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# Nutritional Evaluation and Consumer Preference of Legume Fortified Maize-meal Porridge

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**Abstract** Maize-meal porridge is commonly consumed meal for the adults as breakfast food and for the children as complementary food. Food-to-food fortification was employed in order to improve the protein content of maize-meal porridge using soy flour and local groundnut paste. The study was aimed at evaluating the nutritional properties and consumer preference of the attributes of the unfortified porridge, legume-fortified porridge, and powdered milk-fortified porridge. The influence of consumers' knowledge of the type of fortificant added to the porridge was also investigated. Soy-fortified porridges provide comparable ash, crude fibre and fat contents to powdered milk-fortified porridge but with higher protein than powdered milk-fortified porridge. Soy flour raised the protein and ash content of the porridge by 90% and 63% respectively, the groundnut paste raised the protein and ash content by 88% and 41% and the powdered milk by 87% and 65% respectively. The unfortified porridge was the least preferred while the milk-fortified porridge was the most preferred. There was no significant difference between preference for some of the attributes of the groundnut paste fortified-porridge and the soy flour-fortified. There was no significant difference between consumption intent for the soy flour and groundnut paste -fortified porridge. Soy-fortified porridges provide comparable ash, crude fibre and fat contents to powdered milk- fortified porridge but with higher protein than powdered milk-fortified porridge. Soy-flour has shown to be a good substitute for powdered milk as a protein-fortificant for porridge and soy-fortified porridge could be a possible means of alleviating Protein-energy malnutrition among low income populations.

***Keywords:*** *maize-meal porridge, porridge fortificant, legume fortified porridge, Eastern Zambia*

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## 1. Introduction

Protein-Energy Malnutrition (PEM) is a prevailing public health problem in most developing countries [19], most especially Zambia. According to World Health Organization [25] report, 40% of children in Zambia are stunted as at 2014.While the Government of Zambia and its development partners have achieved some milestones in addressing malnutrition, the results of such efforts have been mildly evident as all forms of malnutrition remains high. Stunting (low height-for-age, reflecting chronic hunger), the most common nutrition disorder among children, still affects, 40% of children below 5 years and 14% of infants below 6 months. The prevalence of wasting is at 6% and the prevalence of underweight (low weight-for-age) children is at 15% (ZDHS, 2014). Around 10% of women aged between 15 and 49 are underweight. The high prevalence of stunting is well above the average in sub-Saharan Africa (SSA) and is affecting Zambia's potential to meet economic and development targets. In addition to being responsible for stunting in children, PEM has also been identified as the major cause of childhood morbidity and mortality [24] and has been attributed to deficiency of protein in commonly consumed staples. Maize porridge which is a bulky food low in nutrient density constitutes a major proportion of everyday diet of Zambians. It is used in both breakfast porridges and as complementary food in many African countries [4,10,12]. While urban consumers purchase maize meal processed with large plants from markets and supermarkets, rural consumers take their maize to small milling machines (hammer mills) for processing as this is a cheaper alternative to purchasing commercially milled maize meal [11].

Fortification of plant-based complementary foods can be an effective strategy for addressing childhood malnutrition in developing countries [12], provided that it is affordable for most of the population. Fortification of traditional cereal based meals with protein-rich legumes has been identified as a possible means of alleviating PEM among low income populations [7]. Although powdered milk (dried whole milk) would have been an ideal fortificant for maize meal porridge owing to its high protein content of up to 37.0% [20] and its non-perishable nature which makes it suitable for storage without refrigeration. However, this may be too expensive for low income populace where PEM is prevalent and it is highly necessary to make use of locally available cheap protein sources as alternatives. In Zambia, the soya bean is mostly used as an industrial crop. It is used in oil production and in products such as soya chunks and soya meal. Soya beans offer a variety of potential benefits to the production systems, diets, and incomes of smallholder producers. In addition to being a potentially profitable cash crop, the highprotein content (about 40%) in soya means it could also contribute to improved nutritional status of rural households [5]. Though soya beans are not usually boiled and eaten like other legumes such as beans, cowpeas, or groundnuts, the soya flour could be mixed with other ingredients to form a nutritious rich protein blend that can be prepared into breakfast porridge. Given high levels of under nutrition in Eastern Province [23], it is believed that soya porridge can improve the health of the malnourished children. Groundnut is also an important crop, with an estimated 700,000 small-scale farmers producing the crop annually [14]. Groundnuts play an integral role in the livelihoods of the majority of the Zambian population, particularly the rural households. The crop is equally important in Zambian diets. Groundnuts are often eaten in their raw form, or processed as powder and/ or groundnut. In total, groundnuts constitute approximately 3.3% of the urban household food expenditure in Zambia. In Eastern province, groundnut plays a key role in diets, being utilized in their raw form, in powder, or as peanut butter [14]. However, Soybeans and groundnut are locally available and not so expensive protein option but information on whether or not these cheap alternatives provide the same nutritional quality as powdered milk at the same level of substitution is limited in the literature. Also the success of any dietary interventions program is to a large extent dependent on the extent to which consumers accept such interventions. Most studies on consumer acceptance of food-to-food fortified samples have been based on blind tests with participants having no knowledge of what was presented to them, not much has been done to investigate the extent to which having knowledge of fortificants in the food samples influence consumer preference/acceptance of the foods. The objective of this study is in threefold:

1. Compare the nutritional properties, consumer preference and consumption intent of maize meal porridge fortified with two protein-rich legumes (soy flour and groundnut paste) against unfortified maize meal porridge and the same porridge fortified with powdered milk.
2. Investigate the influence of knowledge of the type of fortificant used for fortification on consumer acceptance of the maize meal porridges.
3. Investigate the contribution of sensory preference to intention to consume the porridges.

## 2. Materials and Methods

### 2.1. Selection of Study Sites

The study was conducted in Chipata, Katete and Lundazi regions of Eastern province of Zambia. These locations were purposively selected because of the high prevalence of malnutrition in this region despite the high Agricultural productivity. The province is the third largest maize producer and the first largest groundnut producer producing 23% and 30% of maize and groundnut respectively of the whole country [15]. The high Agricultural productivity of the Eastern region notwithstanding, the province recorded a stunting rate of 51.7% in 2010; the second largest in the whole country and higher than the national average of 46.7% [22].

### 2.2. Materials

Maize meal and powdered milk (Cowbell brand) were purchased from supermarket in Lusaka, Zambia. Groundnut paste was obtained from local market while soybean grains were obtained from International Institute of Tropical Agriculture (IITA), Zambia.

### 2.3. Methods

#### 2.3.1. Processing of Soy Bean Grains into Flour

Soy bean grains were processed into flour using a modification of the method described by [16]. Grains were cleaned and sorted to remove stones and other impurities before roasting slightly under low heat until light brown and until seed coat can be removed by hand. The roasted grains were then coarse-milled and winnowed to remove seed coat. The decorticated grains were finely milled into powder and sieved.

**Figure 1.** Types of porridges (from left to right): Unfortified; Soy-fortified; groundnut-fortified and powdered milk-fortified

#### 2.3.2. Preparation of Porridge Samples

Four variants of porridges were made, these are – the unfortified (without any fortificant), soy -fortified, groundnut paste-fortified and powdered milk-fortified (Figure 1). For the unfortified porridge, 500g of maize meal was mixed with 2500g of water (ratio 1:5) and cooked for approximately 30 minutes. The same level of substitution (20%) was used for the other three porridge types. This level was chosen because past studies have shown that legumes can be used to supplement cereals at this level without off-flavour [3]. For soy-fortified, 100g of the maize meal was replaced with soy flour so that the combination was 400g of maize meal,100g of soy flour and 2500g of water. The maize- meal soy flour mix was thoroughly mixed with water and cooked for approximately 30 minutes. This was done in order to ensure the soy was properly cooked and does not taste or smell raw in the porridge. The groundnut and powdered milk variants were also substituted in the same proportion. However, the milk and groundnut were added after the porridge was cooked for a while and thoroughly mixed with the porridge.

#### 2.3.3. Proximate Composition Analysis

The four porridge samples (unfortified, soy-fortified, groundnut-fortified and powdered milk-fortified) were analysed for moisture, ash, protein, fat, total sugars, starch, amylose, crude fibre, and total carbohydrate (by difference).

***2.3.3.1 Moisture content*:** This was determined using the AOAC [2] method. The sample was dried at 100-105°C for 24 hrs in a draft air Fisher Scientific Isotemp$^{R}$ Oven model 655F. The loss in weight was recorded as moisture content.

***2.3.3.2 Ash content:*** This was determined by the method of AOAC [2]. The method involved burning off moisture and all organic constituents at 600°C in a VULCAN$^{TM}$ furnace model 3-1750. The weight of the residue after incineration was recorded as the Ash content.

***2.3.3.3 Crude protein:*** This was determined by the Kjeldahl method using Kjeltec$^{TM}$ model 2300, as described in Foss Analytical Manual AB. (2003). The method involved digestion of the sample at 420°C for 1 h to liberate the organically bound nitrogen in the form of ammonium sulphate. The ammonia in the digest (ammonium sulphate) was then distilled off into a boric acid receiver solution, and then titrated with standard Hydrochloric acid. A conversion factor of 6.25 was used to convert from total nitrogen to percentage crude protein.

***2.3.3.4 Crude fat**:* This was determined using the AOAC [2] method in a Soxtec System HT2 fat extractor. Crude fat was extracted from the sample with hexane, and the solvent evaporated off to get the fat. The difference between the initial and final weight of the extraction cup was recorded as the crude fat content.

***2.3.3.5 Starch and Sugar:*** The method of Dubois et al. [6] was used for the starch and sugar determination. This involved extraction of starch and free sugar from the samples with 95% ethanol, and the hydrolysis of the starch residue with perchloric acid to sugars. The sugar obtained after hydrolysis of the residue was converted to starch by multiplying by 0.9. The absorbance of both starch and sugar was read at 490 nm.

***2.3.3.6 Amylose content:*** This was determined using the method described by Williams et al. [26]. This is aspectrophotometric method based on the formation of deep blue-colored complex with iodine, the absorbance of which is read at 620 nm.

***2.3.3.7 Crude fib**er:* This was determined by the Tecator (1978) method using FOSS Fibertec$^{TM}$ 2010 model.

***2.3.3.8* Total carbohydrate:** This was determined by difference, which is the addition of percentage of moisture, protein, fat and ash contents were subtracted from 100%.

$$\%\ CHO = 100 - \left\{ \begin{matrix} \%\ MC + \%\ protein + \%\ fat \\ + \%\ ash + crude\ fibre \end{matrix} \right\}.$$

## 2.4. Sensory and Consumer Preference Evaluation

Survey was carried out in Chipata, Lundazi and Katete districts. All three districts are in Eastern province of Zambia**.** A total of 284 respondents (91 males and 193 females) took part in the survey. For the blind evaluation condition, the samples were coded with three-digit random numbers and each participant presented with the four porridge samples in similar plastic cups. Participants rated the appearance, aroma, consistency, mouthfeel and taste of each sample on 7-point hedonic scale ranging from dislike very much = 1 to like very much = 7.Consumption intent was measured on a 5 point scale ranging from 'will definitely not consume' =1 to will definitely consume'= 5. Afterwards, participants were told what each of the porridges contained (labelled condition) and were again asked to rate for preference and consumption intent.

## 2.5. Data Analysis

All chemical analysis were done in duplicate. The sensory scores and consumption intent data were analysed using Analysis of Variance (ANOVA) with the attributes being dependent on the type of protein supplement used. The Tukey's HSD multiple comparison range test was used to test for significance between the variables at 0.05 level. A linear regression analysis was carried out to predict consumption intent from sensory attributes.

# 3. Results and Discussion

## 3.1. Characteristics and Consumption Frequency of the Survey Respondents

Table 1 showed details of the characteristics of consumer survey participants across the three locations. Over 60% of the participants were females while the average age was 37years. A larger percentage of the participants were frequent consumer of maize meal porridge with over 50% of the participants consuming the product three or more times a week. This is an indication that maize meal porridge constitutes a significant proportion of the diet of the three communities.

## 3.2 Nutritional Qualities of Unfortified and Fortified Porridges:

Results showed a significant difference in the proximate composition of the four porridge types except for Carbohydrate {$F(1, 2) = 4.68$, $p= 0.09$}. Samples differed significantly in the moisture content {$F(1, 2) = 10.02$, $p=0.03$}; Ash content {$F(1, 2) = 154.26$, $p=0.00$}; amylose {$F(1, 2) = 768.27$, $p= 0.00$}; protein {$F(1, 2) = 44.65$, $p = 0.002$}; sugar {$F(1, 2) = 183.32$, $p=0.00$} and Starch {$F(1, 2)=135.78$, $p=0.00$} (Table 2). The samples differ significantly in fat {$F (1, 2) = 5043.31$, $p=0.00$} as well as crude fibre contents{F (1, 2) =187.35, p=0.00}. The unfortified porridge had the lowest ash content followed by the groundnut paste-porridge while the powdered milk-porridge had the highest ash content. Nonetheless, there is no significant difference between the ash content of the soy- porridge and the powdered milk-porridge. There was no significant difference between amylose content of the powdered milk and soy flour-porridges while the groundnut paste-porridge contained the highest amylose. Overall, both powdered milk and soy flour fortified-porridges were comparable in terms of ash, amylose, fat and crude fibre content. With respect to protein content, soy-porridge contained the highest level of protein followed by the groundnut paste porridge while the unfortified porridge contained the least level of protein. Although the soy flour fortified-porridge contained significantly higher level of protein than powdered milk fortified porridge, the difference between the protein level in soy flour fortified and groundnut paste-fortified was not statistically significant.

**Table 1. Characteristics and consumption frequency of the Survey Respondents**

| Variables | Location | | | |
|---|---|---|---|---|
| | **Lundazi (n=100)** | **Katete(n=94)** | **Chipata(n=90)** | **Total (n=284)** |
| **Gender** | | | | |
| Male | 23 (23.0%) | 36 (38.3%) | 32 (35.6%) | 91 (32.04%) |
| Female | 77 (77.0%) | 58 (61.7%) | 58 (64.4%) | 193 (67.96%) |
| **Age** | | | | |
| Mean ± SD | 40 ± 10 | 40 ± 12.57 | 32 ± 11.62 | 37 ± 12.02 |
| Minimum | 16 | 20 | 17 | 16 |
| Maximum | 67 | 79 | 80 | 80 |
| **Consumption frequency of Porridge** | | | | |
| Less than once a week | 16 (16.0%) | 12 (12.8%) | 9 (10%) | 37 (13.12%) |
| Once in a week | 23 (23.0%) | 17(18.1%) | 12 (13.3%) | 52 (18.44%) |
| Twice a week | 15 (15.0%) | 15 (16.0%) | 16 (17.8%) | 46 (16.32%) |
| Thrice a week | 15 (15.0%) | 23 (24.5%) | 14 (15.6%) | 52 (18.44%) |
| More than thrice a week | 31 (31.0%) | 27 (28.7%) | 37 (41.1%) | 95 (33.69%) |

**Table 2. Proximate composition of porridges fortified with soy flour, groundnut paste and powdered milk at the same level of substitution**

| Parameters | Unfortified | With Soy flour | With groundnut paste | With powdered milk |
|---|---|---|---|---|
| % Moisture | 81.15a ± 0.62 | 80.72 a ± 0.19 | 77.77b ± 0.62 | 79.56a, b ± 1.01 |
| % Ash | 0.14a ± 0.00 | 3.8b ± 0.01 | 2.4c ± 0.02 | 3.4b ± 0.00 |
| % Amylose | 21.17a ± 0.12 | 21.61b ± 0.12 | 24.62c ± 0.06 | 21.91b ± 0.06 |
| % Protein | 2.5a ± 0.03 | 12.66b ± 0.19 | 12.11b ± 0.39 | 12.05c ± 0.10 |
| %Sugar | 0.85a ± 0.10 | 0.91a ± 0.05 | 2.29b ± 0.03 | 1.28c ± 0.07 |
| % Starch | 4.10a ± 0.28 | 3.78a ± 0.33 | 9.46b ± 0.34 | 8.18b ± 0.43 |
| % Fat | 2.0a ± 0.00 | 3.7b ± 0.00 | 4.11 c ± 0.00 | 3.23b ± 0.02 |
| % Crude fibre | 1.8a ± 0.00 | 8.6b ± 0.00 | 3.61c ± 0.22 | 2.53b ± 0.00 |
| % Carbohydrate | 18.18a ± 0.59 | 16.02a ± 0.37 | 18.77 a ± 1.03 | 17.76a ± 0.96 |

Means with different superscripts within the same row are statistically significant at 0.05 level.

## 3.3. Consumer Preference for Maize Meal Porridges (blinded and labelled conditions)

Table 3 and Table 4a showed the Consumer preference for maize meal porridges (blinded and labelled conditions) by location and across the three locations respectively. Across the three locations, the preference ratings of the sensory properties for powdered milk-porridge were significantly higher than the other fortified porridges, irrespective of both blinded and labelled conditions. Although there were changes in preference for the attributes when participants became aware of the type of fortificant used, but the observed changes were not statistically significant. For both blinded and labelled conditions, the attributes of groundnut paste-porridge were the next most preferred followed by soy flour-fortified porridge. Preference for the attributes of unfortified porridge dropped when participants became aware that no form of fortificant was used. There was no significant difference in the preference for appearance, aroma and consistency of soy-porridge and groundnut paste but the two porridge samples differed significantly in taste and mouthfeel.

## 3.4. Respondents Change in Preference when Aware of Fortificant

A negative change in preference was reported for all the sensory properties of unfortified porridge when respondents became aware that it contained no fortificant (Table 4b). On the other hand, preference for groundnut paste-porridge increased for all the sensory attributes except for consistency when respondents became aware of what it contained. There was also an increase in preference for the appearance and mouth feel of soy-porridge when participants were informed of the fortificant.

## 3.5. Consumption intent of the Respondents in Blinded and Labelled Conditions

In Lundazi, powdered milk fortified-porridge had the highest consumption intent both in the blinded and labelled condition. This was followed by soy-porridge and groundnut paste-porridge respectively (Table 5), The consumption intent for powdered-milk porridge was significantly higher than that of groundnut paste, soy flour and unfortified porridges However there was no significant difference in intention to consume groundnut-paste and soyflour -porridge. For participants in Katete, preference for powdered milk fortified-porridge was followed by groundnut paste fortified- porridge and soy flour- fortified porridge but unfortified porridge had the least consumption intent in Katete. There was no significant influence of experimental conditions (blinded and labelled) on consumption intent in Lundazi and Katete, there was a significant difference in consumption intent when consumers became aware of the fortificant type in Chipata {$F(1,706) = 6.24$, $p = 0.0013$}. Also in Chipata, there was no significant difference between consumption intent for milk porridge and groundnut porridge.

**Table 3. Consumer preference for maize meal porridges (blinded and labelled conditions) by location**

| | | Blinded | | | | Labelled | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Districts** | **Sensory properties** | **[a]Unfortified** | **With soy** | **With groundnut** | **With powdered milk** | **Unfortified** | **With soy** | **With groundnut** | **With milk** |
| **Lundazi** | Appearance | 6.04$^{a}$ (1.49) | 6.09$^{a}$ (1.07) | 4.82$^{b}$ (2.43) | 6.53$^{c}$ (1.09) | 5.51$^{a}$ (1.82) | 6.13$^{a}$ (1.09) | 5.10$^{b}$ (2.36) | 6.60$^{c}$ (1.15) |
| | Aroma | 5.33$^{a}$ (1.87) | 6.09$^{b,c}$ (1.16) | 5.59$^{b}$ (2.09) | 6.21$^{c}$ (1.59) | 4.74$^{a}$ (2.13) | 5.94$^{b,c}$ (1.33) | 5.64$^{b}$ (2.08) | 6.50$^{c}$ (1.30) |
| | Consistency | 5.22$^{a}$ (2.06) | 6.11$^{b}$ (1.15) | 5.40$^{c}$ (2.16) | 6.45$^{b}$ (1.26) | 4.65$^{a}$ (2.23) | 6.09$^{b}$ (1.09) | 5.44$^{c}$ (2.15) | 6.50$^{b}$ (1.24) |
| | Mouthfeel | 4.93$^{a}$ (2.13) | 6.03$^{b}$ (1.37) | 5.39$^{c}$ (2.26) | 6.48$^{d}$ (1.27) | 4.66$^{a}$ (2.20) | 6.05$^{b}$ (1.10) | 5.51$^{c}$ (2.03) | 6.64$^{d}$ (1.11) |
| | Taste | 4.63$^{a}$ (2.24) | 6.03$^{b}$ (1.37) | 5.49$^{b}$ (2.20) | 6.59$^{c}$ (1.17) | 4.54$^{a}$ (2.23) | 5.90$^{b}$ (1.40) | 5.66$^{b}$ (1.98) | 6.64$^{c}$ (1.19) |
| **Katete** | Appearance | 5.13$^{a}$ (2.07) | 4.21$^{b}$ (2.13) | 5.06$^{a}$ (1.84) | 6.44$^{c}$ (1.14) | 5.23$^{a}$ (2.10) | 4.55$^{b}$ (2.15) | 5.19$^{a}$ (1.84) | 6.32$^{c}$ (1.43) |
| | Aroma | 4.32$^{a}$ (2.16) | 4.34$^{a}$ (2.33) | 5.07$^{b}$ (1.91) | 6.31$^{c}$ (1.02) | 4.23$^{a}$ (2.16) | 4.33$^{a}$ (2.26) | 5.27$^{b}$ (1.27) | 6.23$^{c}$ (1.35) |
| | Consistency | 4.85$^{a}$ (2.08) | 4.72$^{a}$ (1.95) | 5.10$^{a,b}$ (1.73) | 5.89$^{c}$ (1.70) | 4.65$^{a}$ (2.09) | 4.52$^{a}$ (2.04) | 5.18$^{a,b}$ (1.57) | 6.15$^{c}$ (1.36) |
| | Mouthfeel | 3.81$^{a}$ (2.24) | 4.25$^{a}$ (2.24) | 5.02$^{b}$ (1.95) | 6.54$^{c}$ (0.95) | 3.73$^{a}$ (2.24) | 4.23$^{a}$ (2.26) | 5.01$^{b}$ (1.83) | 6.61$^{c}$ (0.72) |
| | Taste | 3.65$^{a}$ (2.26) | 4.14$^{b}$ (2.24) | 5.05$^{c}$ (1.91) | 6.70$^{d}$ (0.69) | 3.45$^{a}$ (2.29) | 4.18$^{b}$ (2.26) | 5.31$^{c}$ (1.76) | 6.60$^{d}$ (0.89) |
| **Chipata** | Appearance | 4.09$^{a}$ (2.55) | 5.16$^{b}$ (2.07) | 5.38$^{b}$ (1.87) | 5.44$^{b}$ (2.23) | 3.47$^{a}$ (2.63) | 5.58$^{b}$ (1.74) | 5.81$^{b}$ (1.73) | 6.00$^{b}$ (1.70) |
| | Aroma | 2.53$^{a}$ (2.14) | 5.09$^{b}$ (2.02) | 5.49$^{b}$ (1.88) | 5.24$^{b}$ (2.16) | 2.03$^{a}$ (1.80) | 5.30$^{b}$ (1.78) | 5.66$^{b}$ (1.82) | 5.44$^{b}$ (2.01) |
| | Consistency | 3.42$^{a}$ (2.30) | 5.28$^{b}$ (1.69) | 5.61$^{b}$ (1.76) | 5.27$^{b}$ (2.03) | 3.44$^{a}$ (2.40) | 5.17$^{b}$ (1.95) | 5.34$^{b}$ (2.00) | 5.61$^{b}$ (1.92) |
| | Mouthfeel | 3.24$^{a}$ (2.34) | 4.53$^{b}$ (2.02) | 5.70$^{c}$ (1.76) | 5.45$^{c}$ (2.11) | 2.74$^{a}$ (2.16) | 5.33$^{b}$ (1.60) | 5.90$^{c}$ (1.61) | 5.91$^{c}$ (1.71) |
| | Taste | 2.30$^{a}$ (1.98) | 4.70$^{b}$ (1.98) | 5.77$^{c}$ (1.71) | 5.33$^{c}$ (2.22) | 2.30$^{a}$ (1.92) | 5.28$^{b}$ (1.79) | 5.80$^{c}$ (1.72) | 5.91$^{c}$ (1.73) |

[a]Sensory ratings with Stdev in bracket

Means with different superscripts within the same row are statistically significant at 0.05 level.

**Table 4a. Consumer preference for maize meal Porridges across the three locations**

| | Blinded | | | | Labelled | | | |
|---|---|---|---|---|---|---|---|---|
| **Sensory properties** | **[a]Unfortified** | **With soy** | **With groundnut** | **With milk** | **Unfortified** | **With soy** | **With groundnut** | **With milk** |
| Appearance | 5.12$^{a}$ (2.21) | 5.17$^{b}$ (1.96) | 5.08$^{b}$ (2.08) | 6.15$^{c}$ (1.63) | 4.78$^{a}$ (2.36) | 5.43$^{b}$ (1.82) | 5.35$^{b}$ (2.02) | 6.32$^{c}$ (1.45) |
| Aroma | 4.11$^{a}$ (2.35) | 5.19$^{b}$ (2.02) | 5.39$^{b}$ (1.97) | 5.94$^{b}$ (1.71) | 3.72$^{a}$ (2.34) | 5.20$^{b}$ (1.94) | 5.52$^{b}$ (1.87) | 6.08$^{c}$ (1.63) |
| Consistency | 4.53$^{a}$ (2.28) | 5.39$^{b}$ (1.71) | 5.37$^{b}$ (1.91) | 5.89$^{c}$ (1.75) | 4.27$^{a}$ (2.30) | 5.28$^{b}$ (1.85) | 5.32$^{b}$ (1.92) | 6.10$^{c}$ (1.56) |
| Mouth feel | 4.03$^{a}$ (2.34) | 4.97$^{b}$ (2.03) | 5.37$^{c}$ (2.02) | 6.18$^{d}$ (1.58) | 3.75$^{a}$ (2.33) | 5.22$^{b}$ (1.87) | 5.46$^{c}$ (1.86) | 6.40$^{d}$ (1.28) |
| Taste | 3.57$^{a}$ (2.36) | 4.99$^{b}$ (2.05) | 5.44$^{c}$ (1.97) | 6.23$^{d}$ (1.60) | 3.48$^{a}$ (2.32) | 5.14$^{b}$ (2.02) | 5.59$^{c}$ (1.84) | 6.40$^{d}$ (1.34) |

Different superscripts within the same row are statistically significant at 0.05 level

[a]Sensory ratings with Stdev in bracket.

**Table 4b. Percentage change in preference of the respondents**

| Attributes | Unfortified | With soy | With groundnut | With milk |
|---|---|---|---|---|
| Appearance | -7.11 | 4.79 | 5.05 | 2.69 |
| Aroma | - 10.48 | 0.19 | 5.98 | 2.30 |
| Consistency | -6.09 | -2.08 | -0.94 | 3.44 |
| Mouthfeel | -7.47 | 4.79 | 1.65 | 3.44 |
| Taste | -2.59 | 2.92 | 2.68 | 2.65 |

At the same level of substitution, soy flour gave significantly higher levels of protein in maize meal porridge than powdered milk and a non-significantly higher level than groundnut paste. Whereas the soy flour raised the protein and ash content of the porridge by 90% and 63% respectively, the groundnut paste raised the protein and ash content by 88% and 41% and the powdered milk by 87% and 65% respectively. Thus, a 557 g portion size of soy- porridge will meet 100% Recommended daily allowance (RDA) of protein for children between 4 to 8years, while 1349 g and 1642 g portion sizes of soy-porridge will meet 100% RDA of protein for Women (>19yrs) and men (>19yrs) respectively. The significantly higher contribution of soy flour to the protein content of the maize meal porridge can be attributed to the considerable protein quantity of soy bean [18] and it is in agreement with the work of several authors who have attempted to raise the protein content of cereals and even roots and tubers by fortifying with soy. Soy flour was able to make this significant impact on the protein level of the maize meal porridge than groundnut paste or any other protein-rich legume for that matter due to the significantly high protein content of soy beans when compared to other legumes. While some varieties of soy bean contain as much as 38% protein [13], groundnut contains between 15.4% to 30.2% depending on the genotype and growing environment [21]. The higher protein content of soy flour fortified maize meal porridge than the groundnut paste fortified notwithstanding, the protein of the later may be more bioavailable than the former as the protein digestibility of groundnut has been shown to be higher than that of soy [21]. The significantly higher protein content of the soy flour fortified maize meal porridge against the powdered milk fortified maize meal porridge corroborates the review by Hoppe, Andersen et al. [9] who stated that soy flour contained 31.0% protein whereas dried whole milk contained 20%. Contrary to report by [1] that soybean has more oil yield than groundnut, result of this study showed that the groundnut paste fortified maize meal porridge contained significantly more fat than the powdered milk and soy flour fortified porridge. This can be attributed to the possibility that additional oil may have been added to the groundnut while roasting or at any stage during the groundnut paste processing.

**Table 5. Consumption intent of the respondents in blinded and labelled conditions**

| | **Blinded** | | | | **Labelled** | | | |
|---|---|---|---|---|---|---|---|---|
| **Districts** | **Unfortified** | **With soy** | **With groundnut** | **With milk** | **Unfortified** | **With soy** | **With groundnut** | **With milk** |
| Lundazi | $3.23^{a}$ (1.56) | $3.88^{b}$ (1.15) | $3.81^{b}$ (1.52) | $4.79^{c}$ (1.17) | $3.33^{a}$(1.95) | $4.12^{b}$ (1.24) | $3.82^{b}$ (1.44) | $4.68^{c}$ (1.00) |
| Katete | $2.87^{a}$(1.66) | $3.17^{b}$ (1.50) | $3.71^{c}$ (1.35) | $4.73^{d}$ (0.71) | $2.79^{a}$(1.67) | $3.23^{b}$ (1.43) | $3.70^{c}$ (1.31) | $4.67^{d}$ (0.86) |
| Chipata | $1.90^{\{a\}a}$ (1.32) | $3.30^{\{a\}b}$ (1.38) | $4.04^{\{a\}c}$ (1.18) | $3.82^{\{a\}c}$ (1.53) | $1.67^{\{b\}a}$(1.17) | $3.83^{\{b\}b}$ (1.12) | $4.22^{\{b\}c}$ (1.12) | $4.27^{\{b\}c}$ (1.12) |

Similar superscripts within the same row are not statistically significant at 0.05 level
Different superscripts within the same row are statistically significant at 0.05 level
Superscripts within parenthesis {} shows effect of experimental condition (blinded versus labelled)
Superscript outside parenthesis {} shows effect of porridge fortificant.

The significantly low preference for the all the attributes of the unfortified maize meal porridge when compared to the fortified maize porridges used in this study was an indication that consumers preferred consuming their porridges with fortificant This may be true considering that preference for unfortified maize meal porridge fell when participants became aware that it does not contain any form of supplement. Similar preference results were reported by Olapade, Oluwole et al. [17] who observed that consumers found fermented maize porridge supplemented with 20% cowpea acceptable. Preference for porridge with some form of fortificant will go a long way in ensuring success of any dietary intervention program aimed at alleviating PEM by promoting use of fortificant in maize meal porridges.

## 4. Conclusion

The preference for the attributes of the unfortified porridge dropped when consumers were informed that it did not contain any fortificant while preference increased for the other porridge types when consumers became aware of the fortificant type. However, successful application of using legumes as fortificants to maize porridge, ultimately depends on a whole lot of other factors such as availability of the supplements, price and the financial capability of the consumers to purchase such fortificants. On the other hand, a positive change in preference for the soy flour and groundnut paste fortified maize meal porridges, when comparing the blind condition with the labelled condition implied that consumers do not have any aversion for either of the protein-rich legume sources. Hence, impacting food-to-food fortification knowledge to the consumers by way of nutritional education and sensitization will go a long way in promoting these interventions among consumers in the rural vulnerable communities of the developing countries.

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