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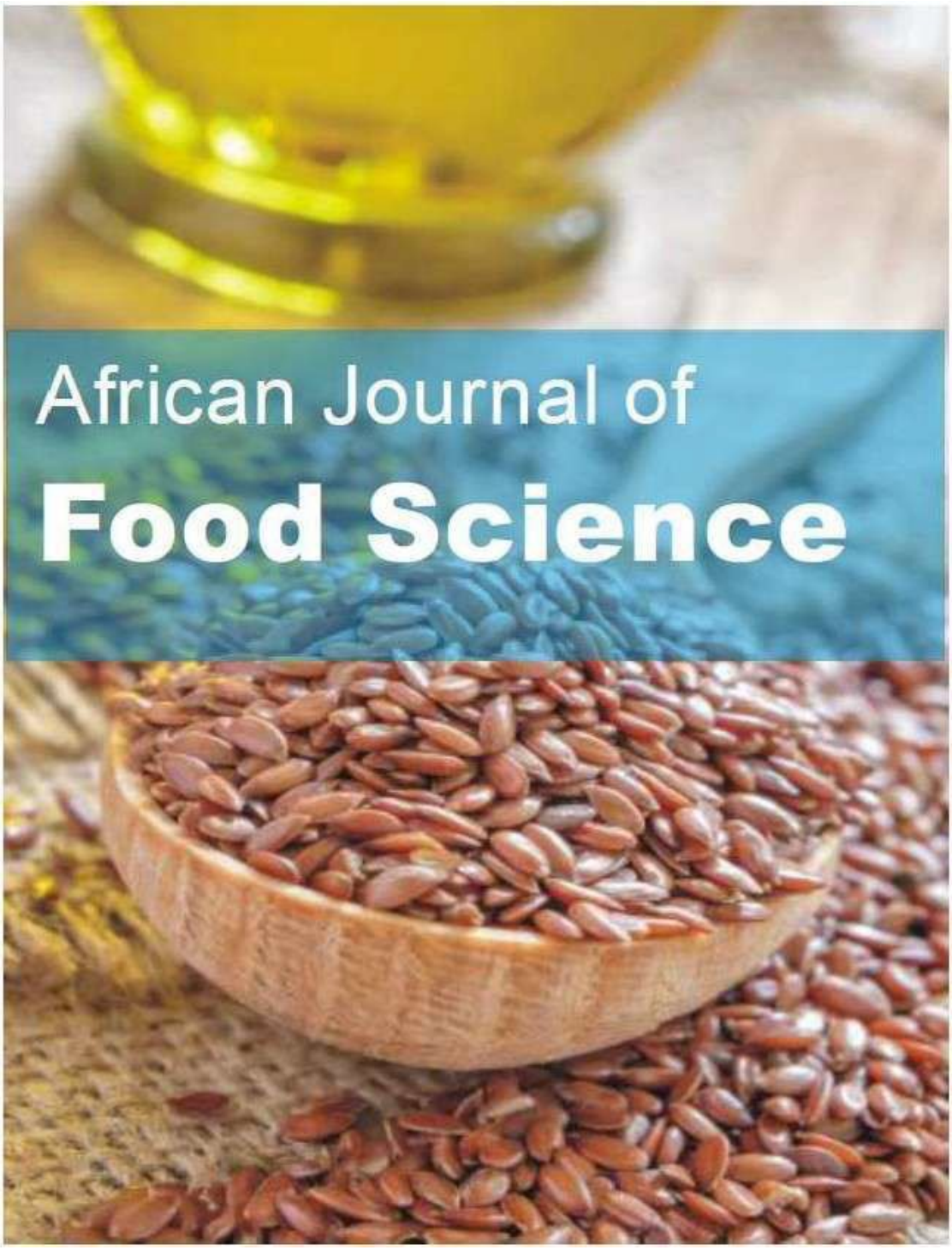

# African Journal of Food Science

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African Journal of Food Science

*Full Length Research Paper*

# Evaluating the proximate chemical composition and sensory properties of composite bread from wheat and cocoyam flours

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**The proximate chemical composition and organoleptic properties of composite bread formulated from cocoyam-wheat mix were determined. A control (AWB) consisting of 100% wheat flour was used, and cocoyam-composite loaves of bread (CBA, CBB, CBC and CBD) were prepared at 5, 15, 25 and 35% levels of substitution of wheat flour with cocoyam flour, respectively. The proximate compositions were determined using the AACC, while sensory characteristics were carried out using the 9-point hedonic scale. The moisture content, crude protein, ash, energy value, fat, fibre and carbohydrate values of the composite bread were in the range of 10.89 - 17.16%, 8.78 - 11.58%, 6.35 - 6.89%, 409.80 - 430.40 (cal/100g), 7.43 - 11.62%, 0.36 - 0.57%, and 71.37 - 75.76%, respectively. Only, the CBD samples had a moisture content (10.89%) significantly different ($p$<0.05) from the control (14.57%). Low crude fibre values were obtained for all samples. Composite sample protein content levels were low, resulting from low protein levels in cocoyam. Ash values were generally higher and significantly different ($p$<0.05) from those of the control. Sensory evaluation showed that there was a decreasing trend in likeness for all sensory parameters from CBA to CBD, and no significant ($p$>0.05) difference was observed in texture, taste and aroma between the control and CBA samples ($p$<0.05). However, the colour, appearance, mouthfeel and acceptability showed a significant difference ($p$<0.05) between the 100% wheat and composite bread samples. These findings demonstrated that a 15% cocoyam flour substitution level in bread making produced acceptable bread samples to consumers with similar texture and aroma comparable to that of 100% wheat bread.**

**Key words:** Cocoyam flour; bread; sensory evaluation; proximate composition.

## INTRODUCTION

In order to lower the imports of large quantities of wheat in Nigeria, the use of composite flours have been proposed by researchers where a portion of the wheat component will be substituted with an abundant domestic alternative in bread making (Kokoh et al., 2022). This is to decrease the demand for imported wheat and stimulate

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the production and use of locally grown non-wheat agricultural products (Abass et al., 2018). From the *Araceae* family, cocoyam (*Xanthosoma sagittifolium*) is a perennial plant recognized as one of the top six strategic root crop on the planet (Ekanem and Osuji, 2006).

It is a major domestic crop cultivated with minimal efforts, giving high yields and can be further explored in raising growers' income levels as wells as mitigating food insecurity in the country (Winara et al., 2022). Cocoyam is also nutritious, containing high levels of essential amino acids, digestible starch and vitamins (Mba and Agu, 2022). It has also been reported to have relatively higher crude protein and highly digestible starch levels compared to other root crops (Woldemariyam et al., 2022). These features thus make it an excellent candidate to investigate and to address critical import and industrial challenges.

As one of humanity's oldest foods, bread is popular around the world. Its consumption has continued to increase among populations in Nigeria and the world. The bread that was not an item of the daily diet in the past has been consumed continuously over decades in developing countries due to a continuous increase in population and changes in eating habits (Ishaya and Oshodi, 2013). At the moment, wheat flour is essential in bread manufacture due to its gluten fraction, which is responsible for the elasticity of the dough by causing it to extend and trap the carbon dioxide generated by yeast during fermentation (Mepba et al., 2007). Only, about 3% of Nigerian's total consumption of this grain is produced locally (Agu et al., 2007). Hence, a large and significant proportion of wheat used for baking is imported because of the inability of local wheat production to meet the rising demand for the product. Recently, Umar and Muhammad (2021) reported that wheat importantion costs the government around $2 bilion and is the second-highest item on the food import bill. This is highly alarming, and these imports are paid for with scarce foreign currency, and this, no doubt, is depleting Nigeria's external currency.

The demand to use novel sources as substitute for the wheat flour was increased to provide the consumers requirements, therefore some roots, including cassava (*Manihot esculenta* Crantz) and sweet potato (*Ipomoea batatas*), some tubers including potato (*Solanum tuberosum*) and yam (*Dioscorea* spp.) and some edible aroids, including taro (*Colocasia esculenta*) and cocoyam (*Xanthosoma sagittifolium*) were used as important calorie sources and wheat flour substitutes (Lamacchia et al., 2014). Studies on various wheat alternatives have been carried out, demonstrating that 2-10% other forms of flours could be used at some inclusion level without compromising the nutritional and organoleptic features of the manufactured bread (Eddy et al., 2007). Moreover, crops like soybean (Statsenko et al., 2021), cocoyam (Adanse et al., 2021; Millicent, 2022), cassava (Oluwamukomi et al., 2011; Okoko et al., 2018), plantain (Adanse et al., 2021; Etti and Ekanem, 2021), sweet potato (Yudhistira et al., 2022), arrowroot starch (Damak et al., 2022) and other tubers (Saranraj et al., 2019; Harbor and Aniedu, 2021) have been explored previously as alternative ingredients in bread manufacture. Therefore, this study aimed to assess the chemical composition and sensory evaluation of wheat-based bread at varying levels of wheat flour substitution with cocoyam flour for human consumption.

## MATERIALS AND METHODS

### Materials

Cocoyam (*Xanthosoma sagittifolium*) samples were purchased from the New Benin market in Benin City, Edo State, Nigeria. Wheat flour, yeast, butter, sugar and milk were purchased from a baking shop in Lagos Street, Ring road, Benin City, Edo State, Nigeria. Chemicals and reagents were provided by the central laboratory in the Faculty of Agriculture, the University of Benin, Nigeria.

### Preparation of cocoyam flour

Cocoyam corms were processed into flour using the method described by Oti and Akobundu (2007). Fresh corms of cocoyam were thoroughly washed with tap water, peeled using a shrap stainless-steel knife, rewashed and cut into slices. The dried slices were milled using laboratory mill to obtain homogeneous granules and sieved through a 150 µm pore size sieve to obtain the fine flour. The flours were packed in high density polyethylene bags, heat sealed and then stored in freezer until used.

### Experiment design

A completely randomized design (CRD) was used in the study, and the treatments tested were bread types (AWB, CBA, CBB, CBC and CBD) with four replicates each. The samples were analyzed for proximate composition and evaluated for sensory attributes.

### Blends preparation

The composite flour was processed by blending wheat and cocoyam flours according to Table 1. 100% wheat flour was used as a control bread sample. The flours were packed in polythene bags and stored until analysis.

### Bread making

The all-wheat flour and composite flour were combined with other ingredients in accordance with their respective proportions (Table 2). The process of kneading, which entails pressing the mixture, was then performed to guarantee the bread's improved and uniform crumb quality. Following the kneading procedure, the dough (a mixture of flour, water, and other ingredients) was divided into the needed quantity and shaped. The dough was allowed to ferment on a pan in a warm environment (fermentation stage). The dough was given around 30 min to ferment. The baked bread was removed from the oven after 40 min at 600 °C. After undergoing all of these steps, the bread was cooled and prepared for sensory and proximate composition analyses (Eddy et al., 2007).

**Table 1.** Formulation of flour blends (%) for bread production.

| Treatment | Wheat flour | Cocoyam flour |
|---|---|---|
| Control (AWB) | 100% | - |
| CBA | 95% | 5% |
| CBB | 85% | 15% |
| CBC | 75% | 25% |
| CBD | 65% | 35% |

Control (AWB)= 100% wheat flour. CBA = Wheat flour (95%) + Cocoyam flour (5%), CBB = Wheat flour (85%) + Cocoyam flour (15%), CBC = Wheat flour (75%) + Cocoyam flour (25%), CBD = Wheat flour (65%) + Cocoyam flour (35%).
Source: Authors

**Table 2.** Ingredients of bread production.

| Flour | Ingredient (Calculated for 100g flour) | | | |
|---|---|---|---|---|
| | Butter (g) | Sugar(g) | Yeast(g) | Milk(g) |
| Control | 125 | 75 | 15 | 50 |
| CBA | 125 | 75 | 15 | 50 |
| CBB | 125 | 75 | 15 | 50 |
| CBC | 125 | 75 | 15 | 50 |
| CBD | 125 | 75 | 15 | 50 |

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### Methods of analysis

#### *Determination of proximate composition of the resultant breads*

The whole wheat and the composite bread samples' proximate composition was determined using the standard methods of the American Association of Cereal Chemists AACC (2000).

#### *Evaluation of sensory evaluation of the resultant breads*

Sensory characteristics of all bread samples were evaluated for different sensory attributes by 25 semi trained panelists drawn from the Department of Animal Science, Faculty of Agriculture, University of Benin, Benin City, Edo State, Nigeria. The test was conducted while the samples were still fresh. All the panelists were briefed before the commencement of the evaluation process. Sensory attributes evaluated were taste, color, texture, appearance, and acceptability (consumer preference) (Meilgaard et al., 2007). 9-point hedonic scale was in the following sequence: like extremely—9, like very much—8, like moderately—7, like slightly—6, neither like nor dislike—5, dislike slightly-4, dislike moderately,—3, dislike very much—2, dislike extremely— 1 (Mishra et al., 2015). All panelists were regular consumers of breads, water at room temperature was provided to rinse the mouth between evaluations.

### Statistical analysis

The data collected were subjected to analysis of variance (ANOVA). Means were separated using Duncan's Multiple Range Test using the statistical package for the GenStat statistical software ver. 12 (2009).

## RESULTS

### Proximate chemical composition of bread samples

The Gross composition of composite bread from varying levels of cocoyam flours is shown in Table 3.

### Moisture content

The moisture content of the various bread samples developed ranged from 10.89 to 17.16%. The CBA samples had the highest values while the CBD samples had the lowest. Between the control (AWB) and samples CBA, CBB, and CBC, there was no discernible difference ($p \geq 0.05$). However, sample CBD differed substantially ($p \leq 0.05$) from the rest of the resultant bread samples.

### Ash

Ash content was lowest in the control group (5.06) and highest in the CBD (6.89 g/100 g) (Table 3). Between the ash content of the control (AWB) and each of the samples, there was a significant ($p \leq 0.05$) difference. The composite bread did not differ from each other, but, significantly ($p \leq 0.05$) with AWB. Generally, the ash values for composite breads were higher than the control.

### Crude fiber

The crude fiber content for all bread and control samples generally did not differ significantly ($p \geq 0.05$). The bread made with wheat flour and cocoyam flour substituted at a 35% level (CBD) had the highest value of crude fiber (0.57 g/100 g), while the control (AWB) had the lowest (0.36 g/100 g).

### Crude protein

For the composite bread samples, the crude protein values ranged from 8.78 to 11.58%, and the results were lower than those found for the control (11.97%). The CBB, CBC, and CBD samples differed significantly ($p \leq 0.05$) from the control. However, there was no difference between the control and sample CBA that was significant ($p \geq 0.05$). CBA and CBB also did not differ considerably from one another. The crude protein content of bread samples decreased in direct proportion to the percentage level of cocoyam flour substitution. This implied that, compared to the control, CBA had the highest level of crude protein (11.58%) and the lowest percentage level of substitution.

**Table 3.** Proximate chemical composition (g/100 g dry basis) and calories (Cal/100g) of all resultant breads.

| Samples (g/100g) | Control | CBA | CBB | CBC | CBD | SEM |
|---|---|---|---|---|---|---|
| Moisture content | 14.57$^{a}$ | 17.16$^{a}$ | 16.04$^{a}$ | 14.63$^{a}$ | 10.89$^{b}$ | 0.83 |
| Ash | 5.06$^{b}$ | 6.35$^{a}$ | 6.52$^{a}$ | 6.72$^{a}$ | 6.89$^{a}$ | 0.41 |
| Crude Fibre | 0.36$^{a}$ | 0.37$^{a}$ | 0.49$^{a}$ | 0.49$^{a}$ | 0.57$^{a}$ | 0.11 |
| Carbohydrate | 71.23$^{c}$ | 71.37$^{c}$ | 72.59$^{bc}$ | 73.67$^{b}$ | 75.76$^{a}$ | 0.49 |
| Protein | 11.97$^{a}$ | 11.58$^{ab}$ | 9.98$^{bc}$ | 9.18$^{c}$ | 8.78$^{c}$ | 0.53 |
| Ether extract | 11.23$^{a}$ | 11.62$^{a}$ | 10.10$^{b}$ | 9.89$^{b}$ | 7.43$^{c}$ | 0.30 |
| Energy value (Cal/100g) | 433.87$^{a}$ | 436.38$^{ab}$ | 421.18$^{bc}$ | 420.41$^{c}$ | 405.63$^{d}$ | 3.0 |

Means with different superscripts are significantly ($p< 0.05$) different in a row. Control (AWB) = 100% wheat flour, CBA = Wheat flour (95%) + Cocoyam flour (5%), CBB = Wheat flour (85%) + Cocoyam flour (15%), CBC = Wheat flour (75%) + Cocoyam flour (25%), CBD = Wheat flour (65%) + Cocoyam flour (35%).
Sources: Authors

**Ether extract**

The control had the lowest value of ether extract (7.43%), whereas sample CBD had the greatest value, followed by the control. The amount of fat in the control (AWB) and sample CBD did not differ significantly ($p\geq 0.05$). The control (AWB) and the sample CBA, CBB, and CBC, however, differed significantly ($p\leq 0.05$).

**Carbohydrate**

CBD and CBA had the greatest and lowest carbohydrate contents, respectively, ranging from 71.37 to 75.76%. The amount of carbohydrates in the control, samples CBA, and CBD were not significantly different ($p\geq 0.05$). However, there was a significant ($p\leq 0.05$) distinction between the CBB and CBC samples and the control group.

**Energy value**

Energy content per 100 grams for composite breads ranged from 409.80 to 430.40 (Cal/100g). When the control was compared with samples CBB, CBC, and CBD, there was a significant difference ($p\leq 0.05$), but there was not a significant difference ($p\geq 0.05$) between the control and sample CBA. In terms of energy value, the CBA sample came in first, followed by the control (AWB), and the CBD sample came in last.

**Sensory evaluation of breads**

Figures 1 to 7 showed that the bread samples' mean sensory scores for all the attributes examined (appearance, aroma, colour, mouth feel, overall acceptability, taste and texture).

**Appearance**

As can be seen in the Figure 1, sample CBA had the highest mean sensory score for appearance (7.06), while sample CBD had the lowest (5.80). Between the control (AWB) and the complete composite bread sample, a significant difference ($p\leq 0.05$) was shown.

The difference between samples CBA and CBB and samples CBB and CBC, however, was not statistically significant ($p\geq 0.05$) among the composite bread samples. The mean score for an appearance from the AWB, CBA, CBB, CBC, and CBD gradually decreased, as shown in Figure 1.

**Aroma**

The mean sensory scores ranged from 4.90 - to 6.80, as shown in Figure 2. Although, a significant ($p\leq 0.05$) difference was observed between the control (AWB) and composite samples of CBC and CBD, no significant ($p\geq 0.05$) difference was observed when the control (AWB) was compared against samples CBA and CBB. A decrease in the mean score for aroma from the AWB, CBA, CBB, CBC and CBD was also observed.

**Colour**

CBA sample had the highest mean color score (6.88) (Figure 3), while sample CBD had the least (5.26). There was a significant ($p\leq 0.05$) difference between the control (AWB) and composite bread samples (Figure 3). No significant ($p\geq 0.05$) difference was observed among samples CBA and CBB and sampled CBC and CBD.

**Mouthfeel**

The control had the highest score (7.84), with the mean

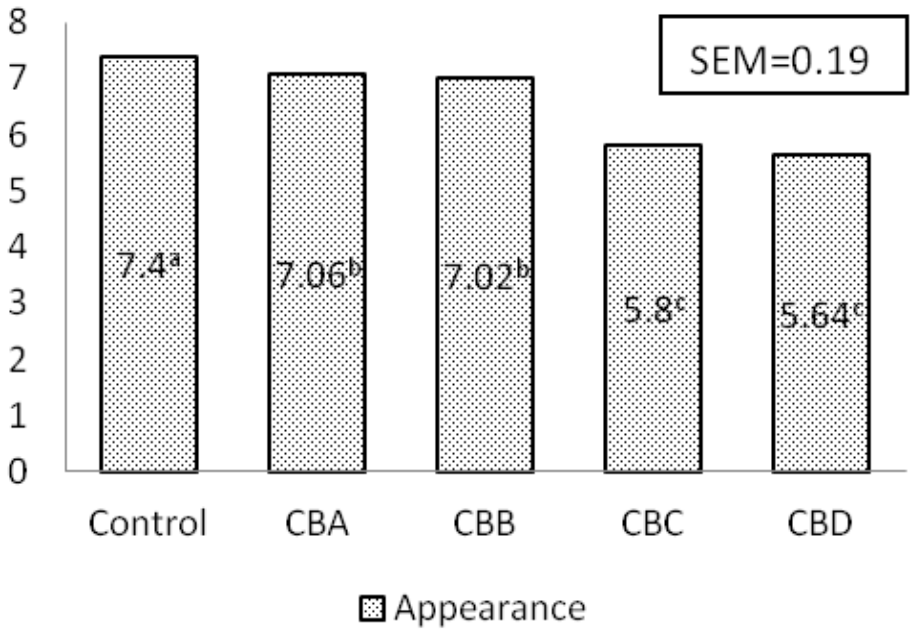


**Figure 1.** The mean scores for the appearance of all the resultant bread samples. Means with different superscripts are significantly (p≤0.05) different. AWB = Control= 100% Wheat flour, CBA = Wheat flour (95%) + Cocoyam flour (5%), CBB = Wheat flour (85%) + Cocoyam flour (15%), CBC = Wheat flour (75%) + Cocoyam flour (25%), CBD = Wheat flour (65%) + cocoyam flour (35%).
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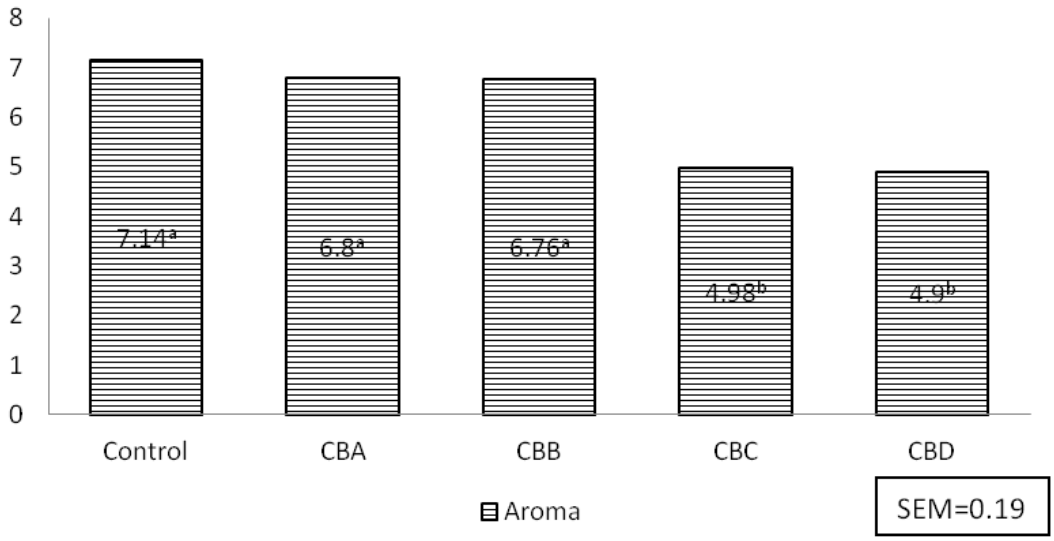


**Figure 2.** The mean scores for the aroma of all the resultant bread samples.
Source Authors

values for the mouthfeel of the various bread samples ranging from 4.04 to 7.84 (Figure 4). Composite bread samples showed a difference from the control sample that was statistically significant (p≤0.05). CBA and CBB did not differ significantly (p≥ 0.05) from the composite bread. But, there was a difference between the CBB, CBC, and CBD samples that was significant (p≤0.05). The mean sensory scores for mouthfeel across all composite bread samples generally showed a downward trend.

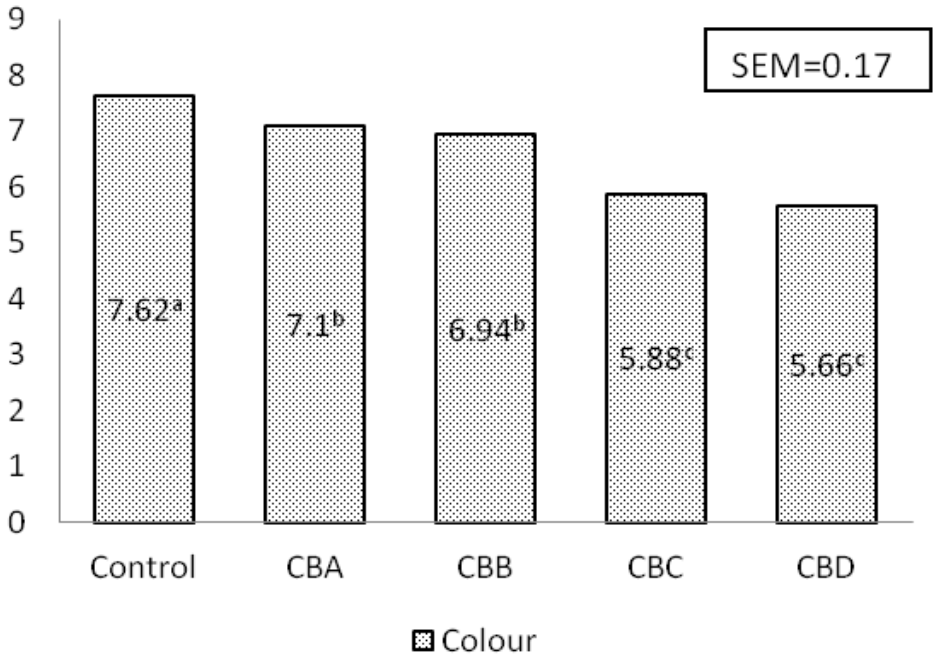


**Figure 3.** The mean scores for the colour of all the resultant bread samples.
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**Overall acceptability**

The overall acceptability exhibited a similar pattern to the aforementioned factors. The composite bread samples CBC and CBD received the lowest score (4.74), whereas the control (AWB) had the highest overall acceptance (8.06) and was broadly approved by all. The mean score for overall acceptability for the AWB, CBA, CBB, CBC, and CBD decreased. When the control (AWB) and composite bread samples were contrasted, a significant ($p \leq 0.05$) difference was found.

**Taste**

The taste values obtained from the sensory evaluation of the bread samples ranged from 4.16 to 7.86. No significant ($p \geq 0.05$) difference was observed between the control (AWB) and sample CBA. However, there was a significant difference between the control and composite samples CBB, CBC and CBD.

There was a significant ($p \leq 0.05$) difference between the control and composite bread samples CBA and CBB. However, there was a significant difference between control and composite bread samples CBC and CBD. The control had the highest value (7.32), followed by sample CBA (6.88), while sample CBD had the lowest score. A significant decrease in the mean score for texture from the AWB, CBA, CBB and CBC, similar to all parameters above.

**DISCUSSION**

The present study thus investigatd bread production by replacing imported wheat flour domestically available cocoyam flour which has several potentials.

**Proximate chemical composition**

The moisture content ranged from 10.89 to 17.16% for both control and composite bread samples made with varying amounts of wheat flour substituted for cocoyam flour. These findings are in line with those of Mepba et al. (2007), but they are at odds with those of Njintang et al. (2008) and Olaoye et al. (2006), who found that the moisture content of the composite breads increased from 30.98% to 35.59% with increasing non-wheat flour substitution (This increase in moisture content was caused by the non-wheat flour's superior ability to store water compared to the wheat flour).

The protein content of composite breads ranged from 8.78 to 11.58 g/100 g. All-wheat bread served as the control had a crude protein content that was 11.97% higher than that of all composite bread. The protein content generally decreased from the control (11.97%) to the composite bread with the lowest percentage of substitution (11.58 - 8.78%).

This was comparable to Eddy et al. (2007) who found that the protein content varied from 9.57 to 12.00% at 0% and 30% levels of cassava flour substitution, respectively.

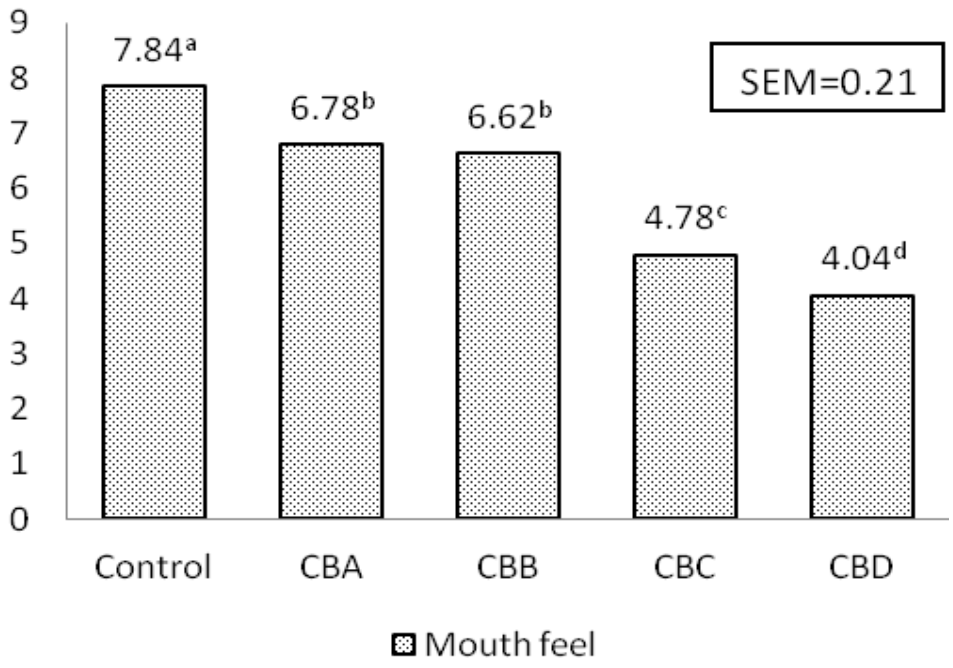


**Figure 4.** The mean scores for the mouthfeel of all resultant bread samples.
Source: Authors

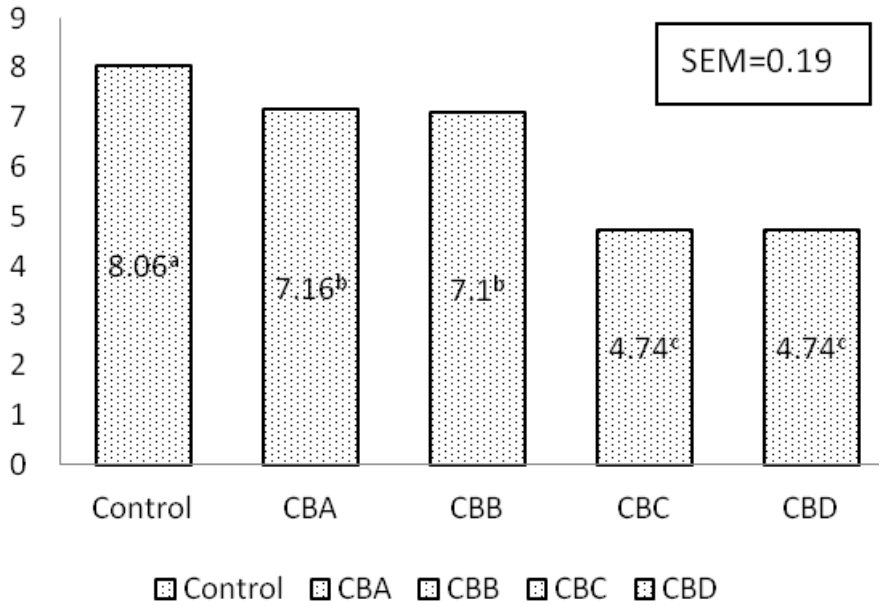


**Figure 5.** The mean scores for the overall acceptability of all resultant bread samples.
Source: Authors

Because there is less wheat flour in the composite flour mix and because cocoyam has a low protein value, composite breads with increasing amounts of cocoyam flour substitution have lower protein contents (Mepba et al., 2007).

Carbohydrates make up the majority of all the solid nutrients found in roots and tubers (like cocoyam) (Enwere, 1998). The composite bread samples' carbohydrate content rose from 71.37 to 75.76% with a higher percentage of cocoyam flour. Oluwamukomi et al

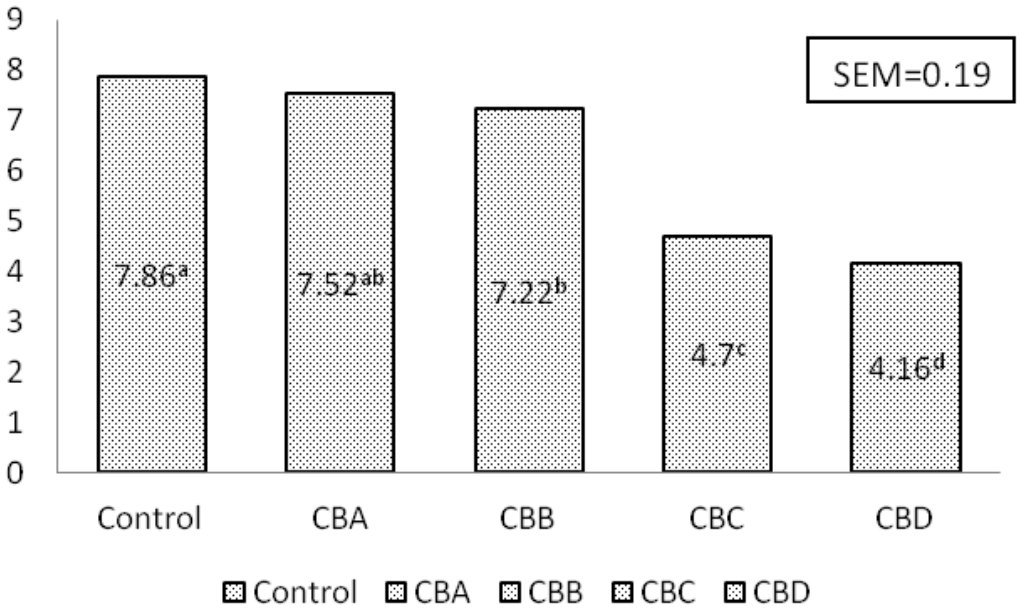


**Figure 6.** The mean scores for the taste of all the resultant bread sample**s.**
Source: Authors

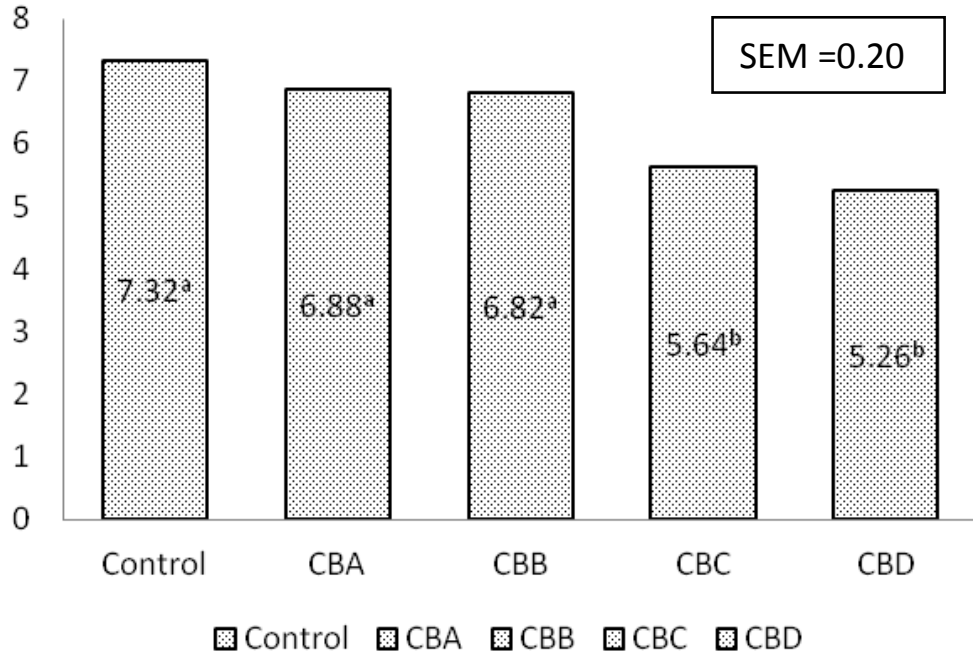


**Figure 7.** The mean scores for the texture of all the resultant bread samples.
Source: Authors

(2011) found that this ranging from 68.89 to 76.81% at 0 and 40% levels of cassava flour substitution, respectively. These results were similar to those of our study. The rise in the carbohydrate (NFE) of the composite bread is due to the use of cocoyam, which is a good source of carbs, mostly starchy carbohydrates (Onyeike et al., 2008).

For the composite bread samples, the mean fiber content scores ranged from 0.3 to 0.57 g/100 g,

compared to 0.36% for the control. The composite bread samples' fibre content gradually increased as more cocoyam flour was substituted, but the control had the lowest fiber level (0.36%). This result is comparable to that found by Mongi et al. (2011), who found that the crude fiber rose from 0.29 to 1.54% at 10 and 30% of cocoyam flour substitution, respectively. This was as a result of wheat flour having lower values for fiber content than cocoyam flour. Crude fiber supported the metabolic and gastrointestinal health of humans, according to Schneeman (2002). Fiber lengthens the time that bile salt derivatives like deoxycholate, a potent chemical carcinogen, travel through the body, decreasing the likelihood of developing colon cancer (Eddy et al., 2007).

The higher levels of ash in cocoyam flour compared to wheat flour may be responsible for the rise in ash content (%) of the bread samples from (5.06 to 6.89). (Mongi et al., 2011). Similar results were obtained by Okpala et al. (2011), who found that substituting 20 and 60% of the flour with cocoyam increased the ash content of composite cookie samples from 3.19 to 3.68, respectively. The ash content (g/100 g) of composite breads generally climbed from 6.35 to 6.89 as the degree of supplementation increased, but the control was at its lowest (5.06), suggesting that the composite bread contains more inorganic nutrients than wheat bread (Eddy et al., 2007).

With more cocoyam flour being substituted, the bread samples' fat content drastically dropped from 11.62 to 7.43 g/100 g. This pattern echoed the conclusions made by Mongi et al. (2011). Mepba et al. (2007), whose composite bread samples values steadily decreased from 1.6 (at a 5% level of plantain flour substitution) to 0.6% (at a 30% level of plantain flour substitution), were likewise identical to the results. This might be because cocoyam, a tuber crop, has a low fat content. Foods' ability to be stored for a long time depends in part on fat. A high fat content can hasten deterioration by encouraging rancidity, which produced bad flavors and odors. Additionally, high-fat diets put people at risk for conditions including obesity and coronary heart disease. Therefore, both the processor and those who care about their health will like the bread samples' relatively low fat content (Okpala and Chinyelu, 2011).

The energy value of the composite bread samples increased from 405.63 cal/100 g at 35% level of substitution to 433.87cal/100g at 5% level of substitution as the substitution rate of composite flour increased. This outcome was comparable to that of Mongi et al. (2011), where the values rose from 63.25% at 10% substitution of cocoyam flour to 70.49% at 30% substitution. This might be attributable to cocoyam, a tuber crop with a high starch content and good energy production.

## Sensory evaluation

While the appearance of the composite bread samples CBC and CBD was different from that of the control, it was very similar to that of the samples CBA and CBB. The control had the highest score (7.4) and CBD had the lowest (5.64).

Additionally, as non-wheat flour replacement levels rise, the look of breads made with non-glutinous flour became less acceptable since they resemble cakes more than traditional breads and have a crust and hard crumb structure similar to those of cakes (Dhighra and Jood, 2004).

In comparison to the control, the mean scores for aroma ranged from 4.90 to 6.80. As there was no discernible difference, composite sample CBA smelled like the control. With more cocoyam substitution, the aroma of composite bread samples gradually faded. Since other samples were created using other flour mixtures, the high aroma scores up to the 15% level of substitution (moderate resemblance) may be due to the Maillard reaction, also known as the browning reaction, which occurs when sugar and gluten (a protein) in wheat flour combine (Krupa-Kozac et al., 2022; Zhu et al., 2023). It was also noted in the current study that the CBA sample was generally most acceptable compared to other composite formulations while the CBD sample was the least accepted overall. This observation confirms that consumers look out for foods with specific sensory characters as recently opined by Bello et al. (2018).

When the amount of non-wheat flour in blends was increased, the color of the bread changed from creamy white to dull brown or dark, the mean color scores for composite breads decreased from (7.1 at 5% level of cocoyam flour) to (5.66 at 35% level of cocoyam flour), similar to what some researchers recently reported (Cauvain and Clark, 2019; Ekpa, 2020). The cocoyam flour's reddish-brown hue may be to blame for the darker shade. With increased cocoyam substitution, the mouthfeel of the composite bread samples' mean score values decreased. When cocoyam was substituted, the liking for the composite bread decreased (from 4.04 to 7.84). The sample CBA, however, resembled the control. The peculiarly sweet taste of the wheat flour, which was substituted with cocoyam flour, can be blamed for the mouthfeel reduction with increased cocoyam flour substitution.

Overall, as the amount of cocoyam flour substituted increased (from 7.16 at 5% to 4.74 at 35% level of substitution), the acceptability of the bread samples dropped. Although, there are statistical differences between control and composite bread samples in terms of how well customers enjoyed and accepted the items overall, samples using 15% cocoyam flour replacement scored in the middle. Indicating that items produced by substitution levels beyond 15% may not have a good market value due to low customer acceptability, CBC and CBD samples were neither liked nor disapproved of. The taste for all composite bread samples differed from one composite sample to another and was reduced with increased cocoyam flour substitution. However, this can

be attributed to the less sweetened and acceptable taste of cocoyam compared to wheat. The control sample had the best taste rating (7.86 mean sensory score), with the CBA sample having the next highest rating of 7.52. The taste was a major driver in the bread sample's acceptability, and this aligns with some recent studies, which opined that taste is also the single most determining factor of a products's market success (Santos et al., 2021; Gurdian et al., 2022).

Comparing the composite bread samples to the control and among themselves, the control had the highest mean score (7.32), followed by the CBA composite sample (6.88). In the past, it has been said that the gluten in wheat flour helps to make elastic dough that feels firm after baking (Oluwafemi and Seidu, 2017). As a result of using cocoyam flour instead of regular flour, the mean texture scores for the composite bread gradually dropped from 6.88 to 5.26. But in terms of sensory evaluation based on texture, the sample CBA and the control were comparable. The following recommendations can be summarized:

i) Cocoyam flour can successfully replace up to 15% of the wheat flour used in baking. At this point, it has been found that the nutritional and sensory properties of bread are adequate to satisfy customer desires and maintain acceptance. To successfully compete with whole wheat bread, efforts might be taken to improve the appearance and mouthfeel.
ii) More study needs to be done on composite flour manufactured from domestic crops, not just for creating bread but also for other delicacies like cookies and biscuits. These results will help policymakers and business partners make better decisions about how to create and promote the product to the target market.
iii) It is advisable to promote educating the general population about the advantages of consuming composite breads, both economically and nutritionally. Government and private sector stakeholders should collaborate on this.

## Conclusion

This study sought to investigate the feasibility of developing an alternative material that was readily available domestically and evaluated the proximate and sensory properties at various inclusion levels in response to the unprecedented amounts of wheat import in Nigeria. The results demonstrated the nutrient content and sensory characteristics of composite bread samples at varying degrees of 5, 15, 25, and 35% cocoyam flour substitution. Similar to the control in terms of nutrition and sensory qualities, the composite samples CBA (95% wheat flour and 5% cocoyam flour) and CBB (85% wheat flour and 15% cocoyam flour) might be widely accepted by the general people. Utilizing this composite flour up to a 15% level of cocoyam flour substitution will assist minimize the importation of wheat flour, whose running costs are already a burden on the economy, and improve the use of native products (such as cocoyam) for bread manufacture.

## CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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*Full Length Research Paper*

# Implementation of the school feeding and nutrition programmes in Uganda and the contribution of school meals to recommended dietary allowances (RDAs) of children: Challenges and opportunities

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**School going children face a complicated period of growth and development, remarkably affecting their health and productivity. School feeding programmes were assessed using three levels of assessment based on guidelines of school feeding and nutrition: (i) Conducting 11 key informant interviews, (ii) Conducting 45 focus group discussions and (iii) Using 24 h recall and food frequency questionnaires to evaluate the dietary and nutrient quality of school meals among 225 school going children. Two forms of feeding programmes: Parent led and home grown, were implemented concurrently. About 90% of the learners ate food items from 2 to 4 food groups. Children in all categories of schools had sub optimal daily nutrients (energy, proteins, vitamin A and iron) from school meals. Nationally, school children were only accessing 28% of their energy needs, 64% proteins requirements and 42% of iron requirements. School meals provide about 40-≥ 100% vitamin A requirements, 40-62% of iron requirements and about 30% daily energy requirements. In order to improve school feeding, there is need to enhance coordination and stakeholder engagement, strengthen local and community engagement, improve the nutrient content of school meals and engage stakeholders to change their attitudes and practices toward healthy eating.**

**Key words:** Education, dietary quality, school feeding, agriculture.

## INTRODUCTION

Globally, there about 1.4 billion school going children, of which about three quarters reside in developing counties (FAO, IFAD, UNICEF, WFP and WHO, 2021; UNICEF, WHO and World Bank, 2021). As a result of their rapid physical growth, health and cognitive demand, school children have a heightened need for nutrients (Galloway et al., 2009), underpinning for a healthy adulthood (Chabite et al., 2018; AU, NEPAD, ECA and WFP, 2014). Children who are under fed, are greatly predisposed to poor health, reduced cognitive development, poor

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academic performance, threatening their economic progression towards enhanced income and gained opportunities (Bundy et al., 2009; AU, NEPAD, ECA and WFP, 2014; Christensen et al., 2019; Gelli et al., 2016). Having physically demanding bodies, the age bracket of school going children provides a window of opportunity to prevent poor health later in life, by engaging in an active lifestyle including sports and adapting to consuming healthful diets (Ochola and Masibo, 2014; Christensen et al., 2019).

Despite multiple interventions being spearheaded by the Ugandan government to address malnutrition, malnutrition continues to be a public health problem. An estimated twelve million children in Uganda are suffering from any form of micronutrient deficiency, with about 920,000 children suffering from wasting or acute undernourishment (UBOS and IYC, 2016). During the past 20 years, stunting levels for children have dropped, from 45% in 2000 to 38% in 2006, to 33% in 2011 to 29% in 2016 (UBOS and IYC, 2001, 2011, 2016). Over years, the proportion of children in Uganda, who are underweight, has also declined, from 18% in 2000 to 16% in 2006, 14% in 2011, and 11% in 2016. Majority of previous nutrition studies conducted in Uganda (Ashaba et al., 2015; Nankinga et al., 2019; Madzorera et al., 2021) focused on children (0-59 months) and women of reproductive age. While this age group is the most susceptible to under-nutrition (Prentice et al., 2013), lack of adequate data on school going children (primary and secondary school age) can conceal the gravity of malnutrition in the group.

School feeding and nutrition programmes are increasingly gaining acceptance in several African and low developed countries as a tool of safety net that can improve nutrition and health for children and surrounding communities (Doak, 2002; NEPAD, 2003; Bennet, 2003; Global Panel, 2015). For instance, in the review by Doak (2002), reported that in Chile, South Africa, Morocco and Brazil, there is an increasing requirement for schools to prepare school meals, using locally available or minimally processed foods. It has been positively correlated with improvement of academic performance, memory and attention span among school going girls fed on biofortified beans in Rwanda (Murray-Kolb et al., 2017) and biofortified pearl millet in India (Scott et al., 2018). In Ghana, Nigeria and Kenya, it was observed to support livelihoods for farmers and surrounding communities who supply nutritious produce to the schools (Singh and Fernandes, 2018; Sumberg and Sabates-Wheeler, 2011). Furthermore, an investment of US$1 in school feeding is projected by United Nations, to return US$9 to the economy (AU, NEPAD, ECA and WFP, 2014). In this line, the government of Uganda is currently implementing the school feeding and nutrition guidelines using an integrated sector wide approach to sustainably address malnutrition among children holistically (MoES, 2013). Integrated sector wide systems connecting education, agriculture, health, nutrition and social protection have been documented in Ghana, Kenya and Nigeria (Gelli et al., 2016) as successful solutions to malnutrition among school going children and communities. These school feeding interventions must provide quantifiable returns (UWEZO, 2013). For instance, the school feeding guidelines of Uganda indicate that school meals must provide at least a third or all nutrients requirements respectively, for non-boarding or boarding school going children. However, school foods in Uganda are not uniform, affecting the nutrition and health outcomes of children, resulting in increased dropouts from schools. The un-uniform and inadequate meals served in schools are a reflection of how the current school feeding and nutrition guidelines are not fully implemented. As a result, this study documented the various school feeding programmes in Uganda, the successes and challenges experienced in implementing the programmes, in view of identifying opportunities on how to scale up implementation. The data will provide essential information necessary for improving the school feeding facilities and operations in order to supply adequate nutrients to children.

## METHODOLOGY

### Study approach

The approach used in this study was developed based on the players in the field of school feeding and nutrition in Uganda. This resulted in an evaluation plan that was implemented at three levels. This included: (i) conducting key informant interviews with different players at policy level in government, development partners and the private sector (level 1), (ii) holding focus group discussions among schools food-service managers (level 2), and (iii) evaluating the dietary and nutritional quality of school meals (level 3).

### Study sites and selection of participants

A three-stage cluster study sites and respondents sampling technique involving one stage of stratified and purposeful selection and two stages of simple randomization were used in the selection of the study regions, study schools, and respondents including students, key informants and focus group discussants. In the first stage, purposive and stratified sampling technique was used to select 45 schools from five geographical regions of West, North, West Nile, Central and East in the country. With the guidance of the Ministry of Education and Sports (MoES), the 45 schools were selected and equally distributed across the regions of the country because of access costs to the schools. Access to locations is directly correlated to costs, playing a significant role in sample determination (Brus et al., 2019). In the second stage, using stratification techniques, nine schools were selected in each region comprising of three rural schools, three peri-urban schools and three urban schools. During the third stage within each school, purposive selection of the head teachers, teachers in charge of school feeding and student representatives were conducted to identify respondents who took part in the three focus group discussions (FGDs) per school. For each school three FGDs including teachers, students and parents were interviewed.

Also purposive sampling technique was used to select 11 key

informants in key government departments and non-governmental organizations located in Kampala and Entebbe cities. Identified informants were familiar with school feeding programmes in the country; therefore, the most knowledgeable informants were selected. The key informants were specifically requested to give more detailed information regarding the implementation of school feeding in the communities from the policy view. To collect data on food and nutrient intake, in each school, four students were randomly and systematically selected from school registers of four classes and ensuring equal sex ratio representation. From the list of 16 students per school, four to eight students were randomly selected to participate in the dietary and nutrient intake study and 7-day food intake survey. A total of 225 students were recruited, from the 45 schools.

**Data collection**

Data collected during the FGDs, KIIs and observations, were based on the government guidelines and requirements to have school feeding and nutrition program in Ugandan schools (MoES, 2013).

**Key informant interviews**

A semi structured open-ended questionnaire was administered to 11 key informants (KIs), who were nutrition focal persons and directly involved in school feeding and nutrition agenda. These included government ministries and departments (Ministries of Education and Sports, Health, Local Government, Gender and Social Development, Agriculture, Animal Industry and Fisheries and National Planning Authority), non-governmental agencies (The Hunger Project-Uganda and World Food Program and HarvestPlus). In addition to taking notes, interview audio recordings were made using digital recorders. The questionnaire for KIs consisted of seventeen semi-structured questions, categorized into four sections. The first section of the KI questionnaire sought for information about the respondents' knowledge and views on the quality and diversity of school meals in the country, challenges faced in ensuring availability of quality school meals, methods used in preparing school meals, and how to improve food preparation methods. Second part of the questionnaire included questions on levels of satisfaction with frequency of meals served and the existence of the agreed specifications in terms of nutrients supplied by meals. The third section of the questionnaire probed for information related with affordability of meals, regulation of procurement of school food supply, how small holder farmers were linked to supplying school food, and access to information (food prices) by schools. The last section of the KIs questionnaire, sought for information related with existence of standard infrastructure, utilization of school farms, use of energy saving facilities, desired human resources to sustain school feeding, application of partnership and governance system for school feeding.

**Focus group discussions**

The second set of questions, were prepared to guide the 135 Focus Group Discussions (FGDs) with each group consisting of about 6 to 10 participants. Notes were taken during the discussions. FGDs were conducted at schools with teachers, student representatives and parents included. Only schools that provided at least one meal a day were included in this study. To cover the entire spectrum of schools, interviews were carried out in primary, secondary, boarding, non-boarding, public and as well as private schools. The FGDs questionnaire consisted of 12 semi-structured questions, categorized into three sections. The first section consisted of questions seeking for answers on how the quality of school meals were met, challenges faced in ensuring quality of meals, existence of standard menus, how safety of school meals is ensured and methods used to prepare the meals. The second section sought for how food was procured, suggestions on alternative procurement methods and existence of suppliers of food among school communities. The third section probed discussants if they were satisfied with existing infrastructure, use of energy saving technologies, partnerships and management of school feeding.

**Evaluating the dietary quality of school meals**

Quantitative assessment of dietary intakes was conducted using two 24 h recalls, with one recall estimating intake among children in boarding schools where all meals to the learners are provided by the school. The second 24-h recall was administered to learners who obtained at least one meal from school and other meals are obtained elsewhere. Prior to administering the recall, a statement of the menu used during the last 24 h was sought from the school administrators in charge of school feeding. Learners were interviewed because they have a memory of foods they consumed during the last one day and they can estimate portion sizes consumed. The recall questionnaire was validated based on earlier studies conducted in Ugandan schools (Turyashemererwa et al., 2013; Acham et al., 2012). A list of meals, dishes, food items and beverages consumed during the previous 24 h was recorded. The full description of ingredients dishes was documented and amounts eaten by learners were estimated using a variety of different local utensils and models (Gibson and Ferguson, 1999). In addition, two digital scales (Soehnle, Nassau, Germany; precision 10 g) were used to estimate weights of foods consumed.

Dietary diversity scores were obtained using 7 days recall questionnaire that was designed to capture information from the week preceding the survey. A total of nine food groups specified in the FAO (2001) guidelines for measuring individual and household dietary intake were assessed. The food items mentioned by respondents were allocated among the nine food groups. The household dietary diversity score (HDDS) was calculated by summing the number of unique food groups consumed by each student. The food variety score (FVS); the number of different food varieties consumed over the recall period of 7 days (Acham et al., 2012) was also calculated.

**Data analysis**

Both FGDs and KII responses were transcribed following the Gisted transcription approach (Corbin and Strauss, 2014). The transcription was done anonymously and verbatim. The transcribed data were coded to permit generation themes. The transcripts were analyzed in Dedoose (v. 7.0.23), a web based, mixed-methods analytic application (Socio Cultural Research Consultants, Los Angeles, CA). Mean values were computed for continuous variables while proportions were computed for the categorical variables.

Mean nutrient intakes were computed using the daily consumed quantities, derived from the average of the two 24 h recalls, using the computer program Nutrisurvey ® 2013. Nutrisurvey programme provides nutrient values associated with specific foods in given quantities. Nutrient compositions for foods which were not found in the Nutrisurvey program were derived from the Uganda food composition table (Hotz et al., 2012), and the US Department of Agriculture nutrient database (http://ndb.nal.usda.gov/ndb/search/list). During the computation nutrient intakes, bioavailability of nutrients in focus was taken into consideration when calculating (WHO and FAO, 2004; IOM, 2005; Hotz et al., 2012). Average nutrient intakes were compared with the estimated recommended daily allowances (RDA) (WHO and FAO,

2004; IOM, 2005) and the proportions of learners with inadequate intake were computed. The RDA is the average daily nutrient intake estimated to meet the needs of half the healthy individuals in a particular age and gender group (WHO and FAO, 2004). All data were analyzed using SPSS version 24 (SPSS Inc., Chicago Ill, USA).

#### Ethical considerations

The study was approved by the School Feeding and Nutrition Ethics Committee at the Ministry of Education and Sports (MoES). The Permanent Secretary of the MoES wrote a written letter permitting and introducing the Lead Consultant and Enumerators to School Heads and District Education Officers, seeking support for the study to be carried out. Permission to conduct the study was obtained from Local Government Authorities (LGAs) in the districts visited. A verbal and written informed consent was obtained from the KIs and FGDs participants. Enumerators explained the purpose of the research and confidentiality issues to the respondents. Participants signed a consent form prior to the interviews or discussions.

## FINDINGS AND DISCUSSION

### Characterization of the feeding and nutrition programmes from six regions of Uganda

Two forms of feeding and nutrition programmes were concurrently being implemented by the schools in the present study. All (45) schools visited were running the mandatory parent led school feeding programme (PLSFP) (Table 1), as proposed by the Ugandan government policy document, the school feeding and nutrition guidelines (MoES, 2013). Interestingly, the findings further revealed that despite all schools in the present study implementing the PLSFP, they were also practicing home grown school feeding programme (HGSFP) by purchasing some (about 30%) of the school food, directly from the farmers neighboring the schools and the rest of the food from the markets or middle men (Table 1). The variation or inclusion of home grown school feeding as part and parcel of parent led school feeding programmes, in different schools depended on whether they were public or private, or whether they were primary or secondary schools.

The PLSFP is the official government school feeding programme policy, which encourages parents to feed their children while at school (MoES, 2013). The parental contributions are mostly financial in the form of fees or in form of food in kind especially in rural areas such as Western Uganda and in Northern Ugandan districts. Although all schools visited in the present study provided food to all students, during the FGDs, it was revealed that, some learners also carried home packed food which was consumed at break (between 10:00 to 10:30 am) for primary school children and at lunch (between 1:00 and 2:00 pm) for secondary school children. In some instances, learners were given money by parents to buy food/snacks from school canteens during lunch and tea breaks. Home packed school meals included ‘matoke’ (green cooked bananas) (*Musa* species), Irish potatoes (*Solanum tuberosum* L), beans (*Phaseolus vulgaris* L) and at times stiff prepared from maize porridge commonly referred to as *Ugali* or *posho*. Ugali or *posho* is a stiff porridge prepared by mixing maize flour with boiling water. Based on FGD remarks, home packed foods and canteen foods such as cereals snacks, can be a basis for revising the school meals, through national programs such as industrial mandatory fortification of grain flour, edible oils and salts used in making snacks. Fortified flours or oils can go a long way to address micronutrients deficiencies such as vitamin A and anemia in school going children (Fiedler and Afidra, 2010; National Industrial Food Fortification Strategy, 2017). In the present study, four schools were documented to receive food from parents in kind. These included two schools registered in Western Uganda comprising Rwamurunga Primary School and Isingiro Secondary School where parents were making in kind contributions of food in form of milk, beans or *ugali* or *posho*. The other two were registered in Gulu district located in Northern Uganda; St John Paul Primary school and Pope Paul VI Secondary School. The Gulu parent led model, is a school feeding model, supported by an ordinance which was passed by the local government of Gulu district compelling parents who cannot make contributions in form of money, to make in kind contributions in form of food. The local government ordinance was concretized through the annual general meetings of the Parents Teachers Assembly (PTA), where the in-kind contributions plan, was agreed upon. The feeding programmes for most public schools and faith (catholic) based private schools were coordinated and operated by parents, teachers and students representatives committee known as the school feeding committee, locally referred to as verification committees. Out of 45 schools, 27 had school feeding committees. Members of this committee are usually nominated during the PTA meetings. The roles and responsibilities of the school feeding committees include: verifying that the purchased foods meet the specifications of foods ordered for and rejecting foods that were contaminated and do not conform to the specifications. The committee also sets amounts of fees to be charged for food per term per child and quantities of food to be contributed in kind by parents per child per school term, procuring food, ensuring safe storage of food, hiring casual laborers such as cooks, kitchen cleaners or professional caterers and supervising the cooking and serving of food. They are also responsible for, keeping inventory of food stocks, during lunch breaks among non-boarding schools, conducting fumigation of stores, and acting as a link between local government authorities and head teachers regarding school feeding and nutrition programme being implemented in their respective schools. In this study, it was further noted that in some

**Table 1.** Meals and meal diversity, procurement and school feeding programmes of Uganda.

| Region | School | Nature of school | School or farm garden | Type of meals | Variety of foods | Time for meals | Consideration for nutritious food in meals | Procurement of food | Funding | Nature of contributions | Source of school food |
|---|---|---|---|---|---|---|---|---|---|---|---|
| West | Rwamurunga Primary School | Public | Has a school garden operated by students | Porridge for breakfast<br>Lunch<br>Supper | Maize porridge<br>Ugali with beans<br>Ugali/rice with beans/meat | 6.30am breakfast<br>1Pm lunch<br>7.00PM supper | Considered if vegetables and fruits are in plenty | School food committee of teachers, students and parents | Contributions from parents | Monetary contributions | Purchased from farmers and markets |
| West | Premier HS | Public | Has a small school garden operated by students | Porridge for breakfast<br>Lunch<br>Supper | Maize porridge<br>Ugali with beans<br>Ugali with beans | 6.30am breakfast<br>1Pm lunch<br>7.00PM supper | Considered when cheap vegetables and fruits are available | School food committee of teachers, students and parents | Contributions from parents | Monetary contributions | Purchased from farmers and markets |
| West | Nsambya HWS | Private | No school garden | Porridge for breakfast<br>Lunch<br>Supper | Maize porridge<br>Ugali/rice with beans/meat<br>Ugali with beans | 6.30am breakfast<br>1Pm lunch<br>7.00PM supper | To some extent considered if vegetables and fruits are in plenty | Director (owner) of school | Parents pay as part of school fees | Monetary contribution | Purchased from farmers and markets |
| West | WeldenSch-Mbr | Private | No school garden | Porridge for breakfast<br>Lunch | Maize porridge<br>Ugali with beans | 10.30am breakfast<br>1Pm lunch | Not considered. | Director (owner) of school | Parents pay as part of school fees | Monetary contribution | Purchased from farmers and markets |
| West | Alliance HS | Private | Has school garden but not fully used. Operated by casual laborers | Porridge for breakfast<br>Lunch<br>Supper | Maize porridge/milk<br>Ugali with beans<br>Ugali/rice with beans/meat | 6.30am breakfast<br>1Pm lunch<br>7.00PM supper | Considered to some extent when budget permits and when vegetables and fruits are plenty | Director (owner) of school | Parents pay as part of school fees | Monetary contribution | Purchased from farmers and markets |
| West | Isingiro town HS | Public | Has school garden used for practical lessons | Porridge for breakfast<br>Lunch<br>Supper | Maize porridge<br>Ugali with beans<br>Ugali with beans | 6.30am breakfast<br>1Pm lunch<br>7.00PM supper | Considered if vegetables and fruits are in plenty and available in school gardens | School food committee of teachers, students and parents | Contributions from parents | Monetary contributions | Purchased from farmers and markets |
| West | Isingiro SS | Public | Has school garden used for practical lessons | Porridge for breakfast<br>Lunch<br>Supper | Maize porridge<br>Ugali with beans<br>Ugali with beans | 6.30am breakfast<br>1Pm lunch<br>7.00PM supper | Considered if vegetables and fruits are in plenty and available in school gardens | School food committee of teachers, students and parents | Contributions from parents | Monetary contributions | Purchased from farmers and markets |
| West | Ibanda SS | Public Catholic Boys school | Has school garden for practical lessons | Porridge for breakfast<br>Lunch<br>Supper | Maize porridge<br>Ugali/rice with beans/meat<br>Ugali/bananas with beans | 6.30am breakfast<br>1Pm lunch<br>7.00PM supper | Considered if vegetables and fruits are in plenty and available in school gardens | School food committee of teachers, students and parents | Contributions from parents | Monetary contributions | Purchased from farmers and markets |
| West | Heritage Voc. SS | Private | Has school garden | Porridge for breakfast<br>Lunch | Maize porridge<br>Ugali with beans | 10.30am breakfast<br>1Pm lunch | Not considered. | Director (owner) of school | Parents pay as part of school fees | Monetary contribution | Purchased from farmers and markets |
| W.Nile | Muni Girls | Public school Anglican church founded | Has school garden used to produce food | Porridge for breakfast<br>Lunch<br>Supper | Maize porridge<br>Ugali with beans<br>Ugali with beans | 6.30am breakfast<br>1Pm lunch<br>7.00PM supper | Considered if vegetables and fruits are in plenty and available in school gardens | School food committee of teachers, students and parents | Contributions from parents | Monetary contributions | Purchased from farmers and markets |

**Table 1.** Contd.

| Region | School | Nature of school | School or farm garden | Type of meals | Variety of foods | Time for meals | Consideration for nutritious food in meals | Procurement of food | Funding | Nature of contributions | Source of school food |
|---|---|---|---|---|---|---|---|---|---|---|---|
| W.Nile | Arua Islamic Primary School | Public Muslim school | No school garden | Porridge for breakfast<br>Lunch | Maize porridge<br>Ugali with beans | 10.30am breakfast<br>1Pm lunch | Not considered. | School food committee of teachers, students and parents | Contributions from parents | Monetary contributions | Purchased from farmers and markets |
| W.Nile | Manibe Public SS | Private school | No school garden | Porridge for breakfast<br>Lunch<br>Supper | Maize porridge<br>Ugali with beans<br>Ugali with beans | 6.30am breakfast<br>1Pm lunch<br>7.00PM supper | Not considered. | Director (owner) of school | Parents pay as part of school fees | Monetary contribution | Purchased from farmers and markets |
| W.Nile | Nile High | Private school | No school garden | Porridge for breakfast<br>Lunch | Maize porridge<br>Ugali with beans | 10.30am breakfast<br>1Pm lunch | Not considered. | Director (owner) of school | Parents pay as part of school fees | Monetary contribution | Purchased from farmers and markets |
| W.Nile | Arua public Primary School | Public school | No school garden | Porridge for breakfast<br>Lunch | Maize porridge<br>Ugali with beans | 10.30am breakfast<br>1Pm lunch | Not considered. | School food committee of teachers, students and parents | Contributions from parents | Monetary contributions | Purchased from farmers and markets |
| W.Nile | Ediofe Girls SS | Public girls school | Owns school garden for classes and rest operated by casual laborers | Porridge for breakfast<br>Lunch<br>Supper | Maize porridge<br>Ugali with beans<br>Ugali with beans | 6.30am breakfast<br>1Pm lunch<br>7.00PM supper | Considered if vegetables and fruits are in plenty and available in school gardens | School food committee of teachers, students and parents | Contributions from parents | Monetary contributions | Purchased from farmers and markets |
| W.Nile | Najah Muslim SS | Private Muslim | No school garden | Porridge for breakfast<br>Lunch | Maize porridge<br>Ugali with beans | 10.30am breakfast<br>1Pm lunch | Not considered. | Head Teacher | Parents pay as part of school fees | Monetary contribution | Purchased from farmers and markets |
| North | Gulu Central SS | Private school | No school garden | Porridge for breakfast<br>Lunch | Maize porridge<br>Ugali with beans | 10.30am breakfast<br>1Pm lunch | Not considered. | Director (owner) of school | Parents pay as part of school fees | Monetary contribution | Purchased from farmers and markets |
| North | St. John Paul Primary School | Private catholic | Owns school garden | Porridge for breakfast<br>Lunch<br>Supper | Maize porridge<br>Ugali with beans<br>Ugali with beans | 6.30am breakfast<br>1Pm lunch<br>7.00PM supper | Considered, if the school garden has vegetables. | Head Teacher | Parents pay as part of school fees | Monetary contribution | Purchased from farmers and markets |
| North | Bishop Angelo Primary School | Private Catholic school | No school garden | Porridge for breakfast<br>Lunch | Maize porridge<br>Ugali with beans | 10.30am breakfast<br>1Pm lunch | Not considered | Head Teacher | Parents pay as part of school fees | Monetary contribution | Purchased from farmers and markets |
| North | Pope Paul VI | Public school | Owns school garden used for classes | Porridge for breakfast<br>Lunch<br>Supper | Maize porridge<br>Ugali with beans<br>Ugali with beans | 6.30am breakfast<br>1Pm lunch<br>7.00PM supper | Vegetables and fruits are served based on availability | School food committee of teachers, students and parents | Contributions from parents | Monetary contributions | Purchased from farmers and markets |
| North | Alliance HS-Gulu | Private school | No school garden | Porridge for breakfast<br>Lunch | Maize porridge<br>Ugali with beans | 10.30am breakfast<br>1Pm lunch | Not considered. What matters is for students to have something | Director (owner) of school | Parents pay as part of school fees | Monetary contribution | Purchased from farmers and markets |

**Table 1.** Contd.

| Region | School | Nature of school | School or farm garden | Type of meals | Variety of foods | Time for meals | Consideration for nutritious food in meals | Procurement of food | Funding | Nature of contributions | Source of school food |
|---|---|---|---|---|---|---|---|---|---|---|---|
| East | Nakabango Primary School | Public school | No school garden | Porridge for breakfast<br>Lunch | Maize porridge<br>Ugali with beans | 10.30am breakfast<br>1Pm lunch | Not considered. What matters is for students to have something | School food committee of teachers, students and parents | Contributions from parents | Monetary contributions | Purchased from farmers and markets |
| East | Nsuube HS | Private School | Has school garden for practical lessons, with another section operated by casual laborers | Porridge for breakfast<br>Lunch<br>Supper | Maize porridge<br>Ugali with beans<br>Ugali with beans | 6.30am breakfast<br>1Pm lunch<br>7.00PM supper | Considered periodically depending on availability and budget permitting | Director (owner) of school | Parents pay as part of school fees | Monetary contribution | Purchased from farmers and markets |
| East | Nakabango Lutheran Primary School | Private Lutheran Church school | Owns school garden used for classes | Porridge for breakfast<br>Lunch<br>Supper | Maize porridge<br>Ugali with beans<br>Ugali with beans | 6.30am breakfast<br>1Pm lunch<br>7.00PM supper | Considered if vegetables and fruits are in plenty and available in school gardens | Head Teacher | Parents pay as part of school fees | Monetary contribution | Purchased from farmers and markets |
| East | Lwanda HS | Private school | Has school garden for classes | Porridge for breakfast<br>Lunch<br>Supper | Maize porridge<br>Ugali with beans<br>Ugali with beans | 6.30am breakfast<br>1Pm lunch<br>7.00PM supper | Considered if vegetables and fruits are in plenty and available in school gardens | Director (owner) of school | Parents pay as part of school fees | Monetary contribution | Purchased from farmers and markets |
| East | Masese seed Sch | Public school | No school garden | Porridge for breakfast<br>Lunch | Maize porridge<br>Ugali with beans | 10.30am breakfast<br>1Pm lunch | Not considered. What matters is for students to have something | School food committee of teachers, students and parents | Contributions from parents | Monetary contributions | Purchased from farmers and markets |
| East | Mother Kevin Primary School | Public primary school | Has no school garden | Porridge for breakfast<br>Lunch<br>Supper | Maize porridge<br>Ugali with beans<br>Ugali with beans | 6.30am breakfast<br>1Pm lunch<br>7.00PM supper | Considered if vegetables and fruits are in plenty | School food committee of teachers, students and parents | Contributions from parents | Monetary contributions | Purchased from farmers and markets |
| East | PMM Girl's | Public Girls school | Owns a school garden for classes | Porridge for breakfast<br>Lunch<br>Supper | Maize porridge<br>Ugali with beans<br>Ugali with beans | 6.30am breakfast<br>1Pm lunch<br>7.00PM supper | Considered if vegetables and fruits are in plenty and available in school gardens | School food committee of teachers, students and parents | Contributions from parents | Monetary contributions | Purchased from farmers and markets |
| East | St.James SS, Jinja | Private Catholic school | No school garden | Porridge for breakfast<br>Lunch | Maize porridge<br>Ugali with beans | 10.30am breakfast<br>1Pm lunch | Not considered because of budget constraints | Head Teacher | Parents pay as part of school fees | Monetary contribution | Purchased from farmers and markets |
| East | St.Peter's HS-Jinja | Private Catholic school | No school garden | Porridge for breakfast<br>Lunch | Maize porridge<br>Ugali with beans | 10.30am breakfast<br>1Pm lunch | Not considered | Head Teacher | Parents pay as part of school fees | Monetary contribution | Purchased from farmers and markets |
| East | Jinja SS | Public school | Owns school garden operated by casual laborers | Porridge for breakfast<br>Lunch | Maize porridge<br>Ugali with beans | 10.30am breakfast<br>1Pm lunch | Not considered | School food committee of teachers, students and parents | Contributions from parents | Monetary contributions | Purchased from farmers and markets |
| Central | Makerere Modern SS | Private School | No school garden | Porridge for breakfast<br>Lunch<br>Supper | Maize porridge<br>Ugali with beans<br>Ugali with beans | 6.30am breakfast<br>1Pm lunch<br>7.00PM supper | Not considered because of budget constraints | Director (owner) of school | Parents pay as part of school fees | Monetary contribution | Purchased from farmers and markets |

**Table 1.** Contd.

| Region | School | Nature of school | School or farm garden | Type of meals | Variety of foods | Time for meals | Consideration for nutritious food in meals | Procurement of food | Funding | Nature of contributions | Source of school food |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Central | Trinity HS | Private School | No school garden | Porridge for breakfast<br>Lunch<br>Supper | Maize porridge<br>Ugali with beans<br>Ugali with beans | 6.30am breakfast<br>1Pm lunch<br>7.00PM supper | Depending on availability | Director (owner) of school | Parents pay as part of school fees | Monetary contribution | Purchased from farmers and markets |
| Central | Kazo Hill Col | Public school | No school garden | Porridge for breakfast<br>Lunch<br>Supper | Maize porridge<br>Ugali with beans<br>Ugali with beans | 6.30am breakfast<br>1Pm lunch<br>7.00PM supper | Considered if vegetables such as amaranths are plenty | School food committee of teachers, students and parents | Contributions from parents | Monetary contributions | Purchased from farmers and markets |
| Central | Nsambya Hillside HS | Private catholic | No school garden | Porridge for breakfast<br>Lunch<br>Supper | Maize porridge<br>Ugali with beans<br>Ugali with beans | 6.30am breakfast<br>1Pm lunch<br>7.00PM supper | Considered if budget permits | Head Teacher | Parents pay as part of school fees | Monetary contribution | Purchased from farmers and markets |
| Central | High Field Sec. Sch of EA | Private School | Owns school garden used for practical lessons | Porridge for breakfast<br>Lunch | Maize porridge<br>Ugali with beans | 10.30am breakfast<br>1Pm lunch | Considered depending on availability in school gardens | Director (owner) of school | Parents pay as part of school fees | Monetary contribution | Purchased from farmers and markets |
| Central | Brilliant HS | Private School | No school garden | Porridge for breakfast<br>Lunch | Maize porridge<br>Ugali with beans | 10.30am breakfast<br>1Pm lunch | Not considered | Director (owner) of school | Parents pay as part of school fees | Monetary contribution | Purchased from farmers and markets |
| Central | Namanoga SS | Public school | No school garden | Porridge for breakfast<br>Lunch | Maize porridge<br>Ugali with beans | 10.30am breakfast<br>1Pm lunch | Not considered | School food committee of teachers, students and parents | Contributions from parents | Monetary contributions | Purchased from farmers and markets |
| Central | St.Joseph'sss, Nagalama | Private catholic non-boarding and boarding school | Owns school garden although not operational at time of survey | Porridge for breakfast<br>Lunch<br>Supper | Maize porridge<br>Ugali/rice/bananas with beans<br>Ugali with beans/meat/chicken | 6.30am breakfast<br>1Pm lunch<br>7.00PM supper | Considered if vegetables and fruits are in plenty and available in school gardens | Head Teacher | Parents pay as part of school fees | Monetary contribution | Purchased from farmers and markets |

Source: Author

schools, school committees reported operating bank accounts for school feeding programme funds. Out of 27 schools with feeding committees, only 15 operated bank accounts. Twelve schools with school feeding committees, that collected funds for school meals from parents, physically kept the funds with a nominated member of committee appointed by the PTA. To remove issues of mistrust, the designated member was required to submit accountability of funds used for school feeding on a weekly basis to members of the school feeding committee. In private schools, all funds raised for the school feeding programme were paid on the school fees bank account together with tuition, making school feeding in private schools in Uganda mandatory. This is in agreement with a study conducted in Tanzania (Roothaert et al., 2021) where it was observed that children in private schools were having a meal daily, because meals are mandatory in private schools. This reveals that parents taking their children to private schools are interested in educational excellence of their children than meals cooked at schools (Roothaert et al., 2021). The daily management of school feeding in private schools, in the present study, was observed to be contrary to the recommendations

of the official government policy of school feeding and nutrition guidelines. Owners of the schools or school directors, in private schools single handedly operated the school feeding programmes, as opposed to the school feeding committees or verification committees managing the school feeding and nutrition programmes in public schools and faith-based schools.

Overall, the two forms of school feeding and nutrition programmes (PLSFP and HGSFP) in the present study were held in high regard by parents, students and teachers. Reasons mentioned for during the FGDs and KIs, for valuing this programme include:

(1) Children fed at school concentrate better than those not fed at school, hence increasing school attendance.
(2) Long distances walked to look for food during lunch breaks, are eliminated with PLSFP and HGSFP.
(3) Adherence to school timetable by students, is easier when school meals are served than when students walk home for lunch.

The importance was further reemphasized by the Assistant Commissioner for nutrition at the Ministry of Agriculture, who considered school feeding as a human right, putting in perspective that underfed or poorly fed children perform poorly at school.

**Access to a hot school meal**

In the present study, all students accessed at least one meal a day, when they were at school (Table 1). This is in line with the government of Uganda mandatory parent led school feeding programme (PLSFP), where parents are responsible for feeding their children while at school. For both public and private schools, irrespective whether non-boarding or boarding, all students benefitted from the existing school feeding programme. Irrespective of social economics status, Ugandan students from rural and poor backgrounds in the present study accessed school meals. This is contrary to the Tanzanian findings reported by Roothaert et al. (2021), in which it was revealed that Tanzanian students whose parents did not contribute to the school feeding programme, did not access a hot meal while at school. In Uganda, access to school meal by all students was guaranteed, because as a government policy, students are not supposed to be discriminated against while serving food. Students whose parents had not made monetary contribution towards school feeding programme were given reminders to deliver to the parents to pay, even when the school term or semester had ended, parents were requested to make their monetary or in kind contribution. The FGDs with students and teachers revealed that some parents whose children were in public schools, misunderstood the free basic education introduced by the government in 1997. Free education in Uganda is made possible by the modest capitation grant (approx. 3$ per children per term) contributed by government towards the learners studies, under either the Universal Primary Education (UPE) or Universal Secondary Education (USE) host schools (Kan and Klasen, 2020). Therefore, some parents did not pay for school meals, because they expected the capitation grant to cover the school meals. However, teachers and parents that participated in the FGDs, indicated that through persuasion and explanation, such parents were convinced that provision of school meals was a responsibility of the parents. This observation is in agreement with findings reported in Tanzania by Roothaert et al. (2021). Tanzanian parents with children in public schools receiving free basic education, expected the schools to also provide free meals paid for by the government. On the other hand, schools that are private, urban and boarding, targeting children from the urban elites, were reported by KIs and FGDs discussants in the present study, that prior to the start of the term, every student accessing the school premises must have made contribution towards school feeding in form of school fees. As a result, students enrolled in urban, private and boarding schools in Uganda have access to a more diverse diet of school meals than children in public and rural schools (Table 1). Plant based diets were the most consumed school meals (Table 2). Cereals dominated by maize (*Zea mays*) (in form of *Ugali* or *posho* - a stiff porridge) and rice (*Oryza sativa*), and pulses including beans were the most prepared food groups. The major sources of energy registered in the present study included rice, *ugali* or *posho,* cassava (*Manihot esculenta*) and sweat potatoes (*Ipomoea batatas*). Beans (*Phaseolus vulgaris L.*) were observed to be the main source of proteins in Ugandan school meals. This finding is similar to findings reported in Tanzania by Sanya (2015), in which he postulated that stiff maize porridge (*ugali* or *posho*) was the main source of energy while pigeon pea was the main source of proteins. It was further observed that challenges of making contribution towards school feeding in Uganda, was of a less burden among parents with children registered in secondary schools. This may be attributed to the fact that parents with children in USE secondary schools were used to paying for school feeding programmes of their children, since their children had previously been enrolled in UPE schools than parents with children who are currently registered in primary schools and experiencing the free education services.

**Diversity of school meals and their nutrients content accessed by learners in boarding and non-boarding schools**

A total of twenty-two food items consumed were mentioned (Table 1). The food items when allocated to the food groups, nine food groups were generated across

**Table 2.** Food groups consumed in boarding and non-boarding schools of Uganda.

| Food group | School Type | | Total |
|---|---|---|---|
| | Boarding | Non-boarding | |
| Cereals | 65 | 31 | 96 |
| Fats and oils | 30 | 10 | 40 |
| Pulses and legumes | 42 | 19 | 61 |
| Vegetables | 19 | 20 | 39 |
| Bulbs | 11 | 9 | 20 |
| Meat, poultry and fish | 2 | 2 | 4 |
| Roots and Tubers | 1 | 3 | 4 |
| Nuts | 1 | 1 | 2 |
| Fruits | 0 | 1 | 1 |
| Total | 171 | 96 | 267 |

Source: Author

**Table 3.** Dietary diversity score of school children.

| DDS | |
|---|---|
| Number of food groups consumed | % of total (n=225) |
| ≤ 2 | 33.3 |
| 3 | 25.6 |
| 4 | 40.3 |
| 5 | 0.4 |
| 6 | 0.4 |

Source: Author

the 45 schools considered in the present study (Table 2). These included: (i) cereals; (ii) roots and tubers; (iii) pulses and legumes; (iv) vegetables; (v) bulbs; (vi) meat, poultry and fish (vii) fruits; (viii) fats and oils; and (ix) nuts. Two varieties of foods were included in the cereals group, four in roots and tubers, one in legumes and pulses, one in fats and oils, three in meat, poultry and fish, four in vegetables, five in fruits and one in nuts. When diversity scores were computed using data collected in the present study, about 90% of the learners ate food items from only 2 to 4 food groups (cereals, pulses and legumes, vegetables and bulbs), while about only 1% had DDS of 5 and above consuming food items from five and six food groups (Tables 2 and 3). This observation is comparable to previous findings reported among several African countries (Ochola and Masibo, 2014; Roothaert et al., 2021). School going children in Tanzania, Zambia and Kenya, do not consume a diverse diet, and dominantly consume plant-based diets, derived from cereals, roots and tubers and limited animal foods. In both Zambia and Tanzania *Ugali,* a stiff maize porridge and beans are served to children during lunch and or supper (Ochola and Masibo, 2014). Also, the dietary diversity findings are in agreement with the views of the key informants, who observed that schools do not offer a variety of foods to the learners. Boarding schools in the present study were observed to provide a higher diversity of food varieties per food group than non-boarding schools in Uganda.

When supply of nutrients from school meals was calculated according to the different regions of the country, it was observed that children in schools located in the West and West Nile regions of the country, had the highest amount of nutrients accessed from their school meals (Table 4). Children in Western Uganda received about 546.5 µg/100 g for vitamin A, 4.9 mg/100 g for iron, 880 Kcal/100 g for energy and 24.9 mg/100 g for proteins. While children in West Nile region received about 1,535.2 µg/100 g for vitamin A, 5.1 mg/100 g for iron and 22.5 mg/100 g for proteins. The high nutrients supplied by school meals served in Western region can be attributed to the school milk feeding programme being implemented in Western Uganda by an NGO, the Netherlands Development Organization (SNV). In Western Uganda, two schools including Rwamurunga Primary School and Isingiro Secondary School, parents make in kind contributions of milk. While in West Nile the high nutrients most especially vitamin A, can be attributed to the, indigenous fish served with vegetables as sauce, in school meals in some schools such as Ediofe Girls

**Table 4.** Nutrients (per day) supplied in meals eaten by school children.

| Region/School type | No. of children | Energy (kcal/100g) | Protein (g/100 g) | Iron (mg/100 g) | Vitamin A (µg/100 g) |
|---|---|---|---|---|---|
| West | 50 | 880.0 | 24.9 | 4.9 | 546.5 |
| West Nile | 45 | 625.1 | 22.5 | 5.1 | 1535.2 |
| North | 35 | 602.3 | 16.7 | 3.3 | 367.2 |
| East | 50 | 637.1 | 19.5 | 4.3 | 386.5 |
| Central | 45 | 846.1 | 23.6 | 4.9 | 509.3 |
| **Private/public** | | | | | |
| Private | 140 | 702.9 | 19.8 | 4.3 | 418.9 |
| Public | 85 | 673.5 | 21.3 | 4.5 | 759.0 |
| **Primary/secondary** | | | | | |
| Primary | 40 | 698.2 | 19.5 | 3.8 | 427.4 |
| Secondary | 185 | 684.7 | 20.9 | 4.5 | 658.4 |
| **Boarding/non-boarding** | | | | | |
| Boarding | 105 | 711.9 | 28.2 | 5.7 | 596.7 |
| Non-boarding | 120 | 661.8 | 29.0 | 7.2 | 1516.4 |

Source: Author

Secondary School. Fish is high in vitamin A (Roos et al., 2002). Generally, children in the Northern region of the country received the least amount of nutrients from the school meals. This can be attributed to lack of diversity, poor parents who cannot afford private schools that supply more diverse school meals and lack of government support to implement the school feeding programme.

## Impact of school meals on nutrient requirements of school going children

The amount of local starchy staples such as cassava, stiff maize porridge (*Ugali* or *posho*), rice, banana or sweat potatoes prepared with sauce such as beans, and consumed by school going children in Uganda is estimated at around 500 g daily for non-boarding school going children and 1000 g for boarding school children (MoES, 2013). Therefore, when these estimations are used for the amounts that may be commonly consumed by all categories of learners, it is possible to compute the potential contribution of the local school feeding meals on meeting the nutrients requirements as recommended by Uganda's Ministry of Education (MoES, 2013) and United Nations Organizations (WHO and FAO, 2004; IoM, 2005). Nationally, school children in the present study, were only accessing 28% of their energy needs from school meals, 64% proteins requirements and 42% of iron requirements. The Uganda, school feeding guidelines recommends that school meals should provide at least 30 and 100% daily nutrients requirements for non-boarding and boarding school going children, respectively (MoES, 2013).

Overall, at the national level, the findings in the present study revealed that Ugandan school going children in all categories of schools were being supplied with sub optimal daily nutrients (energy, proteins, vitamin A and iron) from school meals (Table 5). This finding is important because low intakes of energy, vitamin A, iron and proteins are well documented risk factors for poor nutritional status and poor academic performance among school going children (Li et al., 2009).

Although children in most school categories had lower overall micronutrient and macronutrients intakes, those who were in non-boarding schools category obtained much of their 30% requirements for vitamin A and iron intake. Generally, meals served in Ugandan non-boarding schools, were found to provide the daily-recommended 30% requirements of proteins (52%), vitamins (151%) and iron (62%).

The meals can provide about 40% to more than 100% vitamin A requirements, in private and boarding schools (42%) to 151% in non-boarding schools, about 40-62% of iron requirements in all categories of schools and about 30% daily energy nutrients requirements in all school categories. This scenario may be attributed to the mandatory fortification programme of cooking oil sold on market (Fiedler and Afidra, 2010), inclusion of fish and vegetables in school meals menus and release of high iron bean varieties to farmers (Katungi et al., 2020; HarvestPlus, 2016). Findings further revealed that Ugandan school meals can also provide about 40-62% of iron requirements in all categories of schools and about 30% daily energy nutrients requirements in all school categories.

**Table 5.** School meals contribution (%) to the daily requirements (RDAs)*of key nutrients of Boarding and Non-boarding school children

| School type | Energy | Protein | Vitamin A | Iron |
|---|---|---|---|---|
| Private | 28 | 42 | 42 | 40 |
| Public | 27 | 46 | 76 | 41 |
| Primary | 28 | 42 | 43 | 38 |
| Secondary | 27 | 45 | 66 | 41 |
| Boarding | 28 | 55 | 59 | 53 |
| Non-boarding | 26 | 52 | 151 | 62 |
| National | 28 | 47 | 72.5 | 42.2 |

*Percentage of children below the estimated recommended dietary allowances (RDA) for school going children.
Source: Author

## Experiences from HGSF projects

The KI from World Food Programme (WFP) revealed that since 1983, the Government of Uganda (GOU), and in collaboration WFP, have been implementing the home grown school feeding (HGSF) programme, in the Karamoja region located North East of the country. He revealed that HGSF programme in Uganda, is characterized by (i) the school having the school feeding committee, (ii) parents contributing financially or in kind towards food for their children at school and (iii) a breakfast and/or lunch provided to both children and teachers. In the case of Karamoja region, because of it is recurrent food insecurity episodes, WFP through local governments and schools, buys food items from the farmers and distributes it to schools located in places where parents cannot afford to contribute. The local governments and schools receive cash from WFP to purchase and distribute maize and beans from contracted farmers who are mobilized and organized into cooperatives. Per meal served in Karamoja schools, each child receives about 150 g of maize for lunch, 40 g of beans, 5 g of oil and 3 g of salt. The KI revealed that the WFP school feeding model in Karamoja, constitutes an inherent sustainability approach, built among the local communities supplying food to schools. The model eliminates middle men, and directly links farmers (suppliers) with schools. Fortified oil is also distributed to schools by WFP. In 2019, WFP reached 315 schools, providing a daily hot meal to more than 155,000 children of which 46 percent were girls (WFP, 2020).

It was further revealed during the FGDs and KI interviews, that as a result of WFP advocacy initiatives and successful piloting of HGSF in Karamoja, several NGOs including SNV, the Pan-Africa Bean Research Alliance (PABRA), HarvestPlus and government agencies such as National Agricultural Research Organization (NARO), started similar programme in different locations using different vehicle foods. For instance, SNV, pioneered implementing the school milk programme in Western Uganda, reaching 300,000 school children between 2016 and 2019, through procurement of milk and other commodities for school meals directly from farmers organized in cooperative societies. Also the KIs revealed that the Consultative Group for International Agricultural Research (CGIAR) Programmes of HarvestPlus and PABRA, through their partners such as NARO and community based organizations (CBOs), are currently supporting HGSFPs. They are linking farmers to schools by encouraging farmers to sell biofortified high iron beans and orange-fleshed sweat potatoes to schools. For instance, PABRA introduced high iron and zinc beans (HIZB) to selected primary schools as a pilot phase in Central Uganda. The distribution was coupled with conducting nutrition awareness sessions with managements of schools, district education and agriculture officers, who were imparted with the technical support (e.g. nutritional education/analysis and training on bean agronomy) by NARO, PABRA and District Nutrition Officers. In addition, schools were each supplied a starter seed pack of 10 kg per variety to set up demonstration plots at their school farms of which children and parents come to learn the importance of HIZBs both for nutritional and economical values. Each school in the pilot phase harvested an average of 100 kg and was required to distribute equivalent of start-up seed to 2 to 3 neighboring schools.

## Challenges and opportunities

The FGDs discussants and KI interviewees were requested to share challenges and opportunities faced by school feeding programmes in Uganda. The challenges and opportunities listed are the following.

### *Coordination challenges*

The current school feeding and nutrition guidelines

(MoES, 2013) do not provide for coordination of the school feeding programmes at national and district level. It only mentions coordination at school level, where a school feeding committee is drawn from members of school finance and development subcommittee, with representatives from parents and students. The school feeding programmes in public schools are left to the school feeding committees or the director or owner of school in case of privately-owned schools, eliminating the monitoring and evaluation responsibilities, which would be performed by the line Ministry of Education and the district or local government officials. This observation is similar to findings reported in Tanzania by Roothaert et al. (2021), who documented lack of national and district coordination of school feeding activities in Tanzania. On a brighter note, the discussants in the FGDs and KIs informants revealed that the district officials and Ministry of Education officials were playing an important role in advocating for school feeding programmes. KI informants advised that to promote inclusiveness and community ownership of school feeding and nutrition projects, district education, nutrition, health, extension and community development officers, should be involved in community advocacy activities. In addition, the FGDs discussants, advised that at the Ministry of Education level, a coordination unit or directorate be created with a primary purpose to enforce adherence to the school feeding guidelines being implemented in the country.

### *Production and procurement challenges*

Generally, it was observed, that most rural and public schools had limited innovation in producing their own food. During the FGDs, public schools administrators revealed that because of limited funding from government, farming inputs for the school farmland, were not procured. In order not have idol land, the school administrators, allotted pieces of plots of school land to teachers and casual workers, to produce food for their families and sale to the school and communities. Two private and catholic church found schools in the present study, were running successful school gardens producing food that was supplementing procured food. For instance, St Joseph Nagalama SS School in Central Uganda, not only did it, produce its own food from the school garden, it was also running a dairy farm, supplying milk to the school. Supporting school food production can be vital in strengthening school-based food production. This can be achieved through government allocating funds for farming inputs in public schools, while parents contributing towards farming in private schools.

Whereas the PLSF model encourages schools to locally procure foods, it does not clearly stipulate how farmers and surrounding communities can be engaged. Furthermore, this study revealed that most farmers surrounding schools throughout the country have not organized themselves into groups or cooperative societies so as to tap into local procurement by schools. In effect, there are weak linkages between farmers groups and schools to support direct local procurement. On the other hand, although all schools in Uganda were operating under the PLSF model, majority (about 70%) of the schools (both public and private) preferred procuring food from relatives, friends and intermediaries, ignoring the farmers because they were not organized in groups, to supply large quantities of food.

In most public schools where teachers and parents had strained relations due to free primary and secondary school education, had challenges with purchasing a variety of school meals in adequate amounts. Some parents believed contributing to school feeding programme is not mandatory. A similar finding has been documented in Tanzania (Roothaert et al., 2021). On the other hand, procurement decisions in all private schools were observed to be unilaterally made and often taken by the director or school owners, without input from the school feeding committee. As a result most schools were not procuring food from farmers, leading to purchasing food in poorly branded bags, weevil infested beans and dishonest suppliers mixing poor grade food with good grade food. Unilateral decisions to procure food were reported by the FGDs participants to lead to overstocking of supplies in stores, which led to food spoilage.

### *Infrastructure challenges*

School feeding programmes in Uganda, are seriously hampered by limited availability of relevant infrastructure including suitable kitchen, clean working surfaces and floors, utensils and water for cooking and appropriate storage rooms. Majority of schools (both private and public) lack dining halls for students to use during lunch or supper. Often students consume food under trees or use classrooms, raising concerns of hygiene and sanitation. In public schools, most of the existing facilities were installed during the colonial times, that is, before Uganda got independence, and as such most infrastructures are old and need to be routinely refurbished or replaced. Of recent, through NGOs and government, some schools have been supported to establish rainwater-harvesting systems, storage tanks for water, toilets and establish energy saving kitchens. This is an important support because most schools are poor and cannot afford to have these facilities.

### *Nutrition and dietary diversity challenges*

The approach of parent-led school feeding programme (PLSFP) in Uganda, has negatively impacted the quality of meals served, diversity of school meals and nutrition value of the meals. Firstly, in public schools that are

located in both rural and urban settings, offering the universal free education to all, parents did not make timely contributions towards feeding of their children at school because they misunderstood the PLSFP. As a result of parents not paying the school feeding fees, this negatively affected the diversity and eventually the nutritive content of school meals served to children. The Ugandan government policy of feeding all children in public schools, irrespective of the contributions by the parents, has further demotivated parents who make timely contributions towards the PLSFP. In contrast, private schools and boarding schools in the present study served more diverse meals per food group, than public schools and non-boarding schools, respectively, because the owners of the private schools, do not admit a student on school premises before their parents make contributions towards the school feeding programme in form of school tuition. Private schools especially boarding schools and schools with school farms to some extent and periodically served diversified school meals with vegetables, fruits and fish during lunch breaks, an egg per child during breakfast, and some public holidays or weekends with chicken or beef during lunch and supper. Most private schools in the country are constituted with children of elite and from urban areas, who can afford to pay for the higher cost attached to school feeding.

## Proposed areas to improve school feeding in Uganda

The present study unearthed several suggestions to address the challenges related to school feeding programmes in Uganda.

### *Coordination and stakeholder engagement*

The current guidelines for school feeding and nutrition programmes in public and private schools lack a clear approach of how to coordinate the programme nationally and at the local government level in districts. The guidelines only mention coordination at the school level, with establishment of the school feeding committee, comprising representatives from parents, teachers and students. However, this committee lacks supervision, from the Ministry of Education and local government district officials. It is recommended that a national coordination office for school feeding programmes, at the Ministry of Education be established, with a primary purpose to enforce adherence to the school feeding guidelines. At district level, with support from the local government, a district school feeding office is recommended to be established, to support the Ministry of Education to monitor and supervise school feeding initiatives at a local level. Passing of ordinances or bylaws by districts to enforce school feeding programmes, should be encouraged by stakeholders. This will go a long way in ensuring children have access to a hot meal thus increasing their enrolment and being retained at school.

### *Nutrient content of meals improved*

There is paucity of data on the quality and type of school meals served to school children in Uganda, limiting the assessment of the nutrient adequacy of meals served to school children. The preliminary information in the present study generated from 45 pilot schools, reveals that Ugandan school meals not only are they lacking in diversity but they do not provide adequate energy, proteins, iron and vitamin A. This implies there is need to enforce the implementation and monitoring of the school feeding and nutrition guidelines, which provide policy direction on ensuring that all students access a balanced diet while at school. In addition, there is need for government to invest in advocacy and awareness creation initiatives targeting parents and guardians who are not contributing funds towards the parent school feeding programme. This has negatively affected the quantity and quality of food served to each child, compromising on the nutrients content available to the child. The introduction of free universal schools for primary and secondary going children in public schools has also undesirably affected the nutrient and quantity adequacy of school meals. Some parents who are misinformed do not pay the school feeding programme fee contribution, because they believe the capitation grant made by government towards schooling, also covers the school meals. Through persuasion and explanation, the negative attitude towards not contributing to school feeding can be changed among parents over time. In addition, parents should be encouraged to make in kind contributions if they cannot pay cash.

### *Engage stakeholders to change their attitudes and practices toward healthy eating*

For school feeding to be a success, there is need to involve stakeholders at national, district and local levels. The example of parent led school feeding programmes, engaging farmers through district ordinances such as in Gulu district, shows that working with district administrations can be critical in spurring implementing school feeding with communities. Then also, involvement of community-based organizations and international development agencies such as SNV has also supported linking dairy farmers to supply milk to schools in South Western Uganda. One of the main challenges faced by several NGOs and proponents of school feeding in Uganda was mobilizing and engaging government officials and local communities. Then again, access to

nutrient rich foods by schools, coupled with nutrition education and awareness how school meals can improve health and retention of children in schools, turned out to be important factors listed by KIs and FGDs discussants for adopting school feeding. Despite majority of parents being aware of the importance of school feeding to children, they were not aware of their roles in school feeding programmes. Deliberate engagement and empowerment of all stakeholders from parents, communities, school administrators, students, NGOs, local government, development partners and policy makers is necessary for the success of school feeding. Probably, this engagement, will address the concerns, parents who have misinterpreted, misunderstood and believed that the free education policy for primary and secondary school going children, meant school meals were free to all children. Opportunely in Uganda, the parent led school feeding programme, is incorporated policies such as National Development Plan III (NDP III), Uganda Nutrition Action Plan II (UNAP II) and the School Feeding and Nutrition Guidelines. This has created a conducive environment for NGOs and public agencies to positively influence promotion of school feeding. The KIs and participants in FGDs, revealed that schools should have influence on surrounding community's perception towards healthy diets fed to school children. For instance, it was observed that schools with school gardens can provide education related activities in nutrition, health and agriculture to both students and surrounding communities. McGovern (2015) reported that school gardens not only supply vegetables to schools and communities, but also are important educational tools for students and surrounding communities. While public schools in Uganda have land to establish school gardens, most private schools do not. Local government administration at district level can play a role in putting to use land in public schools, to provide nutritious foods.

## Conclusion

The guidelines on school feeding and nutrition intervention programme provide strategies on how the parent led school feeding can be implemented in Uganda. However, it is not clear on how to source food from the communities, whether parent-led school feeding is mandatory, coordination of school feeding at national and district level and how to deal with parents who do not contribute to the feeding of their children. As a result, the policy has resulted in conflict between parents and schools' administrators. These have significantly affected the portion size and diversity of school meals, compromising nutrients available to students. The guideline is further not clear on portion sizes, quality standards and costs of school meals, further leading to poor quality of diets and sometimes too small portions. It is recommended that the current school feeding and nutrition guideline and policies, need to be reviewed holistically using multi-sectoral approaches. The study revealed that issues related to parents contributions; school infrastructure and operation modalities; school diversity and nutrition quality and coordination and awareness need to be considered in order to have a successful school feeding and nutrition programme. There is need to have a legal framework to guide the implementation of sustainable school feeding programme in the country. A solid policy foundation will strengthen the school feeding programme's sustainability and quality of implementation. National planning for school feeding as part of the country's poverty reduction strategy or other equivalent development strategies should be a priority for government. This will convey the importance the government places on school feeding as part of its development agenda. The current school feeding programmes in Uganda can be strengthened by addressing challenges related with weak community involvement in school feeding programmes. There is need to strengthen local and community focused school feeding, including establishment of local committees and implementing homegrown school feeding where appropriate. School feeding and nutrition programmes that are locally owned incorporate contributions from local farming communities and respond to specific community needs, are strongest. Programmes involving communities are most likely to make a successful transition from donor assistance to national ownership if communities are involved, in supplying the school food and also exposed to continuous accrued benefits of school feeding.

## CONFLICT OF INTERESTS

The author has not declared any conflict of interest.

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