Consumption and wastage of home-fortified maize flour products in northern Malawi

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Abstract

Objective: The objective of the study was to determine the amount of home-fortified maize flour products consumed and wasted by women aged 15-49 years, and children aged ≤ 5 years.

Design: This was a descriptive cross-sectional study.

Setting: The study took place in Ekwendeni, a home fortification project area in Mzimba District, Northern Region, Malawi.

Subjects: The study subjects were members of a random sample of 205 households practising home fortification.

Outcome measures: The study's outcome measures included weighing fortified *nsima*, a thick maize flour-based porridge which was consumed, and its leftovers, using a kitchen scale. Using systematic random sampling, fortified maize flour and *nsima* samples were collected from households for energy, iron, zinc and vitamin A analysis. The data were analysed using descriptive statistics.

Results: The food intake and plate waste of fortified food products pertaining to 94 children (49% male and 51% female) and 173 women was analysed. Predominantly, *nsima* (55%) was the main food product made from fortified maize flour. Other foods were porridge and *chigumu*, whole maize flour-based bread. Overall, the daily average consumption of fortified foods (*nsima*, porridge and *chigumu*) was 332 g/day for children, and 1011 g/day for women. Plate waste accounted for 25% of the food served to the children, and 12% served to the women. Discarding fortified *nsima* resulted in a 23% loss of energy and micronutrients in the children, and a 11.2% loss in the women.

Conclusion: Commonly consumed home-fortified maize flour products were *nsim*a, porridge and *chigumu*. The plate waste of the fortified foods, primarily *nsima,* resulted in considerable loss of energy and micronutrients, especially in the children. Home-fortification interventions should include nutrition messages on food budgeting to minimise food and nutrient losses in women and children in northern Malawi.

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Introduction

Micronutrient deficiencies affect approximately two billion people globally, in whom deficiencies of vitamin A, iron, zinc and iodine are major public health problems in the developing world.[1] The causes of vitamin and mineral deficiencies are multiple and interconnected, but relate to diet at basic level.[2] In Malawi, 22% of children aged ≤ 5 years and 2% of non-pregnant women have a vitamin A deficiency (< 20 µg/dl of serum retinal value), and 55% of children aged ≤ 5 years and 32% of non-pregnant women are anaemic.[3] Urinary iodine levels < 50 µg/l were recorded in 11% of schoolchildren and 12% of non-pregnant women.[3] Furthermore, 47% of children aged ≤ 5 years are stunted in Malawi,[4] a proxy indicator of zinc deficiency.

Flour fortification is one strategy among many which form a comprehensive and holistic approach to enhancing nutrition and health by improving the micronutrient status of the population.[5] Maize is one of Malawi's staple foods. Thus, fortifying it with micronutrients is a convenient way of delivering micronutrients to the general population whose diet is generally deficient in micronutrients.[6] Community-level flour fortification is carried out in Malawi on a voluntary basis, and on a very small scale in isolated communities, such as Ekwendeni in the Northern Region, where a micronutrient intervention has been sustained since 2006, whereby households add a maize premix (IS-353®) to the flour. Little is known of the effect of the programme in countries where food fortification is performed voluntarily because very few evaluations are conducted.[7] Therefore, we undertook this study to determine the consumption of home-fortified flour and its products, and to quantify energy and micronutrient losses as a result of plate waste.

Method

Study area and population

This was descriptive cross-sectional study in which household members who were voluntarily practising home fortification in Ekwendeni, Mzimba District, northern Malawi, were recruited for the study. Women of reproductive age, i.e. 15-49 years old, and children ≤ 5 years, were targeted.

Sampling technique

The results of the 2009 National Micronutrient Survey showed that 18% of children aged ≤ 5 years in northern Malawi had iron deficiency anaemia (IDA).[3] Ekwendeni is the only area in Northern Region, Malawi, where a flour fortification programme has been implemented, and it was assumed that the prevalence of IDA in this area would be three percentage points lower than that in the region. It was estimated that the study sample should comprise 193 households, based on the following parameters: 95% confidence level, 1.96% two-tailed z-score, absolute precision of 5% and an estimated prevalence of IDA of 15%. Owing to the possibilities of non-responses, 10% was added to result in a sample of 212.

Simple random sampling was used to select 205 households whose members voluntarily fortified their flour. Systematic random sampling was employed to select every tenth household, resulting in a total of 20 households where samples of flour and *nsima* were collected. *Nsima* is a dish of maize flour cooked with water to a thick porridge or dough-like consistency.

Data collection

Using a structured questionnaire, interviews were conducted with the members of selected households within a two-week period between October and November 2011 by a team of trained research assistants. The questionnaire was designed to capture data on household characteristics, flour fortification using the IS-353® maize premix at household level, and the amount of fortified food served, consumed and wasted by women and children aged ≤ 5 years. In addition, fortified maize flour and *nsima* samples were collected from 20 households whose members fortified maize flour at household level in order to determine the energy and micronutrients levels.

Energy and micronutrient analysis

Energy and micronutrient analysis was performed according to the methods outlined in Table I.

Data analysis

The data were analysed using SPSS® for Windows® 16. Descriptive statistics [mean ± standard deviation (SD) and frequencies and percentages] were generated.

Results

Household characteristics

Data were collected from the members of 205 households, 21% of whom were headed by women (Table II). Farming was the main occupation (50%) in the study population. Business was the main occupation for 20%. The majority of the household heads (58%) had attained some form of primary school education. Only 3% had received a tertiary education.

Table I: Methods used for energy and micronutrient analysis

Energy and micronutrients	Method of determination
Moisture content	Oven-drying method[8]
Energy content	Calorimetric method using a 2 K calorimeter[8]
Ash content	Dry ashing method[8]
Zinc content	Atomic absorption spectrophotometer[8]
Iron content	Ultraviolet spectrophotometric method[8]
Vitamin A content	Spectrophotometric method[8]

Table II: Characteristics of the household heads

Characteristics of the household heads	n (%)
Gender	
Male	163 (80)
Female	42 (21)
Education	
None	3 (2)
Standard 1-4	12 (6)
Standard 5-8	106 (52)
Form 1-2	36 (18)
Form 3-4	41 (20)
Tertiary	6 (3)
Do not remember	1 (1)
Main occupation	
Farming	103 (50)
Regular wage earner	16 (8)
Casual employment	21 (10)
Business	41 (20)
Vacation work	22 (11)
Domestic or housework	2 (1)

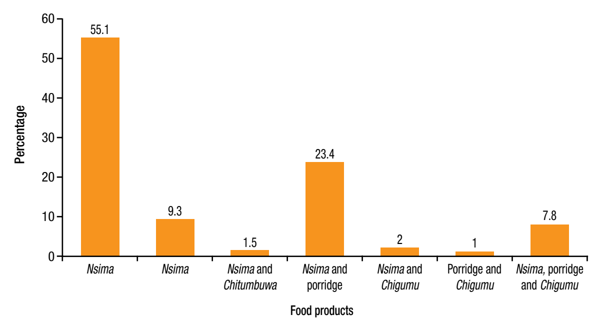
Fortification of flour at household level

It is shown in Table III that almost half (49%) of the households processed refined maize flour, one fifth (20%) processed whole maize flour, and 12% made degermed and dehulled maize flour, to which the IS-353® maize premix was added. The average period during which households fortified their flour was 21 months (a range of 1-72 months). The consumption of fortified food occurred almost daily, i.e. 6 days/week.

A variety of home-processed products were reported to have been prepared from fortified maize flour. The foods processed from fortified maize flour are shown in Figure I. *Nsima* (55%) was predominantly the main food product made from fortified maize flour.

Table III: The proportion of households who processed different types of maize flour

Type of flour	n (%)
Whole maize	40 (20)
Degermed and dehulled maize	24 (12)
Refined maize	101 (49)
Whole, degermed, dehulled and refined maize	3 (2)
Whole, degermed and dehulled	3 (2)
Degermed, dehulled and refined maize	17 (8)
Whole and refined maize	17 (8)



Nsima: Thick porridge made from maize flour
Chitumbuwa: Maize flour fritters
Chigumu: Traditional African cake made from maize flour

Figure I: The food products made from home-fortified flour at household level

Table IV: The micronutrient content of the IS-353® maize premix[9]

Micronutrients	Amount per kg
Vitamin A	37 551 600 IU
Thiamine (vitamin B_1 base)	12 502 mg
Riboflavin (vitamin B_2)	9 350 mg
Pyridoxine (vitamin B_6 base)	17 457 mg
Niacinamide	137 500 mg
Folic acid anhydrous (vitamin B_9)	11 000 mg
Iron	192 775 mg
Zinc	82 885 mg

It is normally recommended that at household level, the IS-353® maize premix (Table IV) should be added to the maize flour or maize grit before milling, after milling or before cooking.[9] In this study, 67% of households added the premix to the flour soon after milling, 17% before cooking, and 16% before milling. When the maize premix needs to be added to the maize flour, one container heaped with approximately 2 kg flour or grit must be mixed with one premix pack of 15 g. When households process more flour, the premix is added proportionally, depending on the quantity of flour.

The consumption of home-fortified foods by women and children

The food intake and plate waste of fortified foods were measured for 94 children aged ≤ 5 years (49% male and 51% female). The mean age of the children was 30 months. The food intake and plate waste of 173 women of reproductive age (31 years) was also determined.[1] Plate waste was defined as the quantity or percentage of edible portion of home-fortified food served and discarded by the women and children for purposes of this study.[10]

The overall consumption of fortified foods (porridge, *chigumu* and *nsima*) by the women was greater than that by the children (Table V). Average plate waste translated to 25% and 11% of the food served to the children and women, respectively. The percentage of food wastage varied according to food product and age category, but ranged from 4-24%. Plate waste was higher in the children than in the women.

Daily energy and micronutrient waste from fortified maize nsima

Samples of fortified *nsima* collected from the households showed that 100 g of fortified *nsima* contained 150.5 kcal, 10.4 mg of iron, 653.0 µg of vitamin A and 0.2 mg of zinc. Therefore, energy and micronutrient losses occurred when the women and children discarded *nsima* (Table VI). The plate waste of the *nsima* served to the women resulted in 11% energy loss, 11% iron, 9% zinc and 11%

Table V: The amount of fortified food that was served, consumed and wasted

Food	Served (g)		Consumed (g)		Wasted (g)	
	Women	Children	Women	Children	Women	Children
Nsima	1 178.0 ± 1.5	439.2 ± 1.6	1 040.2 ± 1.5	335.9 ± 1.9	132.3 ± 3.9	104.3 ± 3.2
Porridge	583.8 ± 1.3	340.6 ± 1.4	508.6 ± 1.3	239.5 ± 1.7	73.8 ± 2.0	77.4 ± 5.0
Chigumu	242.6 ± 1.5	-	223.1 ± 1.6	-	10.5 ± 5.9	-
Overall	1 144.7 ± 1.5	445.6 ± 1.6	1 010.9 ± 1.6	332.4 ± 1.8	131.6 ± 3.9	109.3 ± 3.1

* Values are ± standard deviation

Table VI: Daily energy and micronutrients served, consumed and wasted from fortified maize *nsima*

Energy and micronutrients	Served		Consumed		Wasted	
	Women	Children	Women	Children	Women	Children
Energy (kcal/100 g)	1 773.2	661.2	1 565.8	505.6	199.2	157
Iron (mg/100 g)	122.5	45.6	108.1	34.9	13.7	10.8
Zinc (mg/100 g)	3.3	1.2	2.9	0.9	0.3	0.2
Vitamin A (µg/100 g)	7 692.5	2 868.3	6 792.8	2 193.6	864.4	681.0
Mean amount (g)	1 178	439.2	1 040.2	335.9	132.3	104.3

vitamin A loss. There were more energy and micronutrient losses in the children than in the women. The plate waste of *nsima* served to the children resulted in a 24% loss in energy, 24% iron, 17% zinc and 24% vitamin A.

Discussion

We aimed to determine the consumption of home-fortified flour and its products in this descriptive study, as well as to quantify energy and micronutrient losses as a result of plate waste. A variety of home-processed foods, particularly *nsima* and porridge, were prepared from fortified maize flour.

The overall consumption levels of fortified foods in this study were higher than the national average of 203 g in women, and 102 g in children.[3] This could be owing to the fact that the present study was localised and targeted a project area in which households practised fortification, whereas the 2009 National Micronutrient Survey was performed cross-sectionally countrywide. Hence, the finding of a lower average consumption was unsurpising.

The plate waste of fortified food was evident in the women (131 g) and children (109 g). The children wasted more than twice the food than their mothers (25% vs. 12%). Considerable food waste occurred at consumption level. The study was conducted in October and November, regarded as the beginning of the "lean period" in Mzuzu Agriculture Development Division. However, the reasons for plate waste were not quantified in this study. This was a limitation of the study. Wasteful behaviour by household members at consumption level can reduce food availability at household level, which, in turn, can lead to reduced food intake, thereby contributing to undernutrition in household members.

Plate waste is one of the reasons for food loss at household level, accounted for day-to-day variations in appetite, energy needs, tastes and preferences.[11] Reasons for plate waste in this study were overestimation of the food quantities need to be prepared at household level, too much food being served per individual, loss of appetite and the relish (side dish) not being palatable.

Although zinc in fortified *nsima* does not provide an adequate daily zinc requirement for women and children, the consumption of fortified food is more important than that of unfortified food. According to a study conducted in Canada on preschool children aged 3-5 years, it was found that the consumption of zinc-fortified food contributed 9% of the daily intake in preschool children.[12]

Therefore, it was demonstrated in this study that there is need for nutrition education with regard to proper meal planning, preparation and the appropriate estimation of serving size according to individual needs. However, merely reducing portion size may not improve nutrient intake unless this is combined with increased nutrient density in the food.[13] Hence, a comprehensive nutrition education package which includes food budgeting, improved nutrient quality and efforts to curtail wasteful behaviour should be implemented in Ekwendeni.

Conclusion

It was shown in this localised study in a rural setting in northern Malawi, where a home-based fortification programme has been implemented for six years, that while fortified foods are consumed, *nsima* is the most common. Plate waste is common, resulting into significant energy and micronutrient (vitamin A, iron and zinc) losses in women and children. Proper meal planning, preparation and an appropriate estimation of serving size should form part of nutrition education in the area.

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