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The effects of soybean (*Glycine max*) and pigeon pea (*Cajanus cajan*) food mixtures on the nutritional status of school children in Suba District, Kenya

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Abstract

The effects of HIV and AIDS are reversing the developmental gains on malnutrition in Africa. It is important to reposition nutrition for development that is sustainable, especially in resource poor areas, an example which is Suba District in Nyanza province. Suba District has the highest prevalence of HIV and AIDS which is currently 31%. This has resulted in inadequate food at the household level leading to macro and micronutrient deficiencies. The objective of the work was to establish the effect of corn-soy and corn-pigeon pea blends on nutritional status of school children aged 6-9 years in Suba District, Kenya. An experimental research design was adopted that would enable the data to be analyzed statistically. Two primary schools were purposively selected followed by a systematic sampling of the pupils leading to the selection of 49 pupils from Mbita and 52 pupils from Ong'ayo schools. The children were purposely chosen to be affected by HIV and known to be vulnerable in the community. Soybean or pigeon pea-corn mixtures were commercially prepared at NUTRO EPZ, Athi River, Kenya, to give 14% protein of roasted flour. The children were fed at mid-day in school and a take home ration was prepared to serve a family of five during the weekend to ensure that the index child was allowed to eat his/her portion. Anthropometric techniques were used for data collection. Pupils from Mbita were fed on corn-soy while those from Ong'ayo were fed on corn-pigeon pea blends for five months. Nutrisurvey and SPSS were used for data analysis. Descriptive and inferential statistics were used to interpret results at $p<0.05$ confidence interval. Stunting level in Mbita decreased from 21.6 to 16.4% and in Ong'ayo from 21.5 to 18.8%. Underweight and wasting decreased significantly ($p<0.05$). Grain legumes can improve nutritional status of children; however, a longer feeding (intervention) period and a more dense food type are needed to allow for a better impact. Grain legumes, especially soybeans, contain genistein and immune-boosting substances that can improve growth and could decrease the use of nutritional intervention.

Key words: Corn-soy blend, corn-pigeon pea blend, nutritional status.

Introduction

School children from households affected by HIV and AIDS are often malnourished for several reasons including scarcity of food in the household [1]. Nutrition interventions such as supplementation and complementation can be used to address malnutrition among such populations [2]. Research has shown the potential of using high-yielding grain legumes to alleviate malnutrition, especially protein energy malnutrition (PEM) and micronutrient deficiency (hidden hunger) [3]. Such grain legumes include soybean and pigeon pea which are nutrient dense, especially when dried and processed, to reinforce them so as to counter the effects of anti-nutrients such as trypsin inhibitor and phytates [4].

Pigeon pea (*Cajanus cajan*) is a good source of protein being specifically rich in methionine, lysine and tryptophan which are some of the most important amino acids. In addition, it is an important source of vitamin B and supplies minerals such as calcium, iron, zinc, phosphorus and potassium [6]. The seed may be eaten whole, dehulled or ground into flour and used in a variety of dishes. People in the Caribbean use it while green (immature green pea) and process most of it into "dhal", i.e. decorticated split pea. When combined with cereals, it makes well balanced diets. On the other hand, studies by Dilger *et al.* [7] show that soybean (*Glycine max*) is a food with very high nutritional content yet simple and cheap to produce. It can be used efficiently to alleviate protein-energy malnutrition (PEM) in sub-Saharan Africa. Soy bean contains selenium, cysteine, tryptophan and glutamine which are keys to preventing and treating AIDS. Soy is a primary ingredient in most nutrition complements for HIV and AIDS patients in the USA. Soy protein can alleviate suffering due to malnutrition and disease [9]. Table 1 presents a comparison of nutritional content of corn-soy bean and corn-pigeon pea flour mixtures.

While no food is exactly similar to another in nutrient value, this study sought to experiment through feeding trials, the effectiveness of two grain legumes in addressing malnutrition among school children in Suba District, Nyanza Province, Kenya. High levels of malnutrition, poverty and food insecurity with a high burden of HIV and AIDS against a background of deepening hunger have been continually reported in this district [10, 11].

Table 1. Nutritional values of corn- soy blend and corn-pigeon pea blend/100 g flour.

Nutrient	Corn-soybean blend	Corn-pigeon pea blend
Kilocalories	363.8	373
Protein %	12-14	12-14
Ash %	5	3.9-4.3
Vitamin A IU	1665	15,000
Vitamin C mg	48.0	25
Vitamin B mg	10.128	2
Vitamin B2 mg	0.448	5.5
Vitamin B12 mg	1.2	0.01
Iron mg	8.0	2.5-4.7
Zinc mg	5.0	7.2-8.2
Calcium mg	100	120-167

Orphaned school children (as a result of HIV and AIDS) and those with ailing parents have been worst hit [12]. It was on this basis that the study targeted school children between the ages of 6 and 9 years selected from households affected by HIV and AIDS. The agro-ecology of the study area (Suba District, Kenya) favors the production of both of these grain legumes, and the documentation of effects of the grain legumes in addressing malnutrition was deemed necessary in helping national planners select interventions that are both sustainable and cost effective.

Materials and Methods

The experiment involved monitoring the effect of corn-soy blend and corn-pigeon pea blend food mixtures on the nutritional status of school children in Suba District of Nyanza province, Kenya.

Study design: Two schools (Mbita and Ong'ayo primary schools) were purposively selected for the feeding trial. The pupils' households were affected with HIV and AIDS. Systematic sampling was done to select pupils by age and their vulnerability status. The children ranged in age from 6 to 9 years. The assistance of class teachers in the respective schools was sought to identify orphaned children and those deemed vulnerable. A sampling frame was made from where random sampling was done to select the study children in both schools. Forty nine children were selected from Mbita primary school and fifty two from Ong'ayo primary school bringing the total number to 101. Mugenda and Mugenda [13] reported that for experimental studies, 30 controls and 30 experimental subjects are adequate. In this case an additional number was included to take care of potential drop outs during the study.

Description of the intervention: Pupils from Mbita primary school were fed on porridge made from corn-soy blend for five months and anthropometric assessment was carried out at monthly intervals during the feeding period. The porridge (precooked and roasted) was given once daily at mid-morning. The porridge was prepared in the school by adding boiling water to a paste from corn-soy flour (or corn-pigeon pea flour) and then stirring for five to ten minutes until it was cooked using the consistency and aroma of the porridge to determine when the mixture was cooked. At the end of the five months, evaluation was done to determine the effect of porridge mixture on the pupils' nutritional status. The same methodology was used with children from Ong'ayo primary school except that corn-pigeon pea flour was used. Each of the study children received 100 g corn-soy blend/corn-pigeon pea blend as porridge per day for a period of five months with a take-home ration of 500 g for the two-day weekend. The additional ration was to feed both the index child and four other people to ensure that the index child partook in eating the porridge during the weekend so as to ensure continuity of the feeding trial. According to FAO/WHO [14], 100 g of soybean per day in combination with a cereal will provide most of the daily protein requirement of 40 g per day. In this regard, the ratio of carbohydrate to soybean/pigeon pea was 3:1. The corn-soy and corn-pigeon pea blends were fed with vegetable oil (5 g with 12-14% protein content) providing additional 363.8 kilocalories.

Other components of the intervention included nutrition and health education offered to pupils and their parents/guardians in both schools. The purpose of the nutrition education was to improve knowledge and understanding of the intervention for the parents/guardians of the children on the feeding trial. This exercise was not evaluated. Among the issues dealt with was the role of soybean/pigeon pea in nutrition and health, proper hygiene and sanitation, HIV and food security. In addition, all the children in the study had supplementary vitamin A to reduce risk of vitamin A deficiency, were dewormed and issued with insecticide-treated mosquito nets for malaria control. Water was treated using Water Guard® (a chemical treatment). This was in accordance with the essential package of health services which is proposed wherever feeding trials are to be implemented and also in the interest of public health.

Data collection: Data for the study was collected by using a structured questionnaire and by anthropometric measurements of children's weight (wt) and height (ht). The wt and ht were used in the calculation of the Z scores. A mechanical weighing scale (CAMRY) model BR 9012 was used to take the weight of the children to the nearest 0.1 kg while dressed in minimal clothing. Three measurements were taken and the average was calculated and recorded. A height stadiometer model 265-200 cm (Germany) was used to take the height of the children to the nearest 0.1 cm. Three measurements were also taken one after the other as described by Bruce [15], recorded and the average calculated and recorded as the final reading. These equipments were calibrated regularly in order to obtain quality data. Also head counting of the children was carried out before and during the feeding trial to determine the degree of absenteeism.

Data analysis: The height-for-age (HAZ), weight-for-height (WHZ) and weight-for-age (WAZ) Z scores, based on the National Center for Health Statistics [16] standard, were calculated using the Nutrisurvey (2005) computer package. Height-for-age (HAZ), weight-for-height (WHZ) and weight-for-age (WAZ) Z scores represent stunting, wasting and underweight, respectively. School children with HAZ, WAZ and WHZ Z scores of below -2 standard deviations of the reference population were considered moderately stunted, wasted and underweight respectively while those below -3 standard deviations were considered severely stunted, wasted and underweight respectively [17, 18]. SPSS Version 11.5 computer package was used for further analysis. Descriptive and inferential statistics were used to interpret results in percentages and other measures of central tendency such as means and presented in tables and figures. Independent t-tests were used to compare

differences between the two experimental groups before and after the feeding trial while chi-square was used to test relationships and significance at P<0.05 at 95% confidence interval (CI). Ethical clearance for this study was given from the Ministry of Health, Suba District. Informed consent was also obtained from the parents/guardians of the study pupils and the pupils themselves before commencement of the study.

Results

Differences in malnutrition levels within schools before and after the feeding trials: Results from Mbita primary school, which was fed with corn-soy blend porridge, indicated no significant differences (P = 0.101) in height/age (stunting) with Z values of 21.6 and 16.4% before and after the intervention, respectively. Results from Ong'ayo primary school, which was fed on corn-pigeon pea blend porridge, showed a similar trend. Differences in stunting levels before and after intervention were also not significant (P = 0.139) (Table 2).

Underweight levels were significantly reduced (P<0.05) in both schools after the intervention. In Mbita primary school weight/age levels (underweight) were reduced significantly (P = 0.039) from 9.8% before intervention to 4.3% after intervention. In Ong'ayo school there was slightly significant (P = 0.045) improvement. Wasting levels also were reduced significantly by almost half for both schools (from 5.4 to 2.2%, P = 0.028 and from 9.5 to 4.3%, P = 0.030) for Mbita primary school and Ong'ayo primary school, respectively (Table 2).

Differences in malnutrition levels between schools before and after the feeding trial: The differences in stunting and underweight levels between schools before intervention were not significant (P = 0.131). However, differences in wasting levels between schools before intervention were slightly significant (P = 0.048). Levels of all forms of malnutrition in both schools declined after the intervention. Although not significantly different (P>0.05), there was a higher drop in chronic malnutrition (stunting) in Mbita primary school (from 21.6 to 16.4%) compared to Ong'ayo primary school (from 21.5 to 18.8%). Table 3 shows a comparison between the two schools before and after the feeding trial on the respective foods.

From Table 3, the differences in the prevalence of underweight and wasting between the two schools were also significant after the intervention. It is important to note that from a previous survey conducted in Suba District school children in both schools reported minimal, almost negligible consumption of pigeon pea and soybean or any other legume and therefore the improvements reported here were most likely as a result of the intervention [19, 20].

Distribution of Z score means among study pupils before and after intervention: A distribution of mean Z scores of school children in Mbita primary school over the period of the feeding trial (5 months) is shown in Table 4. The weight for age (WAZ) Z score representing underweight showed a steady improvement from -0.62 at baseline to -0.45 by the fifth month of feeding. This represents a significant (P<0.05) improvement (t = -1.20, DF = 48, P = 0.026). Although not significantly different (P>0.05), the height for age (HAZ) Z score representing stunting also improved steadily from a mean of -0.68 to -0.216 t = -3.626 and P = 0.522. Weight for height (WHZ, wasting) means also showed a steady significant improvement (t =1.326, P = 0.192) from the third month (Table 4).

Table 2. Differences of malnutrition levels within schools before and after the intervention.

Form of malnutrition	Mbita primary school Corn-soy blend porridge			Ong'ayo primary school Corn-pigeon pea blend porridge		
	Before % N = 54	After % N = 49	*Significant (P<0.05)	Before % N = 54	After % N = 53	*Significant (P<0.05)
Stunting (Z score <2SD)	21.6	16.4	**0.101	21.5	18.8	**0.139
Underweight (Z score <2SD)	9.8	4.3	0.039	14.3	7.5	0.045
Wasting (Z score <2SD)	5.4	2.2	0.028	9.5	4.3	0.030

*Chi-square test **Differences not significant

Table 3. Differences of malnutrition levels between schools before and after the intervention.

Form of malnutrition	Before intervention (%)			After intervention (%)		
	Mbita N = 54	Ong'ayo N = 54	*Significant (P<0.05)	Mbita N = 49	Ong'ayo N = 53	*Significant (P<0.05)
Stunting (Z score <2SD)	21.6	21.5	0.131	16.4	18.8	0.112
Underweight (Z score <2SD)	9.8	14.3	0.052	4.3	7.5	0.049
Wasting (Z score <2SD)	5.4	9.5	**0.048	2.2	4.3	0.031

*Chi-square test **Differences significant before intervention

Table 4. Mean Z score distribution of children from Mbita primary school during the corn-soy blend feeding trial.

Z-score	Baseline	1st month	2nd month	3rd month	4th month	5th month
Weight-for-age (WAZ)	-0.624	-0.620	-0.614	-0.516	-0.468	-0.452
Height-for-age (HAZ)	-0.680	-0.517	-0.514	-0.374	-0.265	-0.216
Weight-for-height (WHZ)	-0.395	*-0.284	-0.354	-0.345	-0.309	-0.234

*Mean improvement in the 1st month could have resulted from reasons other than the feeding trial

Table 5 shows the distribution of mean Z scores for children from Ong'ayo primary school that was fed on corn-pigeon pea blend for 5 months. Results show improvement in all three indices of malnutrition with only weight for height (WHZ, wasting) being significant (t = -1.98, DF = 51, P = 0.043). This recorded a mean of -0.697 at baseline which improved to -0.337 by the fifth month of the feeding period. Weight for age index (WAZ, underweight) improved from a mean of -0.64 to -0.25 representing a significant improvement (P<0.05) (t = -5.569, DF = 51, P = 0.010). Height for age (stunting), showed slight but not significant improvement (t = -5.89, DF = 51, P = 0.197).

Finally, in a class of 56 children in each school before at the beginning of the feeding trial, 8-10 children (average of 18%) did not attend school. However, during the feeding trial 2-3 children (average of 2%) were absent.

Discussion

This study showed that stunting levels within and between schools was not significantly different. This could be explained by the fact that the feeding trial was carried out for only five months. Stunting represents nutritional history which cannot change significantly as a result of short-term intervention; therefore, a longer period of feeding would be required for a significant improvement of this variable. A similar study conducted by Mbithe *et al.* for nine months reported similar results; with differences that were not significant between pupils from experimental schools and those from control schools [21]. The results presented in this study need to take into account the fact that the school children were only receiving the corn-soy blend or corn-pigeon pea blend as a mid morning snack while main meals, which were without any of the intervention ingredients, were consumed at home. This fact was confirmed with the 24 hour recall which was undertaken once every month during the five months feeding period. The take-home ration given to the children contributed to the overall results to a lesser degree since it was also in form of a snack and catered for Saturdays and Sundays only. While improvement in underweight and wasting levels can be attributed to the study interventions, the research cannot rule out the impact of other extrinsic factors such as food availability at home in the period the intervention was ongoing.

The improvement in nutritional status, however, cannot be ignored as it contributed a great deal to improved school attendance regardless of the food mixture that was offered to the different schools. Absenteeism dropped by 16% in both schools. Various studies have shown that school health programs such as school feeding can help improve school attendance, enrollment and cognitive levels of pupils. In one such study carried out in Jamaica, children who received breakfast in school for one semester recorded improved arithmetic tests because they attended school regularly and studied in a more effective way [22]. A similar study by Pivik revealed the importance of morning nutrition to children of school going age as it gives them much needed energy to concentrate on learning [23]. According to Bundy *et al.*, good health and nutrition are necessary for effective learning and child development [24].

Although it might appear (from the mean Z scores) that pupils from Mbita primary school who were fed on corn-soybean blend porridge were slightly better nourished than their Ong'ayo counterparts who were fed on corn-pigeon pea blend porridge, it should also be noted that at baseline, a higher percentage of children from Mbita primary school were slightly better nourished than those from Ong'ayo. The latter could have had additional benefits from the corn-soy blend due to the presence of omega-3 fatty acids which are otherwise only available in fatty fish. Research has shown that these fatty acids can reduce deaths from heart disease and all other causes significantly [7]. In addition, presence of omega-3 fatty acids induces happy moods as low concentrations of omega-3 fatty acids in the body are linked to mood disorders [7]. However, results from the baseline survey showed a minimal consumption of soybean and a nil consumption of pigeon pea in the pupils' households [19]. This could also have influenced these findings. It appears that if the intervention could be continued for a longer period, impacts from the different blends could be better established.

Conclusions and Recommendations

Results generally showed improvement in both schools indicating that both crops (soybean and pigeon pea) can be used to improve the nutritional status of school children. In processed form, for example when made into flour then used to make porridge as demonstrated by this study. Both blends are nutrient dense and have the potential to address malnutrition. Overall, the differences between the schools after the feeding trials were not significantly different. On the other hand, to effectively measure the impact of each of the blends, a longer period of time is required. This is especially so for stunting which shows the nutritional history of an individual. It is recommended that a longer period of intervention be undertaken to effectively measure the impact of each of the grain legumes in addressing malnutrition. It is also recommended that the intervention should allow the pupils to take the corn-soy or corn-pigeon pea as main meals (lunch or dinner) rather than as a snack since nutritional status is highly influenced by meals providing quantity food intake. The two food mixtures also had some impact in the children's nutritional status and should therefore be promoted in Suba District to help alleviate malnutrition.

Table 5. Mean Z score distribution of children from Ong'ayo primary school during the corn pigeon pea feeding trial.

Z-score	Baseline	1st month	2nd month	3rd month	4th month	5th month
Weight-for-age (WAZ)	-0.635	-0.638	-0.408	-0.441	-0.229	-0.254
Height-for-age (HAZ)	-0.351	-0.175	-0.148	-0.064	-0.083	-0.035
Weight-for-height (WHZ)	-0.697	-0.839	-0.518	-0.463	-0.062	-0.337

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References

[1]Gillespie, M. 2003. HIV/AIDS, Food Security and Rural Livelihoods: Understanding and Responding. Food Consumption and Nutrition Division Discussion paper No. 157. International Food Policy Research Institute, Washington DC.

[2]Sanghvi, T., Ameringen, M.V., Baker, J. and Fiedler, J. 2007. Vitamin and mineral deficiencies technical situation analysis: A report for the reduction of vitamin and mineral deficiencies. Food and Nutrition Bulletin Vol. 28, No. 1 (supplement). United Nations University.

[3]Messina, M.J. 1999. Legumes and Soybeans: Overview of their nutritional profiles and health effects. Am. J. Clin. Nutr. **70**(3 suppl):439S-450S.

[4]Jambunathan, R., Singh, U. and Subramanian, V. 1980. Nutritional Quality of Pigeon Pea. International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Pantancheru, India.

[5]Akporhonor, E.E., Egwaikhide, P.A. and Eguavoen, I.O. 2006. Effect of sprouting on *in vitro* digestibility of some locally produced leguminous seeds. Journal of Applied Sciences and Environmental Management **10**(3):55-58.

[6]Amarteifio, J.O., Munthali, D.C., Karikari, S.K. and Morake, T.K. 2002. The composition of pigeon peas (*Cajanus cajan* (L. Millsp.) grown in Botswana. Plant Foods for Human Nutrition **57**(2):173-177.

[7]Dilger, R., Sands, J., Ragland, D. and Adeola, O. 2004. Amino acids in soybean flour. Journal of Animal Science **82**:715-724.

[8]Foster, H.D. 2006. What really causes AIDS? Available at: http://www.hdfoster.com/index html

[9]International Food Information Council Federation 2002. Soy protein offers hope for developing countries. Food insight newsletter Nov/Dec. Available from: http://ific.org.

[10]KDHS - Kenya Demographic and Health Survey 2003. Ministry of Planning. Central Bureau of Statistics, Nairobi, Kenya.

[11]Government of Kenya (GoK) 2005. Geographic Dimensions of Well-Being in Kenya. Who and Where are the Poor? A Constituency Level Profile. Vol. II. CBS, Nairobi, Kenya.

[12]De Wagt, A. and Connoly, M. 2006. Orphans and the impact of HIV and AIDS in Sub-Saharan Africa. In Food Nutrition and Agriculture (FAO, 2006/34).

[13]Mugenda, O. and Mugenda, A. 1999. Research Methods; Qualitative and Quantitative Approaches. ACTS Press, Nairobi, Kenya.

[14]FAO/WHO 1985. Energy and Protein Requirements. Report of a Joint FAO/WHO/UN Consultation. WHO Technical Report Series No. 724.

[15]Bruce, C. 2003. Anthropometric Indicators Measurement Guide. Food and Nutrition Technical Assistance Project, Academy for Educational Development, Washington DC.

[16]NCHS 1983. Physical Status. The use and interpretation of anthropometry. WHO Technical Report No. 854. 7-9 and 219-224.

[17]WFP/CDC 2005. A Manual: Measuring and Interpreting Malnutrition and Mortality. Rome.

[18]WHO 2003. Guidelines on management of severe malnutrition in hospitals in Africa. Bulletin of the World Health Organization **81**:237-24S.

[19]Ohiokpehai, O., Kimiywe, J., Naidoo, P., Adesina, A. and Sanginga, N. 2007. Feeding patterns and practices among households with children aged 6-59 months in Mbita, Suba District, Kenya. Journal of Food, Agriculture and Environment **5**(2):17-23.

[20]Ohiokpehai, O. and Kimiywe, J. 2006. Suba Baseline Report. CIAT-TSBF. Nairobi, Kenya.

[21]Mbithe, D. 2007. Promoting Nutrition Education Interventions in Rural and Urban Primary Schools in Machakos District: The Role of School Gardens. PhD thesis, Department of Foods, Nutrition and Dietetics, Kenyatta University, Kenya.

[22]Simeon, D. 1998. School feeding in Jamaica: A review of its evaluation. American Journal of Clinical Nutrition **67**:90-94.

[23]Pivik, R. and Dykman, R. 2007. Event-related variations in alpha band activity during an attentional task in pre-adolescents: Effect of morning nutrition. Journal of Clinical Neurophysiology **118**:615-632.

[24]Bundy, D.A.P., Schaeffer, S. and Jukes M. 2007. Disease control priorities. School-based health and nutrition. In Nutrition Matters, No. 79.