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The effect of orange fleshed sweetpotato on vitamin A and nutritional status of pre- school children in Nambale division Busia district

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Abstract. An interventional study was carried out to determine the effectiveness of orange-fleshed sweetpotato in improving the vitamin A status of pre-school children. The study was conducted in Busia District of Western Province, Kenya. The trial lasted 60 days in a primary school that was purposively selected. The children involved were from middle and low socio-economic status, and were aged between 3 and 7yrs. All the children were treated with SP anti-malarial and de-wormed with mebendazole tablets before and towards the end of the intervention. Two intervention groups were identified among children who met the selection criteria. Baseline and final data were collected from these children and their families. Data were collected for blood haemoglobin levels, erythrocyte sedimentation rates, malaria parasites, serum retinol, serum zinc, and total carotenoids. Additional data and anthropometrical measurements were also taken.

Introduction

Vitamin A deficiency (VAD) is an important cause of blindness in children. It is known that mild or sub-clinical VAD causes impaired immune function (Semba *et al.,* 1994) and increases the risk of mortality from infectious diseases (Sommer *et al.,* 1984; Fawzi *et al.,* 1993). Many developing countries have VAD as a public health problem due to inadequate intake of vitamin A from food (Underwood, 2000). The prevalence of vitamin A alone in children under five is 84% (Mwaniki *et al.,* 1999). Food-based strategies such as food fortification, dietary diversification through home gardening and school health programmes are some of the strategies being used in Kenya. Dietary vitamin A is available as preformed vitamin A, in animal products, and provitamin A carotenoids is found in orange-colored fruits and vegetables. Orange-fleshed sweetpotato (OFSP) are known to be rich in carotenoids especially beta-carotene (Jan Low *et al*., 1997). Work done by the International Potato Center (CIP) and Kenya Agricultural Institute (KARI) in Nyanza Western Province of Kenya indicates that feeding children daily with OFSP could ensure that the recommended daily allowance for vitamin A (RDA) is achieved. This study was therefore undertaken to ascertain the importance of using OFSP to maintain the vitamin A status of pre-school children in Nambale Division, Busia district, Kenya. The main of the study was to determine the effectiveness and contribution of the orange-fleshed sweetpotato porridge on the vitamin A status of pre-school children in Nambale Division, Busia District. Specifically, the study sought to (i) determine the socio-economic and social demographic characteristics for the selected households of pre-school children in Nambale Division Busia District; (2) determine the morbidity patterns and experience in the selected pre-school children during the intervention; (3) determine the type, frequency and quantity of intake of vitamins A rich food sources by the pre-school children; (4) carry out

proximate analysis of OFSP flour for carotenoids; (5) determine baseline and post-intervention micronutrient status (specifically serum retinol, total carotenoids, serum zinc and haemoglobin levels and malaria parasite count) of pre-school children in Nambale Division Busia district; and (6) determine the nutrition status (anthropometrical measurements) among the selected pre-school children.

Research Methodology

Study area. The study took place in Busia district (K), Nambale Division. Busia district is in Western Province of Kenya. The District borders westwards with the Republic of Uganda. Nambale has an area of 232.5 square kilometers and its permanent water source is L. Victoria and has a population of 67,544. The main economic activity is agriculture with emphasis on food crops namely; sweetpotato, maize, cassava, groundnuts, indigenous vegetables, millet, maize, simsim, bananas and beans. Some people engage in petty trade. Malaria is holoendemic in this area.

Subjects. The study targeted pre-school children in the early childhood care and development centre (ECCD) aged 3 – 7yrs. Blood samples were collected from the subjects for analysis.

Variables in the study. Children were divided into two groups of 85 each. One group was fed on OFSP and the other on white-fleshed sweetpotatoes (WFSP) based porridge. The variables analyzed at baseline and post-intervention phases included serum retinol, serum zinc, haemoglobin levels, total carotenoids, malaria parasites and erythrocyte sedimentation rates.

Beta-carotene in food and serum was quantitatively determined using High Performance Liquid Chromatography (HPLC) at 445 nanometer (nm) after a homogenization and extraction procedure. Serum retinol was determined after deproteinization of serum with methanol and subsequent extraction using hexane. Haemoglobin levels were determined using the heamocue photometer. For malaria parasites, thick and thin blood smears were made, stained with Gleams, fixed with methanol and parasites counted and expressed per micro-litre (µl) of blood. Serum zinc was determined using atomic absorption spectrophotometry.

The Winthrop method was used to determine erythrocyte sedimantation rates. A haematocrit tube was filled to the 100 mark with oxalated blood and allowed to stand vertically for one hour and the sedimentation rate determined using a chart specially prepared for this purpose.

Anthropometrical measurements were taken before blood sample collection. The weights and heights of the children were taken and presented as Z-scores. Mid upper arm circumferences of the study childeren were also measured.

Dietary assessments. The pre-tested questionnaire was administered to the children. The questionnaire was meant to determine the unquantified food frequency, 24 hr dietary recall, socio-demographic and economic parameters. Other issues captured by the questionnaire were about health and food security.

Focus group discussions. Focus group discussions with 8-10 women were conducted to enrich the information collected through the questionnaire.

Training and sensitisation of cooks and ECCD teachers. The ECCD cooks and teachers were introduced to the study. The importance of sticking to procedures, monitoring issues, compliance by children and recording of absenteeism and morbidity were emphasised. The school had three resident monitors and two cooks. The monitors were

teachers already familiar with the children, and the cooks were the taken from those employed by the school.

Standardization of the feeding regimen. The feeding regimen was first cooked and standardized in the Kenya Medical Research Institute (KEMRI) nutrition laboratory. The feed for the experimental groups was prepared in such a way to provide 100% RDA of vitamin A (in this case 300 RE µg), the maize and soy bean flours were calculated taking into consideration the calculated amounts of ingredients for basic mixes based on the edible portions of food. In this case where the staple is maize, the feed included 20gm of maize flour per serving per child supplemented with 10 gm of soybean flour. The amount of OFSP and traditional white-fleshed sweetpotato (TWFSP) flour was 150 gm for both, 50 gm of which included to cater for the inevitable losses.

Each child was given 500 ml of porridge in a day in two portions i.e., in the morning and afternoon. The parents of experimental children were advised not to give OFSP at home (this could interfere with the vitamin A consumption in the porridge). Otherwise the parents were advised to feed their children the normal meals at home.

RDA for zinc sulphate for this age category (3-7yrs) is 7.5mg. Since the children's diet is basically cereal and legume based in which the phytate content is definitely high, there was need to adjust the zinc sulphate amount to cater for the difference. Therefore, 15mgs of zinc sulphate solution was included in the porridge for 60 days (8weeks). The composition of the porridge for the two study groups is shown in Table 1.

De-worming and treatment of malaria and low haemoglobin levels. All the children were de-wormed twice according to the procedures of the Integrated Management of childhood Illnesses (IMCI) guidelines. Children 2 years and above who had not been dewormed in the previous 6 months were dewormed using 500mg of mebendazole. They also received malaria treatment according to the National Malaria Control Council guidelines (one and a half tablets of SP oridor were given). Those with severe anaemia were referred to the nearest health facility for treatment.

Procedure for processing flour for the porridge. The potatoes were first washed and then chipped using the potato-chipping machine at the FTC. The potato chips were then dried on canvas for a maximum of eight (8) hours. Dry chips were then milled, the flour weighed, labeled and transported to the school.

Supply of ingredients for porridge preparation. Ministry of Agriculture and Kenya industrial research institute (KIRDI) trained some local women to process the flours that were used in the study. The flours were packed in weekly portions for specific groups. Sugar, oil and zinc sulphate was bought and also supplied on weekly basis.

Preparation of the feeds. The porridge was prepared in the normal way using the usual utensils. The measurement and mixing of ingredients was however, closely supervised. The porridge was served to children at 10:30a.m. The study children (participating) ate first followed by the non-participating ones. Each child was given 500mls of porridge and supervised until each drank up all the porridge.

Monitoring for compliance. The children were made to sit down on mats in a circle. A coloured band was tied on each child's wrist to identify

Table 1: Feed components of the two study groups.

OFSP based porridge	WFSP based porridge
1. OFSP = 150gm	1. TWFSP = 150m
2. Sugar – 5gm	2. Soya bean -10gm
3. White maize – 20gm	3. Sugar – 5gms
4. Oil – 5gms	4. Oil–5gm
5. Zinc Sulphate supplementation	5. Zinc Sulphate supplementation

each of them by group. The children were again fed in the afternoon before they left for home. The teachers marked everyday against every child's name for compliance. For example, records were kept for children who were sick, those who did not finish the feed, and the reason for non-compliance also given. The feed was given 6 days in a week excluding holidays. Compliance was defined as the number of days a particular child received and drank the porridge, and was expressed as a percentage of the total number of potential porridge days.

Collection and recording of morbidity data. Morbidity data was collected daily during school weekdays until the last day of the trial (60th day).

Collection of sweetpotato samples and the feed for analysis of carotenoids. The OFSP flour and the prepared porridge were taken to the laboratory for proximate analysis.

Quality control. The project was strictly monitored to ensure that all study procedures were adhered to. It was also aimed at providing immediate solutions to problems that arose.

Results and Discussion

Percentage distribution of age groups in the study area. Children below 14 years of age were 60.3%;while adults (15-64 years) were 39.1%. Women of reproductive age were 37.5%, while the aged were only 0.4% (Table 2).

Table 2: Socio-demographic and socio- economic results.

Age	Category	Percentage
Below 14yrs	Children	60.3
15-64 yrs	Adults	39.1
65 plus	Aged/Geriatric	0.4
15-49yrs	Women of reproductive age	37.5

Household size. The mean household size was found to be 6.05 with a median of 6.0. The minimum and maximum were 2 and 12, respectively. Compared to the National Fertility Rate (FTR) of 5.4, the household sizes in Nambale FTR were slightly higher.

Respondents. The male respondents were 49.2% (92.4 % were head of households) while women respondents were 50.8 % (7.8% of these were heads of household). Responses were mainly obtained from women.

Religion. Most families in Nambale are Roman Catholics (61%) followed by Protestants (32.7%). Among these 32.7% were males while females were 32.8. %. Muslims and Seventh Day Adventists were 3.7% and 2.5%, respectively. In all these groups women were slightly more than men.

Education. The pre-schoolers in Nambale division were 21.9%. Of these, 9.2% did not attend school. Overall, most of the people in Nambale never studied above upper primary level.

Occupation/type of work. Permanently employed adults in the study area were 3.5%. The un-employed were 32.7% while those on temporary employment were 10.0%. Most of the families in this area are farmers (25.9%). The others are artisans (1.4%), casual labourers (2.8%), teachers (1.0%) and businessmen (3.4%).

Morbidity. The causes of morbidity were reported as malaria (92%), cough (82.9%), worms (53%), diarrhoea (47%) and measles (19%). Others were: fever (17.1%), scabies (12.9%), flu (12.4%) and malnutrition (7.%) (Table 3).

Food frequency. Foods were categorized in seven groups as follows: cereals, starchy tubers/roots/fruits vegetables fruits, legumes oil/oil seeds/nuts, animal proteins, fats and oils and the miscellaneous. Among these food groups the cereals were most frequently

consumed, (54%), followed by green vegetables (31%), animal proteins mainly small fish (26.5%), fruits (23.5%) (mainly avocados) and starchy fruits/tubers/roots (23.5%) among others (Table 4).

Table 3: Morbidity patterns in ECCD children.

Illness	Percentage
Malaria	92.4%
Cough	82.95
Worms	53.5%
Diarrhea	47%
Measles	19%
Fever	17.1%
Scabies	12.9%
Flu	12.4%
Malnutrition	7.1%
Boils	6.5%
Night blindness	2.4%

Health and nutrition. The highest morbidity was malaria. The fully immunized children were 90.0%, while those who had received vitamin A were 90.0%. Most children had received vitamin A doses in June 2002 when the National Immunization Days (NIDS) exercise was on. The anthropometrical measurements for both the orange and the white group (weight for age and height for age) indicated a positive change.

The majority of the children had their serum retinol levels above 0.70mmol/l (Table 5). There was also no significant change in total serum carotenoids (Table 6). This was most likely due to the loss of beta-carotene during the processing of the potatoes into flour, storage and also during cooking. Most erythrocyte sedimentation rates (ESR's) were all elevated (Table 7) suggesting the presence of infection or illness with less improvement attributed to the intervention. Of all the children, 24.7% were below –2SD (HAZ), 9.4%

Table 4: Frequency of consumption of different foods in the study area.

Food categoriy	Type of food (%)	Daily intake (%)	Twice per day (%)	Thrice per day (%)	Four times a day (%)
Cereals	Staple porridge	54	21.1	6.5	0
Starchy Tubers/Roots/Fruits/ Vegetables	Cassava	22.4	10	0	0
Vegetables	Cowpea- leaves (kunde)	31.8	2.4	0	0
Fruits	Avocado	23.5	5.9	0.6	0
Legumes/Oil Seeds/Nuts	Beans	7.1	1.2	0	0
Animal Proteins	Small Fish	26.5	4.1	0	0
Fats and oils	Kimbo	11.6	38.2	0.6	0
Miscellaneous	Sugarcane	4.7	13.5	0	0

Table 5: Effects of the daily feeding intervention of OFSP and WFSP on serum retinol levels of 170 children for 8 weeks (mean 95% confidence interval)

Serum retinol umol	Feeding intervention		P Value
	Orange group n=84	White Group n=79	
Baseline	1.00 (-1.05, +1.07)	1.08 (-1.06, +1.09)	0.6007
8 weeks	0.99 (-0.91, +1.00)	1.03 (-1.02, +1.04)	0.6437
Change	-0.01	-0.05	
Difference	- 0.05 (-0.08, +0.06)		0.8444

below -2 SD (WAZ), while 2.4% were below -2 SD (WHZ). Malaria was among the top 10 diseases reported in Nambale. Haemoglobin levels showed a shift towards improvement (Table 8) .

Nearly all the children in the two study groups had malaria parasites. During both baseline and final physical examinations a few of the children had elevated temperatures and were treated for malaria. The study area being in a malaria endemic and vitamin A deficient zone, it was quite surprising because the serum retinol level were higher than expected. The last vitamin A supplementation in this area had been done in June 2002. The dietary intake for the households in the study suggest

Table 6: Effects of the daily feeding intervention of OFSP and WFSP on total carotenoids of 170 children for 8 weeks (mean 95% confidence interval).

Carotenoids ug/dl	Feeding intervention		P Value
	Orange group n=81	White Group n=79	
Baseline	131.36(-201.35,463.85)	127.73(-163.02, +418.48)	0.9040
8 weeks	129.32 (-124.76, +383.4)	1 26.18 (-177.14, +429.50)	0.4372
Change	-2.04	-1.55	
Difference	0.13(-394.98, +389.06)		0.9612

Table 7: Effects of daily feeding intervention of OFSP and WFSP on eythrocyte sedimentation rates in 170 children after 8 weeks (mean 95% confidence interval)

ESR mm/hr	Feeding intervention		
	Orange group	White Group	P
	n=80	n=79	
Baseline	23.77 (-0.91, +48.45)	23.18 (-0.19, +46.55)	0.7847
8 weeks	25.55 (-9.62, +49.48)	25.87 (-8.71, +43.03)	0.0818
Change	1.78	2.69	
Difference	0.91 (-22.87, +33.87))		3460

Table 8: Effects of a daily feeding intervention of OFSP and WFSP on hemoglobin concentration in 170 children after 8 weeks (mean 95% confidence interval).

Hemoglobin g/l	Feeding intervention		p
	Orange Group n=85	White Group n=81	
Baseline	114.53 (-112.65, +116.32)	116.80 (-116.70, +118.24)	0.3160
8 weeks	117.10 (-115.21, +118.99))	120.00 (-118.82, +121.17)	0.3429
Change	2.57	3.2	
Difference	0.63 (-0.09, +0.028)		0.2126

that the highest intake was from cereals. Vitamin A from plant sources has a problem of bio-availability and bioconversion.

Data collected on meals intake during wet and dry seasons revealed that snacks are not commonly given to children in this community, while dinner is more valued than breakfast and lunch. During dry seasons the consumption of breakfast and lunch are affected. The the number of meals reduces. The food frequency questionnaire revealed that porridge was consumed on a daily basis in many households (54%). Other foods consumed were white tea (35.5%), cowpea leaves (31.8%), kale (25.9%) and small fish (26.5%).

Conclusion and Recommendations

Until all data is analyzed, it will not be possible to conclude on the efficacy of the orange-fleshed sweetpotato porridge. However there are indications of a change towards improvement of individual children's nutrition and health status. The serum retinol levels were generally maintained throughout the study; pointing positively at the feeding intervention and the treatment of malaria and de- worming of the children. From the study, we recomend more bio- efficacy research using the OFSP; doing a similar study in another area with the same age group; and introduction of OFSP and more food based strategies in the school feeding programmes to combat VADD.

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