV	7.127		2.77	
Porridge	No	N (%)	19 (17.9)	40 (61.5)	8 (11.4)	33 (34.7)
	Yes	N (%)	87 (82.1)	25 (38.5)	62 (88.6)	62 (65.3)
		CSV	33.915		11.725	
Do you feed your children thobwa	No	N (%)	67 (63.2)	47 (72.3)	28 (40)	64 (67.4)
	Yes	N (%)	39 (36.8)	18 (27.7)	42 (60)	31 (32.6)
		CSV	1.502		12.238	

Primary farmer= Farmers who have cultivated orange maize for 3 years.
Secondary farmers= Farmers in their first year of cultivating orange maize
CSV= Chi-square value. Values in the same row with different superscript letters are significantly different at *p<0.05

https://doi.org/10.18697/ajfand.114.22305

ajfand SCHOLARLY, PEER REVIEWED AFRICAN JOURNAL OF FOOD, AGRICULTURE, NUTRITION AND DEVELOPMENT Volume 22 No. 9 November 2022 PUBLISHED BY AFRICAN SCHOLARLY SCIENCE COMMUNICATIONS TRUST ISSN 1684 5374

Table 5: Comparison of the percent of women consuming nutrient-rich foods and low nutrient density food groups by district

Food group	No/Yes	Dedza N (%)	Thyolo N (%)
Cereals/Grains	Yes	171 (100%)	165 (100%)
Legumes	No	83 (48.5%)	94 (57%)
	Yes	88 (51.5%)	71 (43%)
Nuts and Seeds	No	146 (85.4%)	151 (91.5%)
	Yes	25 (14.6%)	14 (8.5%)
Milk and milk products	No	159 (93%)	153 (92.7%)
	Yes	12 (7%)	12 (7.3%)
Meat, poultry and fish	No	120 (70.2%)	90 (54.5%)
	Yes	51 (29.8)	75 (45.5%)
Eggs (eggs of chicken, or eggs of fowl)	No	133 (77.8%)	133 (80.6%)
	Yes	38 (22.2%)	32 (19.4%)
Dark green leafy vegetables	No	41 (24%)	42 (25.5%)
	Yes	130 (76%)	123 (74.5%)
Other vitamin A fruits, vegetables and roots	No	131 (76%)	113 (68.5%)
	Yes	40 (23%)	52 (31.5%)
Other vegetables (tomato, onion, cabbage)	No	42 (24.6%)	28 (17%)
	Yes	129 (75.4%)	137 (83%)
Other fruits (banana, orange)	No	108 (63.2%)	115 (69.7%)
	Yes	63 (36.8)	50 (30.3%)
Oils and Fats	No	99 (57.9%)	85 (51.5%)
	Yes	72 (42.1%)	80 (48.%)

ajfand SCHOLARLY, PEER REVIEWED AFRICAN JOURNAL OF FOOD, AGRICULTURE, NUTRITION AND DEVELOPMENT Volume 22 No. 9 November 2022 PUBLISHED BY AFRICAN SCHOLARLY SCIENCE COMMUNICATIONS TRUST ISSN 1684 5374

REFERENCES

1. **Rouf Shah T, Prasad K and K Kumar** Maize—A potential source of human nutrition and health: A review. *Cogent Food and Agriculture*. 2016; **2:** 1166995.

2. **Ekpa O, Palacios-Rojas N, Kruseman G, Fogliano V and AR Linnemann** Sub-Saharan African maize-based foods-processing practices, challenges and opportunities. *Food Reviews International*. 2019; **35(7):** 609-639.

3. **Johan C, Okello J, Muoki P, Heck S and G Prain** Nutrition promotion messages : The effect of information on consumer sensory expectations , experiences and emotions of vitamin A-biofortified sweet potato. *Food Quality and Preference* .2016; **52:** 143-152.

4. **González C, Johnson N and N Qaim** Consumer acceptance of second-generation GM Foods: The case of biofortified cassava in the northeast of Brazil. *Journal of Agricultural Economics.* 2009; **60(3):** 604-24.

5. **Hwalla N, Al Dhaheri AS, Radwan H, Alfawaz HA, Fouda MA, Al-Daghri NM, Zaghloul S and JB Blumberg** The prevalence of micronutrient deficiencies and inadequacies in the Middle East and approaches to interventions. *Nutrients.* 2017; **9(3):** 229.

6. **Darnton-Hill I and UC Mkparu** Micronutrients in pregnancy in low-and middle-income countries. *Nutrients.* 2015: **7(3):** 1744-1768.

7. **Wiseman EM, Dadon SB and R Reifen** The vicious cycle of vitamin A deficiency : A review. Critical Reviews in Food Science and Nutrition 2017; **57(17):** 3703-3714.

8. **Bhutta ZA and RA Salam** Global nutrition epidemiology and trends. *Annals of Nutrition and Metabolism.* 2012; **61(1):** 19-27.

9. **World Health Organization.** Micronutrient deficiencies. Available on: https://www.who.int/nutrition/topics/vad/en/ *Accessed February 2 2021.*

10. **National Statistical Office (NSO).** Community Health Sciences Unit (CHSU) [Malawi], Centers for Disease Control and Prevention (CDC) and EU Malawi Micronutrient Survey 2015- 16: Key Indicators Report. 2016.

11. **Detzel P and S Wieser** Food fortification for addressing iron deficiency in Filipino children: benefits and cost-effectiveness. *Annals of Nutrition and Metabolism.* 2015; **66(2):** 35-42.

12. **De Groote H, Kimenju SC and UB Morawetz** Estimating consumer willingness to pay for food quality with experimental auctions: the case of yellow versus fortified maize meal in Kenya. Agricultural Economics. 2011; **42(1):** 1-6.

13. **Gibson RS** Strategies for preventing multi-micronutrient deficiencies: a review of experiences with food-based approaches in developing countries. Combating micronutrient deficiencies: food-based approaches. Wallingford, UK: CAB International. **2011:** 7-27.

14. **Laurie SM and SM Van Heerden** Consumer acceptability of four products made from beta-carotene-rich sweet potato. *African Journal of Food Science.* 2012; **6(4):** 96-103.

15. **Pillay K, Derera J, Siwela M and F Veldman** Consumer acceptance of yellow, provitamin A-biofortified maize in KwaZulu-Natal. *South African Journal of Clinical Nutrition* 2011; **24(4):** 186-19.

16. **De Groote H and SC Kimenju** Comparing consumer preferences for colour and nutritional quality in maize : Application of a semi-double-bound logistic model on urban consumers in Kenya. *Food Policy*. 2008; **33:** 362-370.

17. **Pixley K, Rojas NP, Babu R, Mutale R, Surles R and E Simpungwe** Biofortification of maize with provitamin A carotenoids. In: Carotenoids and Human Health. Humana Press, Totowa, 2013: 271-292.

18. **Murayama D, Yamazawa T, Munthali C, Bernard EN, Gondwe RL, Palta JP, Tani M, Koaze H and D Aiuchi** Superiority of Malawian orange local maize variety in nutrients, cookability and storability. *African Journal of Agricultural Research.* 2017; **19(5):** 1618-1628.

19. **Hwang T, Ndolo VU, Katundu M, Nyirenda B, Bezner-Kerr R, Arntfield S and T Beta** Provitamin A potential of landrace orange maize variety (Zea mays L.) grown in different geographical locations of central Malawi. *Food Chemistry.* 2016; **196:** 1315-1324.

20. **Food and Agriculture Organisation.** Capacity building for nutrition education. 2016 Available on: http://www.fao.org/ag/humannutrition/nutritioneducation/49739/en/zmb/ *Accessed February 2, 2021.*

21. **Cown MH, Grossman BM and SQ Giraudo** Nutrition education intervention to improve nutrition-related knowledge, attitudes, and behaviours for Hispanic children. *Ecology of Food and Nutrition.* 2017; **56(6):** 493-513.

22. **Global Historical Weather and Climate Data weather and climate.** 2022 Available on: https://tcktcktck.org/malawi/ *Accessed on June 7, 2022*.

23. **Ahmad H and H Halim** Determining sample size for research activities. Selangor Business Review. 2017: 20-34.

24. **Food and Agriculture Organisation**. Minimum dietary diversity for women: a guide for measurement. Rome: FAO. 2016;82.

25. **Muzhingi T, Langyintuo AS, Malaba LC and M Banziger** Consumer acceptability of yellow maize products in Zimbabwe. *Food Policy.* 2008; **33:** 352-361.

26. **Sheftel J, Gannon BM, Davis CR and SA Tanumihardjo** Provitamin A-biofortified maize consumption increases serum xanthophylls and 13 C-natural abundance of retinol in Zambian children. *Experimental Biology and Medicine.* 2017; **242:** 1508-1514.

27. **Giacalone D and SR Jaeger** Better the devil you know ? How product familiarity affects usage versatility of foods and beverages. *Journal of Economic Psychology.* 2016; **55:** 120-138.

28. **Kaguongo W, Ortmann G, Wale E, Darroch M and J Low** Factors influencing adoption and intensity of adoption of orange flesh sweet potato varieties : Evidence from an extension intervention in Nyanza and Western provinces, Kenya. *Journal of Agricultural Research*. 2012; **7(3):** 493-503.

29. **Swanson JA, Olson CM, Miller EO and FC Lawrence** Rural mothers' use of formal programs and informal social supports to meet family food needs: A mixed-methods study. *Journal of Family and Economic Issues*. 2008; **29(4):** 674-90.

30. **Okello JJ, Kwikiriza N, Muoki P, Wambaya J and S Heck** Effect of intensive agriculture-nutrition education and extension program adoption and diffusion of biofortified crops. *Journal of Agricultural and Food Information.* 2019; **20(3):** 254-276.

31. **Boke MM and AB Geremew** Low dietary diversity and associated factors among lactating mothers in Angecha districts, Southern Ethiopia : A community-based cross-sectional study. *BMC Research Notes*. 2018; **11:** 1-6.

32. **Chakona G** Minimum Dietary Diversity Scores for women indicate micronutrient adequacy and food insecurity status in South African towns. *Nutrients*. 2017; **9(8):** 812.

33. **Adubra L, Savy M, Fortin S, Kameli Y, Kodjo NE, Fainke K, Mahamadou T, Le Port A and Y Martin-Prével** The Minimum Dietary Diversity for Women of Reproductive Age (MDD-W) Indicator is related to household food insecurity and farm production diversity : Evidence from rural Mali. *Current Developments in Nutrition.* 2019; **3(3):** 1-9.