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Effect of School Garden Food Production on Nutrient Adequacy of School Meals for Children Attending Namasagali Primary School in Rural Kamuli District, Uganda

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Abstract

Background: Access to good nutrition either at home or school can contribute to the elimination of malnutrition and its associated health and developmental problems among school-going children. School feeding programs supported by school garden food production create diversity in the meals, promote agricultural skill development, boost local food production and reduce over dependence/reliance on donors.

Objective: The purpose of this study was to determine the nutritional adequacy of the meal served to the pupils of Namasagali Primary School (NPS) and contribution to their Recommended Dietary Allowance (RDA).

Design: A cross-sectional study with an analytical design and laboratory analysis were used. Data on socio-economic and demographic characteristics, dietary intake patterns and anthropometric measurements was collected from 226 pupils The meal (stew of whole maize, beans, collards, tomatoes, salt, and vegetable oil) was analyzed in the laboratory for energy, protein, fats, vitamin A, iodine, and iron using Association of Official Analytical Chemist (AOAC) methods (2005). School garden production of three high-value crops (collards, tomatoes, and grain amaranth) were monitored with inputs and yield recorded and cost accordingly. Data was analyzed using SPSS version 17 and Nutri-survey. Descriptive statistics such as mean, frequencies and percentages were used to describe the data.

Setting: This study was conducted at NPS. It is a missionary founded school that began way 1932. It is located in Kabanyoro village, Namasagali Parish, Namasagali Sub County of Kamuli District. The district is in one of the most food-insecure parts of the country with at least 50% of the population not having enough to eat throughout the year as reflected by seasonal fluctuations in food productivity and high malnutrition rates (79%).

Result: A higher level of cross tabulation and correlation test of the three hypothesis was done and P<0.05 was used to determine statistical significance. From the study, 50.4% were male pupils while 49.6% were females. About 51% of the caregivers had attained at least level of primary education with 89% of them being peasant farmers. The most grown crops were maize (97%) and sweet potatoes (87%). The school meal provided a significant amount of calories (853kcal) and all other major nutrients as compared to what the pupils consumed at home.

Conclusion: This study found that the maize and beans diet served at the school for lunch had a high caloric and protein intake as compared to the maize meal porridge (50kcal) that the pupils were initially consuming. The meal contributed a significant amount of nutrient to the pupils RDA between 28%-43% for the age group as compared to 7%-11% of the meals at home.

Keywords: school garden food production and nutrient adequacy

1. Introduction

The conception of the Millennium Development Goals (MDGs) in the year 2000 and Sustainable Development Goals [SDGs] in 2015 resulted from the determination of all countries in the United Nations (UN) to address challenges stemming from advancing globalization. Attention was paid to hunger and poverty as stated in MDG one (SDG 1&2), that is,"eradicate extreme hunger and poverty (Murray, 2015) [1]," specifically expressed in the sub-goal formulated " by the year 2015 the proportion of people who suffer from hunger is halved as compared to 1990" (UN, 2005) [2]. *The State of Food Insecurity in the World 2013* presented updates showing that further progress has been made towards the 2015 MDG target (halving the proportion of hungry people), however, this remains within reach for the developing countries collectively (FAO, 2013) [3]. Globally, it is estimated that in every six seconds a child dies from hunger-related causes (FAO, 2007) [4] and in developing countries, one out of four children are stunted (WFP, 2009; UNICEF, 2007) [5, 6]. Across the developing continents, 66 million primary school-aged children attend classes hungry, 23 million being in Africa (Badri, 2014) [7]. Of the 72 million primary school-age children worldwide, who are not in school, 95 percent are in developing countries; 57 percent are girls; 48–56 percent are stunted, and up to 62 percent are underweight. More than half of the 72 million suffer from iron deficiency anemia, 5 percent from iodine deficiency and 7 percent from vitamin A deficiency (WFP, 2009) [5]. School Feeding Programmes have been reported to improve children's cognitive outcomes and nutritional status depending on the design of the program (Kristjansson, 2007)

[12]. School gardens have been used as a potential source of locally grown agricultural products for SFPs (Mwangi *et al.*, 2010) [13]. The New Partnership for Africa's Development (NEPAD) teamed up with World Food Program (WFP) and other partners to create the Home Grown School Feeding Program (HGSF), a program that provides nutritionally adequate meals for learners and improving enrolment and retention in schools while addressing the needs and growth of the local small farmers (NEPAD, 2007) [15].

The target of the second MDG was to ensure that all boys and girls achieve Universal Primary Education (UPE). Uganda's launch of UPE in 1997 was a landmark towards meeting MDG 2 (now SDG 4), but these gains are being threatened by several factors that include short-term hunger due to lack of proper meals at school, insufficient school supplies and lack of enough teachers in the schools (FAO, 2013, Kibwika *et al.*, 2010) [3, 9]. Other reasons stem from responsibilities at home and pressure to earn additional income. Children belonging to poor and food insecure regions/households have been forced to contribute to household chores rather than go to school (WFP, 2011) [8]. In Kamuli District Eastern Region, poverty and lack of school feeding programs (SFPs) have severely crippled the children's ability to learn because most of the time they are hungry (Kirabo, 2011 & UBOS, 2012) [10, 11]. The policy on school feeding in Uganda is that parents who can afford to pay are allowed to make feeding arrangements with the school management, and those parents who cannot afford the cost of a school meal, they prepare food for their children to carry to school (Uganda Budget, 2007/2008 in Kibwika *et al.*, 2010) [9]. Most rural schools in Uganda, make arrangements with parents to provide the children with a cup of porridge for lunch. Parents contribute in cash or kind towards this lunch. Namasagali Primary School, in Kamuli District, is one of the schools that had such an arrangement; they provided one-cup (250 ml) of maize meal porridge for lunches, which was grossly inadequate (50 kcal) in terms of quality and quantity. In addition, it was never a guaranteed due to the reluctance of parents to make their contribution that is blamed on the high levels of poverty and poor agricultural productivity in the area (CSRL Report, 2011). Guidelines for school feeding programme in Uganda stipulate that no child may be excluded from class or otherwise punished because of parents failure or refusal to contribute for school meals(Ministry of Education and sports); this has made it difficult for most Kamuli rural school to sustain feeding (Kirabo,2011) [10].

Iowa State University's-Centre for Sustainable Rural Livelihoods (CSRL) in partnership with Volunteer Efforts for Development Concerns (VEDCO), a local non-governmental organization in Uganda and Makerere University; established school gardens and feeding programme in the year 2006, at Namasagali Primary School Kamuli District. The program set up school garden/feeding project with an overall goal of enhancing the quality and quantity of the school lunch by providing a hot, solid and nutritious lunch to the children. Food from the gardens is either sold to generate funds for the lunches and garden inputs or used directly to supplement the meals at the school. This has helped create diversity in their diets, reduced over dependency/reliance on donors and boost local food production especially within the school locality (CSRL, 2012) [16]. From the school gardens, grain amaranth (a protein-rich cereal) and occasionally eggs were added to the porridge to enhance its nutrition quality. This marginally improved the caloric content of the porridge from 50kcal to 80kcal but was still inadequate for a primary school going child. With the intention of increasing the caloric intake and ensure that the pupils received the much-needed nutrients, CSRL introduced a solid meal in the year 2010. The meal consisted of whole maize, beans, vegetables, iodized salt, vegetable oil and eggs added once a week as a source of animal protein. This study was designed to determine the adequacy of the school meal with regard to the Recommended Dietary Allowance for a primary school going children. It went further and assessed the nutritional status of the pupils and sought to establish the possibility of sustaining a school feeding programme with interventions such as school gardens and parents involvement.

2. Materials and Methods

This study was a cross sectional study with an analytical design and had a laboratory analysis of the "new" school meal. This study was conducted at one point in time, and no follow up was done. The study employed both quantitative and qualitative methodologies in data collection and analysis. Anthropometric measurements, dietary intake, and socioeconomic data were obtained from the respondents using questionnaires. Proximate and micronutrient analysis of the meal was done at Makerere University Department of Food Science and Technology using Official Methods of Analysis of Association of Official Analytical Chemists (AOAC). Comprehensive sampling was used to examine the entire student population at NPS. Each pupil received a daily portion size of 250g of the meal composed of whole maize, beans, collard kales, iodized salt and oil five days a week (Monday to Friday). An analysis of the meal was done to establish its nutrient composition, and 24hour recall was used to establish what the children had eaten at home. All ingredients for the meal were transported from the school to the laboratory in their raw and dry form to protect the sample from any changes in composition and possible loss of nutrients and contamination. The school meal was prepared in the Makerere University's Department of Food Science and Technology laboratory using the same procedures as on site. Maize and beans in the ratio of 2:1 (200g and 100g respectively) were soaked separately overnight and then boiled the next day for a period 5 hours. The maize was boiled first until soft, and then the beans were added. Once cooked, vegetable oil (20g), iodized salt (4g) and collard/kales (20g) were added, and the mixture was cooked for 2 minutes. The mixture was then left to cool and then ground using a blender into a fine uniform consistency. The blended sample was then analysed for moisture, protein, energy fat, ash, vitamin A, iron, and iodine. The ground paste was then used to determine the proximate analysis of the meal and the micronutrient content using the AOAC method (2005) [18]. All proximate components were analyzed in triplicate and reported as mean on % wet weight basis.

Moisture Content:

Moisture content was determined using oven drying method.

Five grams of homogenized sample was accurately weighed out in triplicate in a clean, dried crucible (W_1). The crucible was allowed in the oven at 105°C for 3 hours until a constant weight was obtained and to avoid the losses of volatile components. After 3 hours of drying the crucibles were placed in a desiccator for 30 minutes to cool. After cooling it was weighed again (W_2), the percentage moisture content was calculated using the formula:

$$\% \text{ Moisture content} = \frac{(W_1 - W_2) \times 100}{\text{Wt. Sample}}$$

Where:
W_1= Initial weight of crucible + sample
W2= Final weight of crucible+ Sample

Protein Content:
Protein in the sample was determined by Kjeldahl method. The samples were digested by heating with concentrated Sulphuric acid (H_2SO_4) in the presence of a digestion mixture. The mixture was then made alkaline. Ammonium sulphate thus formed, releasing ammonia that was collected in 2% boric acid solution and titrated against standard 0.05M Hydrochloric Acid. Methylene blue and methyl red was used as an indicator. Total protein was calculated by multiplying the amount of nitrogen with an appropriate conversion factor (6.25). Percentage crude protein content of the sample was calculated using the following formula:

% Crude protein =6.25*x %N (Correction factor)

$$\%N = \frac{(S-B) \times N \times 0.014 \times D \times 100}{\text{Wt. of Sample} \times V}$$

Where:
S=Sample titration reading
B= Blank titration reading
N= Normality of HCL
D= Dilution of sample after digestion
V= Volume taken for distillation
0.014=Milli equivalent of weight Nitrogen

Crude Fat
The crude fat content was determined according to Soxhlet method (AOAC, 2005) [18]. Triplicate weights of 5g sample were accurately weighed into a thimble. 1-1.5g of sand was added to the sample and mixed using a glass rod. The glass rod was then wiped with a cotton wool and the cotton placed on the top of the thimble. The thimble was then inserted in a Soxhlet liquid/solid extractor and was exhaustively extracted for 6 hours in Soxhtec systems apparatus using petroleum ether (b.p. 40-60 °C) as the extractant. The extractant in the flask was then placed in an oven at 102°c and the contents dried for 1-2 hours until a constant weight was reached. After 2 hours the contents of the flask were cooled in a desiccator and contents weighed after. The % crude fat was calculated using the formula:

$$\% \text{ Crude Fat} = (W2 - W1) \times \frac{100}{S}$$

Where:
W1= weight of empty flask
W2= weight of flask and extracted fat (g)
S=Weight of Sample.

Ash Content
Ash content was determined by incinerating the sample for 12hours in a furnace at 550 °C. 2g of dry sample was weighed in triplicates in pre-weighed crucibles. The crucible was then placed in a muffle furnace set at 550 °c for 8 hours until sample became completely free from carbon and appeared as light gray or white.
The furnace was then turned off to allow the sample to cool. The partially cooled crucible was then transferred into a desiccator and allowed to cool at room temperature. The percentage ash was then calculated using the formula below:

$$\% \text{ Ash Content} = \frac{\text{Weight of residue} \times 100}{\text{Weight of Sample}}$$

Iodine Content
The iodine content of the sample was determined using Iodometric titration method. Ten grams of sample was weighed in triplicates into 250ml flasks with a stopper. 30 ml of water was added and flask swirled to dissolve the sample. Water was then added to make volume up to 50 ml. Afterwards; 1ml of 2N Sulphuric acid (H_2SO_4) was pipetted into the solution. Five milliliters of 10% potassium iodide (KI) was then added to the solution. The solution should turn pale yellow in the presence of iodine. The flask was then stoppered and put in the dark (cupboard or drawer) for 10 minutes. After 10 minutes the solution was then titrated against 0.005M sodium thiosulphate until the solution turned pale yellow. 2ml of starch indicator solution (solution should turn dark purple) was added and titration continued until the solution becomes pink and finally colorless. The level of sodium thiosulphate in the burette was recorded and converted to parts per million (ppm) equivalents to the content of iodine at that level.

Iron Content
The iron content of the sample was determined using the atomic absorption spectrophotometer. The food sample (2.5g) was weighed and placed in a crucible. The crucible was heated for about 20 minutes with a hot burner flame until the food sample was well charred and stopped smoking. The sample was then ashed in a furnace at a temperature of $550\,^{o}$C until ash turned white. The crucible was then allowed to cool and the contents transferred to a small beaker. 10 ml of 2.0 M hydrochloric acid was added into the sample and stirred for one minute. Ten milliliters of distilled water was also added and stirred well to mix. The mixture was then filtered, and 2.5mls of 0.1M potassium thiosulphate added to the filtrate. Using a spectrophotometer (Shimadzu AAS, AA-6300) at a wavelength of 458 nm, each standard solution and the sample was placed into a separate cuvette and the absorbance of each solution measured. A standard curve constructed by plotting concentration of standard solutions vs. absorbance was used to determine the iron (III) concentration of the samples.

Vitamin A (Retinol Equivalent)
Vitamin A content was determined by a photometer using light emitting diode (LED) technology. 5g of the previously crushed sample was weighed into a 1litre flask. 20ml of 50% NaOH solution was added to the sample, and the mixture warmed in a water bath at$90^{0}C$. 100ml diethyl alcohol and 2ml of hydroquinone solution were also added, and the water bath maintained at $90^{0}C$ for 30minutes. The contents were then poured into a decanting vial, and 100mls of water added followed by 50mls of ethylic ether and content mixed uniformly by shaking. 50mls of petroleum ether was added to the mixture and allowed to decant. Extraction was done twice with 50mls of petroleum ether. The ether phase was then

washed three times with 100mls of water. The mixture was then filtered, evaporated and concentrated until 1ml was obtained. Total carotenoids content was determined using the Harvest Plus method and using the Spectrophotometer (Shimadzu AAS, Model AA-6300) to read of the absorbance of the Carotenoid at the wavelength 450nm this value was then converted to Vitamin A by dividing with12 conversion factor.

Energy Content

The energy content was determined using bomb calorimeter method. About 1g of dried sample was weighed in a crucible with a piece of cotton wool and then placed inside a stainless steel vessel (decomposing vessel/bomb) filled with 30atm of oxygen. The bomb was then placed in a calorimeter bucket containing 1.2litres of water. The sample was then ignited through the cotton thread connected to an ignition wire inside the bomb and was burned (combusted) at 1000 °c. The heat created during the burning process was recorded using a thermometer in the calorimeter at intervals of 3 minutes until a stable maximum temperature was reached. After calibrating the bomb with the sample of a known heat, then the amount of energy needed to heat up the water by 1 °C was known, and this unit displayed the amount of energy inside the sample in units of joules or BTU per gram. This was the physical calorific value.

3. Results

According to offline menu planner, the portion size of 250g (maize to beans ratio of 2:1) yielded 306 Kcls, 11.666 grams of protein, 3.3 grams of fat, 1.083ugRAE of Vit A, Fe 3.97 µg. The results on the nutrient composition of the school meal as analyzed in the laboratory are presented in the table below. From the analysis the energy content of the school meal per 100g was 341kcal, Protein was 12g, Fat was 0.8g, Iron was 0.0195ug, Vitamin A was 16.715ug Retinol Activity Equivalent (RAE), and the Iodine content was 0.0037ug.

Nutrient Content of School Lunch at NPS (Maize, Beans and Collard Kale "Sukumawiki")

Parameter measured	Unit (100g)	Results Sample Content
Energy	Kcal	341
Protein	G	12
Fat/oil	G	0.8
Vitamin A	µgRAE	16.715
Iron	µg	0.0195
Iodine	µg	0.0037

These results are similar (except Vit A and iron) when the composition of the school meal is estimated using the online menu planner.

4. Discussion

Nutrients of interest in this study were energy, protein, fats, vitamin A, iron, and iodine. In the analysis, 100 grams of the food for the NPS kitchen yielded, 341 calories, 12 grams of protein, 0.8 of fat, vitamin A 16.715ug, 0.0195ug of iron and 0.0037ug of iodine. This translated to 853 calories, 30 grams of protein, 2 g of fat, vitamin A 41.787ug, 0.0488ug of iron and 0.00488ug of iodine in 250 grams serving. WFP recommends that for a day school, feeding programmes supply two meals: a light meal and lunch. The light meal can be served at the start of classes or mid-morning and should supply approximately between 400-600kcal while lunch provides 700-900kcal. Meal served at NPS provided 853kcal which is in the WFP recommended range for lunch. However, results obtained from the 24-hour recall indicate that the majority of the pupils came to school without having breakfast and only had one meal (dinner) at home. The average nutrient consumption at home was 218kcal of energy, 3.79 of protein,1.54g,43.75ug/RAE and 0.008ug of iodine, 0.154ug iron. With one meal at home and lunch at school, a child at NPS is still not meeting their daily RDA for the day (2000-2200kcal energy, 40-46g protein,> 23g fat, 400-600ug RAE, 120-150ug iodine and 10-15ug of iron). The lunch served is, however, contributing a significant portion to the child's daily nutrient intake for the day and has had a positive impact on the pupil's participation reflected through reduced short term hunger, increased concentration, regular attendance and class participation as reported by the teachers.

5. Summary

The nutrient value of the lunches served at the school had improved with the introduction of a more nutritious solid meal (854kcal). Before this intervention, the school served maize meal porridge (50kcal) (CSRL Report, 2011) [17]. The lunch contributed a larger percentage of the child's Recommended Daily Allowance as compared to the meals they received at home. Namasagali Primary school gardens have helped to diversify and supplement the school feeding programme, but the gardens alone were insufficient in providing the quality and quantity of food required. For success and sustainability purposes, the garden products can either be sold and funds used to purchase food items and garden inputs, and parents can contribute in cash or kind to support the feeding programme.

6. Conclusion

This study found that the lunch of maize and beans stew served at the school for lunch had a high caloric and protein composition compared to the maize meal porridge (50kcal) that the pupils were initially consuming. The meal contributed a significant amount of nutrient to the pupils RDA in relation to their age group (28%-43% as compared to 7%-11%) from the meals served at home. For the School Feeding Program to be sustainable, NPS gardens should be expanded to make them economically productive and viable as a source of food for the school lunch year round. The parents and the community should be involved and educated on the importance of SFP for the benefit of their children's future and cognitive development. Locally sourced foods, especially within the locality of the school and the community encourages production as demand increases and will benefit the children and community in the long run.

7. References

1. Murray CJ. Shifting to Sustainable Development Goals—implications for global health. *New England Journal of Medicine*, 2015; 373(15):1390-1393. Retrieved January 2011 from http://www.nejm.org/doi/pdf/10.1056/NEJMp1510082
2. United Nations. UN Millennium Project. Halving Hunger: It can be done; Report of the Task Force on Hunger, 2005. Retrieved on October 2014 from http://www.unmillenniumproject.org/reports/tf_hunger.htm

3. FAO. The State of Food Security in the World, 2013. Retrieved on October 19, 2013. From www.fao.org/publications/sofi/en/
4. FAO. The State of Food Security in the World, 2007. Retrieved on February 2, 2011, From http://www.fao.org/docrep/007/y5650e/y5650e00.html
5. WFP. Two minutes to Learn about School Meals, 2009. Retrieved on 20th May 2010 from http://www.wfp.org/school-meals.
6. UNICEF. The State of the World's Children, 2007. Retrieved on February 2011 from http://www.unicef.org/sowc/
7. Badri YA. A review of the progress of school meal programs in the globe. Sky journal of food science. 2014; 3(6). Retrieved January 2013 from http://www.skyjournals.org/sjfs/pdf/2014/Dec/Badri%20pdf.pdf
8. WFP, Learning from experience: Good practices from 45 years of school feeding, 2011. Retrieved on May 2010 from https://www.wfp.org/content/learning-experience-good-practices-45-years-school-feeding
9. Kibwika P, Kyazze F, Loga D, Apolot S. Empowering primary school children to produce food to mitigate short term hunger through school gardening: the case of Universal Primary Schools in Kamuli and Soroti Districts, Uganda. Research Application Summary. Second RUFORUM Biennial Meeting, Entebbe, Uganda, 2010. Retrieved on October 2014 from http://www.cabi.org/GARA/FullTextPDF/2013/20133184495.pdf
10. Kirabo S. Sunrise Communications Development. Kamuli parent attack government on school feeding, 2011. Retrieved on April 2012 from http://buzznigeria.com/kaduna-school-feeding-programme-helps-the-poor-returns-kids-to-schools/
11. Uganda Bureau of Statistic Statistical abstract, 2012. Retrieved December 2015 from http://www.ubos.org/onlinefiles/uploads/ubos/pdf%20documents/2012%20Census%20Final%20Reportdoc.pdf
12. Kristjansson B, Petticrew M, MacDonald B, Krasevec J, Janzen L, Greenhalgh T *et al*. School feeding for improving the physical and psychosocial health of disadvantaged students. Cochrane Database of Systematic. 2007. Reviews [1361-6137] vol:- iss:3 pg:CD004676 - CD004676 Retrieved in February 2014 from: http://www.cochrane.org/CD004676/BEHAV_school-feeding-for-improving-the-physical-and-psychosocial-health-of-disadvantaged-schoolchildren
13. Mwangi AM, Foeken D, Owuor SO. Urban School Farming to Improve School Feeding: The Case of Nakuru Town, Kenya. Child Youth and Environments. 2010; 20(1):276-300. Retrieved from: http://www.colorado.edu/journals/cye/20_1/20_1_11_UrbanFarming.pdf
14. Lawson TM. Impact of School Feeding Programs on Educational, Nutritional and Agricultural Development Goals: A systematic review literature. A Plan B paper. Michigan University, 2012. Retrieved in January 2013 from: http://fsg.afre.msu.edu/Mozambique/lawson_thesis_final_version.pdf
15. NEPAD, (New Partnership for Africa's Development). HGSF High-Level Consultation Ghana, Final Report of Proceedings. Ghana WFP Country Office, 2007. Retrieved on September 2013 from http://documents.wfp.org/stellent/groups/public/documents/newsroom/wfp207421.pdf
16. CSRL. Centre for Sustainable Rural Livelihoods, Annual Report. Iowa State University, College of Agriculture and Life Sciences, 2012. Retrieved on October 2014 from: http://www.csrl.cals.iastate.edu/sites/default/files/2012%20Annual%20Report.pdf
17. CSRL. Progress report. Service Learning and School Gardening Program, 2011. Retrieved on October 2014 from http://www.csrl.cals.iastate.edu/sites/default/files/2011%20Annual%20Report.pdf
18. AOAC International Official Methods of Analysis, 2005. (18^{th} ed). AOAC. Retrieved in Jan $2^{nd,}$ 2016 from http://www.eoma.aoac.org/