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Supplementary Feeding and Nutritional Status of Pre-school Children 4-5 Years Old from Busia County Kenya

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Abstract: Poor quality diet is the most immediate factor responsible for malnutrition and ill health among school going children in many developing countries, including Kenya. The aim of the study was to evaluate effect of soybean fortified porridge on nutritional status of pre-school children at Igero Primary School, Busia County. The flour blends developed and used in making supplement porridges were; maize:soybean 70:30, sorghum:soybean 70:30, sorghum: maize:soybean 45:25:30 and 100% maize flour (control). A longitudinal survey and Complete Randomized Design experiment were employed. The 235 childeren enrolled in pre-school at the beginning of the study were randomized into four groups and the four types of porridge randomly allocated to the groups. Pre-school children were fed for a period of six months with approximately 350ml of porridge daily, Monday to Friday while in school. Anthropometric measurements were taken at baseline, every month for 6 months and at 9th month. From the study results, there was significant ($p < 0.05$) reduction in prevalence of underweight and wasting, from 33.6% to 15.5% and from 28.5% to 10.8% respectively, among children fed on soybean fortified porridges by the end of intervention. However change in underweight and wasting among children fed on unfortified 100% maize flour porridge was not significant ($p>0.05$). The group fed on maize:soybean, sorghum:soybean and sorghum:maize:soybean blends gained mean weight of 2.83kg, 1.88kg and 2.19kg respectively by the end of study. Results on nutritional status assessment 3 months later when porridge was withdrawn showed that, 31.5% and 28.3% of children became underweight and wasted respectively. In conclusion, soybean fortified porridges improved the nutritional status of children. It is recommended that maize-soybean or sorghum-soybean blends be used in preparing 10 o'clock porridge in schools to enhance nutritional status of pre-school children.

Keywords: Nutritional Status, Evaluate Effect, Soybean Fortified, Pre-school Children

1. Introduction

Under nutrition is a major nutrition problem in the third world countries. In Africa close to 163 million children are stunted while about half of all pre-school children are deficient of essential minerals and vitamins [1]. Protein Energy Malnutrition (PEM) which affects many children under 5 years in Asia and other developing countries is considered the worst form of malnutrition [2] and a risk factor for illnesses and death among children in developing countries [3]. In Kenya according to KDHS of 2015, 26%, 4% and 11% of children below five years are stunted, wasted and underweight respectively. In Busia County 13.3%, 14.8% and 15.5% are stunted, wasted and underweight respectively [4]. Under nutrition is associated with inequalities in the economic systems and social injustices, which in turn contribute to high levels of poverty and low purchasing power in many households [5]. A survey in Western Kenya [6], documented that low socioeconomic status among the majority of Busia residents contributes to high level of household food insecurity which is associated with high rate of malnutrition prevailing in Busia. Generally low purchasing power in many households of developing countries force them to over rely on undiversified staple cereals, roots and tubers for infants and young children diets. This practice contributes to inadequate nutrient intake, resulting to under nutrition among children [7].

Staples such as maize, sorghum, finger millet and roots/tubers such as cassava, sweet potato and plantains are commonly used for adults and children diets in developing countries. Though they are cheaper their nutritional quality is poorer compared to animal proteins that contain all indispensable amino acids and are highly digestible [8]. However common staple foods can be fortified with multi-micronutrient premix, protein concentrates or commonly consumed legumes, to produce nutrient dense composites for preparing infants and children diets [9]. Combining legumes or other nutrient dense foods with starchy cereals in preparation of porridge composites, is a food-to-food fortification process which can be carried out easily within households. Food-based interventions have been conducted using food-to-food fortified diets to reduce malnutrition among children [10]. In Kenya more attention has been paid in improving quality of porridge since it's a popular weaning diet and supplement food for school going children, especially in rural areas and among low-income earners in urban areas. Still porridge is commonly consumed in most school feeding programmes in Kenya. However most of the porridges used are prepared from maize alone or a blend of maize, cassava with either sorghum or finger millet [11]. Therefore if adequate amount of legumes would be added to cereal base porridge composites, high quality porridge mixture would be produced, which would enhance nutritional status of children [12]. Cereals are low in total protein compared to legumes, and most of them lack essential amino acids such as lysine, tryptophan and threonine [13]. Therefore, compositing cereals with legumes and/or pulses can compensate for the limiting levels of essential amino acids in cereals.

In Kenya sorghum is a staple food crop for many low-income households, mainly consumed in form of porridge and in most cases it is mixed with cassava flour [14]. The advantage of sorghum over maize is that it performs well even in areas with low agricultural potential particularly in areas receiving minimal rainfall, Arid and Semi-Arid lands (ASALs). It is also rated as the second most important cereal after maize in sub-Saharan Africa (SSA) [15]. Climate variability probably due to global warming, diminishing land factor and degradation, has greatly contributed to food deficit experienced in most Kenyan households over the years [16]. This has necessitated the government to come up with programmes to encourage the growing of drought tolerant crops like sorghum as a means of ensuring food security and improved incomes [14]. According to Busia county Integrated Development Plan of 2013-2017 [17], majority of Busia rural community particularly of Matayos sub-county own small land parcels of less than 0.4 hectares. Therefore promotion of sorghum growing and its utilization as a means of ensuring household food security is paramount.

In Kenya legumes are commonly used and are important source of protein in consumed diets. Among the legumes consumed, soybean seeds are the most nutritious in food value [18]. They are excellent source of high quality protein, rival to milk and meat and non-fish sources of omega-3 fatty acids [19]. Soybean proteins are highly digestible and are good source of all indispensable amino acids [13]. They are also rich in minerals especially calcium, potassium, magnesium, iron, zinc and copper and an excellent source of vitamins such as thiamine, riboflavin and niacin [20]. Soybean grows widely and able to adapt in many geographical and climatic conditions [21]. A study by [22] in Western Kenya indicated scarcity use of soybean at household level in diet composition. However it's highly used at industry level in formulation and development of complementary formulas and supplement/relief diet for use during stress period or blanket feeding programs [23]. Since soybean seeds are nutritionally rich food, making it a constituent in blends of supplement/complementary diet may contribute significantly in tackling PEM problems in Busia including other parts of Kenya. Therefore, this study formulated flour blends suitable for porridge using maize, sorghum and soybean, since they are widely grown and readily available in Busia markets including Matayos sub-county, the study area. A feeding trial involving pre-school children at Igero school, Busia County, was conducted to evaluate effect of flour blends formulated on nutritional status of children.

2. Materials and Methods

2.1. Sources of Materials

Red-brown sorghum (*Sorghum bicolor*) and soybean (*Glycine max*) were purchased from Matayos market in Busia, while maize (*Zea mays*) was purchased from University of Eldoret farm.

2.2. Description of Study Area

Feeding trial was carried out in Igero Primary school. Igero school is located in Matayos sub-county, Busia County, Kenya. In Matayos sub-county, prevalence of wasting, underweight and stunting among children aged 48 – 59 months, stands at 21.2%, 16.5% & 11.8% respectively [4]. Igero School was selected because of its high enrolment of children in pre-school section. Data from department of education and vocational training of Busia county (*unpublished*), showed that, among the 51 registered ECD centers in Matayos sub-county, Igero ECD center had the highest number (260) children registered. Therefore sample size required could be obtained from Igero school. The school had also adopted provision of maize porridge at 10 o'clock for pre-school children. Farmers in Matayos sub-county and the larger Busia County grow mainly sorghum, maize, soybean and other legumes as staple food crops. However baseline findings (*unpublished*) from Focus Group Discussion before feeding trial with Matayos sub-county farmers revealed that, most porridges prepared and consumed in their households were blends of maize, sorghum/millet and cassava. Hence the feeding trial study was intended to sensetize the parents with children at pre-school and by extension Matayos community to use sorghum as an alternative cereal complemented with soybean in preparation of porridge four blends.

2.3. Grains Preparation and Flour Formulation

Grain processing and formulation of flour blends was conducted at Food processing unit at University of Eldoret. Sorghum and maize grains were sorted and cleaned manually to remove broken seeds, dust and other foreign materials following procedures described by [24, 25]. Soybean seeds were prepared and roasted following method described by [25, 26]. Following the method, soybeans were sorted to remove stones, rotten ones and those with physical defects. They were then roasted for 20 minutes in an electric roaster fitted with a stainless steel drum, revolving at approximately 55RPM and then cooled at room temperature. Three (3) composites and 100% maize MMN (control) were formulated; Maize 70% + soybean 30% (MSY), Sorghum 70% + soybean 30% (SSY) and Sorghum 45% + maize 25% +soybean 30% (SMS). Composites formulation was based on Codex Alimentarius Commission recommendations of 70% cereals to 30% legumes when making cereal-legume composites for complementary/supplements diets [27]. In formula with sorghum and maize combined in one composite, WHO, recommendation of 55-75% carbohydrates and 10-15% protein in diet composition was considered. The grains were mixed together in their respective proportions and then milled using a commercial hammer mill fitted with a 2.0 mm screen (Powerline®, BM-35, Kirloskar, India), in Eldoret. Resulting flours were mixed manually to homogenize and stored in air tight plastic buckets for later weighing and packing into daily cooking quantities.

2.4. Porridge Recipe Standardization

Cooking tests were carried out in food lab at University of Eldoret, to quantify proportions of water and flour composites that would yield quantity of porridge (350ml mug) that was to be served daily to each child during feeding trial. Test ratio of each flour type to water was 100g: 1000ml. The flour was slurred in a 250ml of water at room temperature. 500ml of water was brought to boil over gas range in a cooking pot and the slurry added stirring continuously to prevent lump formation. The mixture was boiled for 15 minutes while adjusting consistency with the remaining 250 ml of water, to obtain a thick porridge but which could flow from the cup, then cooled to drinking temperature. The ratio of flour to water that yielded 350ml of porridge was then used to estimate higher quantities of each flour composite to water that would be used in large scale production during feeding intervention to produce at least 60 mugs of each porridge type. Large scale cooking tests and recipe standardization were later carried out at the study site for 3 consecutive days with cooks and ECD teachers who were to support the implementation of feeding intervention. The proportions established for each type of flour composite to water is as indicated in Table 1.

Table 1. *Amount of flour composite per 35 liters of water.*

Formulations	Quantity (kg)
100% maize flour (MMN)	2.5
70% maize flour + 30% soybean flour (MSY)	3.5
70% sorghum flour + 30% soybean flour (SSY)	3.0
45% sorghum flour + 25% maize flour + 30% soybean (SMS)	3.5

2.5. Research Design

Complete Randomized Design (CRD) was used to rondomize the four flour composites formulated, to four randomly formed groups of children recruited in the study. All children attending Igero primary school (ECD) center, pre-primary 1 (PP1) and pre-primary 2 (PP2) were recruited. In each level, 2 groups of children were randomly formed, producing a total of 4 groups. The groups were randomly assigned to 1 of the 4 (MMN, MSY, SSY, SMS) porridge blends formulated. Each of the 4 ECD teachers chose a folded paper that contained 1 of 4 letters and the letter was recorded. Each of the 4 letters corresponded to a code in the 4 porridge blends formulated. Children within the same group received the same type of porridge throughout the study period. They were fed while in school (Monday-Friday) for a period of six months with approximately 350 ml of porridge, prepared a fresh everyday at 10 oclock. Throughout the study period, research assistants involved in anthropometric assessment of children, teachers and cooks remained unaware of the composites composition. Household dietary data was obtained through longitudinal survey to establish nutrient adequacy of the children's diets attending (ECD) center at Igero primary school before commencement of feeding trial. Weight, height and Mid Upper Arm Circumference (MUAC) measurements were taken on every child using standard anthropometric equipment following procedure described by [28]. Weight was taken using SECA electronic weighing scale (Vogel and Halke Hamburg, Model 7141014009, Germany, 2008) to the nearest 0.1kg. Scale was checked for accuracy with known weight during every visit and calibrated if necessary before weighing. Height measurements were taken using a portable microtoise to the nearest 0.1 cm. MUAC measurements were taken using non-stretchable arm circumference tape to the nearest 0.1 cm. Each of anthropometric measurements was taken 3 times and average value used for analysis. Anthropometric measurements were taken at baseline, repeated every month for six months and the final measurement taken at 9th month i.e 3 months later after supplement porridge was withdrawn. All 235 children enrolled in ECD at the beginning of the study including those who joined the school later, were fed daily with porridge for 6 months. However 152 children who met inclusion criteria at the end of intervention were used in final analysis.

2.6. Data Analysis

Data on anthropometric measurements was analyzed using ENA for SMART for windows version 2011. Children with height-for-age (HAZ), weight-for-height (WHZ), weight-for-age (WAZ) Z scores below -2SD from the median of the WHO reference population were defined as stunted, wasted and underweight respectively. Data generated was then exported to Minitab statistical software Version 18 for cross analysis with other variables. ANOVA was used to determine significant difference and data presented as means and standard deviation. Fisher's Least Significance Difference (LSD) was used to compare and separate means. Statistical significance was set at $p<0.05$.

3. Results and Discussion

3.1. Nutritional Status of Children at Baseline

At baseline 13.6%, 5.6% and 24.2% of pre-school children participating in the study were underweight, wasted and stunted respectively. Underweight prevalence established in this study is higher than that reported in the Kenya Demographic Health Survey (KDHS) of 2014 in Western Kenya of 2.9%, but almost similar to the national value of 11%. Underweight is an index of acute malnutrition and is widely used to assess protein energy malnutrition. Wasting prevalence established in this study is almost similar to national prevalence of 4% [29]. In Busia County a study by [4] reported higher prevalence (14.8%) of wasting than this study finding of 5.6%. Wasting is a sensitive index to changes in nutritional status. Prevalence of stunting (24.2%) reported in this study, is almost similar to prevalence of 24.4% reported in Western Kenya [29]. However [30] study in rural areas of Western Kenya documented slightly higher rate (29.4%) of stunting than this study findings of 24.2% and the national rate of 26% [29]. Stunting results from extended periods of inadequate food intake and increased morbidity and is generally found in areas of poor economic status [31]. Stunting is associated with low cognitive development in children under 5 years [32]. Prevalence of stunting established in this study could be an indicator that most households were food insecure. Also results on household dietary survey (*unpublished*) showed that majority (52%) of children consumed less than 3 food groups, classified as low dietary diversity. Therefore it is possible that most of the diets fed to children were inadequate to meet their physiological needs for growth.

3.2. Prevalence of Underweight Between Baseline and 9 Month

The prevalence of underweight at baseline among groups of children fed on MMN, MSY and SMS porridges was relatively the same Table 2. The prevalence of underweight among children in group fed on 100% maize (MMN) porridge decreased insignificantly ($p>0.05$) to 13.8% by the 6th month. However underweight prevalence in groups fed on soybean fortified porridges MSY, SSY and SMS reduced significantly ($p<0.05$) to 4.4%, 5.3% and 5.8% respectively by 6th month Table 2.

Table 2. *Prevalence (%) of underweight children between baseline, 6th and 9th month.*

	Base line				6th Month				9th Month			
Experimental groups	**MMN**	**MSY**	**SSY**	**SMS**	**MMN**	**MSY**	**SSY**	**SMS**	**MMN**	**MSY**	**SSY**	**SMS**
<-2SD to > 3SD (moderate)	14.3	14.5	13.8	14.2	13.8	4.4	5.3	5.8	13.8	14.4	13.5	14.2
<-3SD (severe)	1.8	3.6	3.0	1.8	0.0	0.0	0.0	0.0	0.0	1.2	1.8	1.5

<-2SD to >-3SD moderate underweight, <-3SD severe underweight
MMN=100% Maize flour, MSY=70% maize flour+30%soybean flour, SSY=70% sorghum flour + 30%soybean flour, SMS=45% sorghum flour+25% maize flour+30%soybean flour.

Highest mean weight gain of (20.25±2.15) was recorded in MSY fed group by 6th month which was significantly ($p<0.05$) higher than MMN and SMS fed groups, but not significantly ($p>0.05$) different from SSY fed group Table 3.

Table 3. *Effect of porridge type on the mean weight of the children.*

Blends	Time in Months						
	1 (Baseline)	**2**	**3**	**4**	**5**	**6 (End line)**	**9 (Follow up)**
MMN	$16.72^{b}\pm2.42$	$16.87^{d}\pm2.03$	$16.85^{d}\pm2.03$	$16.90^{d}\pm2.03$	$17.02^{c}\pm2.25$	$17.20^{c}\pm2.30$	$17.20^{c}\pm 2.30$
SMS	$16.42^{b}\pm2.04$	$17.27^{d}\pm2.45$	$17.35^{c}\pm2.45$	$17.77^{cd}\pm2.13$	$18.08^{d}\pm2.03$	$18.72^{d}\pm2.20$	$18.2^{de}\pm2.11$
MSY	$17.79^{a}\pm2.09$	$18.6^{ab}\pm2.21$	$18.90^{ab}\pm2.34$	$19.40^{ab}\pm2.56$	$20.20^{e}\pm2.05$	$20.25^{e}\pm2.15$	$19.5^{a}\pm2.50$
SSY	$17.84^{a}\pm2.25$	$18.12^{ab}\pm2.28$	$18.50^{ab}\pm2.15$	$18.93^{ab}\pm2.30$	$19.35^{f}\pm2.01$	$19.72^{ef}\pm2.21$	$18.7^{ab}\pm2.08$

Values are means ± standard deviations. Values followed by the same letter superscripts in the same column are not significantly different at ($p<0.05$) as assessed by Fischer's Least Significant Difference.
MMN=100% Maize flour, MSY=70% maize flour+30%soybean flour, SSY=70% sorghum flour + 30%soybean flour, SMS=45% sorghum flour+25% maize flour+30%soybean flour.

Results on weight change trend Figure 1 indicated slowed and stagnated weight gain among children in control group (MMN) throughout the study, while there was significant ($p<0.05$) increase in weight gain among children in experimental groups (MSY, SSY and SMS) between 1st month (baseline) and 6th month. However significant ($p<0.05$) decrease in weight gain among children in experimental groups was observed between 6th and 9th month when supplement porridge was withdrawn Figure 1.

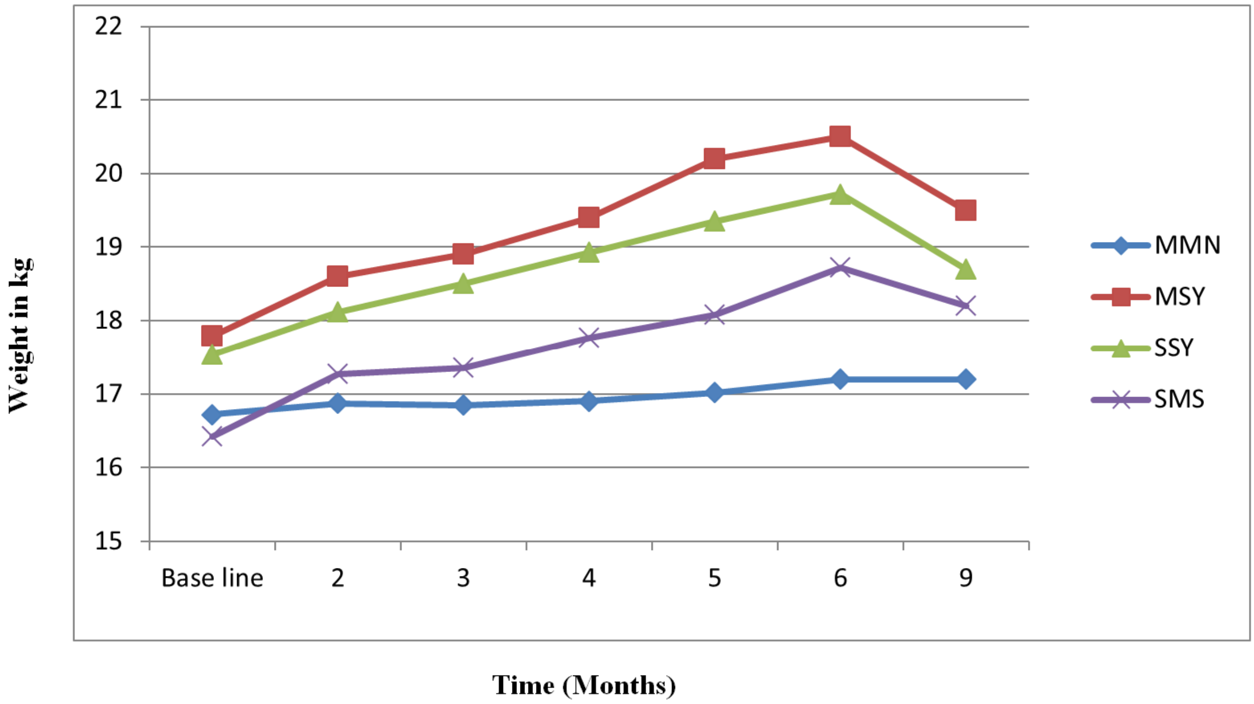

Figure 1. *The trends in weight changes on children during feeding period.*

MMN=100% Maize flour, MSY=70% maize flour+30%soybean flour, SSY=70% sorghum flour + 30%soybean flour, SMS=45% sorghum flour+25% maize flour+30%soybean flour.

The stagnation in growth among group of children fed with control MMN (100% maize) porridge can be attributed to low levels of protein in maize flour. Previous literature shows that maize among other cereals commonly used as children diets in developing countries are low in total protein, specifically limiting in essential amino acids, lysine and tryptophan [33]. Better growth was observed in groups of children fed with soy fortified porridges (MSY, SSY and SMS). This can be attributed to compensation effect achieved in this study by compositing cereals with 30% soybean flour, which is high in lysine and other essential amino acids [13]. Amino acids are important in linear growth, repair and maintenance of body tissues among other functions [34]. Our results of growth stagnation among children fed on porridge from 100% maize flour are similar to [35] who documented growth retardation in experimental rats fed from 100% maize, while those fed on soy fortified diets recorded accelerated growth within a period of 28 days. Also our results of remarkable weight gain among children fed with soybean fortified cereal blends compare favorably with earlier finding in a similar feeding trial conducted in Western Kenya [36]. Another study by [37] that assessed effectiveness of soybean fortified complementary food supplement among children in poor regions of China also documented reduction in prevalence of underweight from 9.4% to 3.8%, while stunting reduced from 18% to 11.8% after 18 months supplementation period. Slow weight gain was observed among children fed on SMS composite porridge compared to the other two soy blend porridge (MSY and SSY). This finding compares favorably with an earlier feeding trial study by [36] who reported similar finding of slowed weight gain among children fed on a flour blend of sorghum, maize and soybean. Consequently children who were fed on Maize/soybean (MSY) porridge showed modest and better weight increase in each month compared to 2 groups of children fed with porridge that contained sorghum (SSY and SMS). The difference can be attributed to high anti-nutrient factors mainly phytate, tannin and other phenolic materials contained in sorghum [38], which are known to lower protein quality and digestibility in the diet. A study by [30] that analysed a soy-maize-sorghum based Ready to Use Complementary Food showed a high phytic acid content and a high phytic acid: iron molar ratio in the food. Similarly [39] found that phytic acid for raw and extruded sorghum-maize soybean products were higher than those preferred for adequate nutrient absorption in young children. However their study further established that removal of phytic acid from the food matrix using microbial phytase contributed to improved weight for age (underweight) and decreased deficiencies of iron and zinc in young children. Additionally presence of anti-nutrient factors such as phytate, limits mineral bioavailability as it chelates divalent cations (Fe, Zn, Ca), which are key nutrients needed for growth and development of young children [40].

3.3. Prevalence of Wasting Between Baseline and 9 Month

The prevalence of wasting at baseline among children in groups fed on soy fortified porridge MSY, SSY and SMS was 10.8%, 10.7% and 12.5% respectively, which reduced significantly ($p<0.05$) to 1.8%, 3.6% and 5.4% respectively by 6th month. Likewise wasting prevalence among children fed with 100% maize (control group) decreased but insignificantly ($p>0.05$) from 10.7% to 10.4% by the end of feeding trial (6th month). However between 6th and 9th month when porridge supplement was withdrawn, wasting among children significantly ($p<0.05$) increased in all groups Table 4.

Table 4. *Prevalence of wasting between baseline, 6th and 9th month.*

Experimental groups	Base line				6th Month				9th Month			
	MMN	MSY	SSY	SMS	MMN	MSY	SSY	SMS	MMN	MSY	SSY	SMS
<-2SD to -3SD (moderate)	10.7	10.8	10.7	12.5	10.4	1.8	3.6	5.4	7.5	7.1	7.1	8.9
<-3SD (severe)	3.6	1.9	1.8	1.8	0.2	0.0	0.0	0.0	1.8	1.8	0.0	1.8

<-2SD to >-3SD moderate underweight, <-3SD severe underweight.

The significant reduction in levels of wasting reported in this study is in line with that reported by [34] in a rehabilitation study of malnourished children. They found that after 8 weeks of nutritional rehabilitation (feeding the malnourished children daily with porridge made from blends of millet soya, peanut), children who had WHZ <-3 decreased from 55.26% to 6.58%, while 63. 81% of children progressed to normal WHZ > −2. Another study in rural areas of Malawi by [41] documented recovery rate of above 75% for moderately wasted children aged between 6 to 60 months who received supplementary diets of either soy/peanut, milk/peanut or corn/soy for a period of 8 weeks. This quick recovery supports the documented evidence in nutrition science that even though wasting often develops very rapidly as a result of deficits in both tissue and fat mass, it can be reversed quickly with appropriate intervention.

3.4. Prevalence of Underweight and Wasting by Z-scores Between Baseline and 9 Month

Underweight (WAZ) and wasting (WHZ) Z-scores between baseline and 9th month are shown in Table 5. At baseline WAZ and WHZ Z-scores were -0.18 and -0.37 respectively. At the end of feeding trial Z-scores improved significantly ($p < 0.05$) to 0.66 and 0.24, for WAZ and WHZ respectively. Our results of significant improvement in WAZ and WHZ Z-scores among children in groups fed with soybean fortified porridge are similar to the results obtained earlier by other researchers [36] who found positive improvement for WAZ and WHZ Z-scores among children fed soy fortified porridge for 6 months. Other studies [7, 38] have also documented similar findings of increased WAZ and WHZ Z-scores after feeding children with soybean fortified supplementary diets. However the WAZ and WHZ Z-scores decreased significantly ($p < 0.05$) between 6th and 9th months when porridge supplement was withdrawn. The mean MUAC measurement in all the 4 groups of children between baseline and 9th month was > 13.5 cm. Though there was an increased MUAC measurement in all the 4 groups of children between baseline and 6th, the difference was not significant ($p > 0.05$). This is due to the fact that between 1 and 5 years children arm circumference remains much the same, even though there is rapid growth. The decrease in MUAC may reflect either reduction in muscle mass, subcutaneous fat or both. Changes in MUAC tend to parallel changes in muscle mass and hence are particularly useful in the diagnosis of PEM and starvation.

Table 5. *Nutritional status of the children by Z scores at baseline and 9th month.*

Nutritional index	Porridge type	Baseline (Mean± sd)	F values	6th month (Mean± sd)	F values	9th month (Mean± sd)	F values
	SSY	$16.01^{a}\pm0.82$		$17.06^{a}\pm1.29$		$17.03^{a}\pm1.19$	
MUAC	SMS	$16.00^{a}\pm1.04$	F=0.18	$17.29^{a}\pm1.24$	F=4.34	$17.08^{a}\pm1.01$	F=1.19
	MSY	$15.88^{a}\pm1.21$	p=0.91	$16.20^{b}\pm1.11$	p=0.007	$16.58^{a}\pm1.31$	P=0.320
	MMN	$15.83^{a}\pm0.77$		$16.97^{a}\pm0.57$		$16.68^{a}\pm0.73$	
	SSY	$-0.13^{ab}\pm0.86$		$0.69^{a}\pm0.74$		$0.16^{a}\pm1.07$	
WAZ	SMS	$-0.51^{bc}\pm0.74$	F=4.15	$0.47^{ab}\pm0.86$	F=3.37	$0.30^{a}\pm0.89$	F =0.58
(Underweight)	MSY	$0.08^{a}\pm0.89$	p=0.008*	$0.81^{a}\pm0.79$	p=0.022*	$0.43^{a}\pm1.24$	P=0.631
	MMN	$-0.76^{c}\pm1.0$		$0.06^{b}\pm1.02$		$0.06^{a}\pm0.83$	
	SMS	$-0.29^{a}\pm0.65$		$0.38^{a}\pm0.71$		$-0.58^{a}\pm0.86$	
WHZ	MSY	$-0.46^{a}\pm0.94$	F=0.63	$0.18^{a}\pm0.83$	F= 0.37	$-0.89^{a}\pm1.38$	F=6.70
(Wasting)	MMN	$-0.12^{a}\pm0.87$	p=0.599	$0.32^{a}\pm0.96$	p=0.772	$-1.77^{b}\pm0.87$	p=0.000*
	SSY	$-0.36^{a}\pm0.94$		$0.16^{a}\pm0.83$		$-1.60^{b}\pm0.93$	

Feeding children with soybean fortified porridges could have contributed to remarkable reduction in underweight and wasting levels established in this study. Alternatively the non significant change in underweight and wasting among children fed from 100% maize (control group) can be attributed low levels of lysine and tryptophan in maize. Lysine and tryptophan are the indispensable amino acids for growth in young children [42]. Additionally maize has Protein Digestibility Corrected Amino acid Scores (PDCAAS) of 35%, indicating that when consumed in isolation the protein quality index may not be met [43]. It is also evident that improvement in underweight and wasting recorded at 6 months reversed drastically within 3 months to almost levels at baseline when supplement porridge was withdrawn. Therefore use of 30% soybean in porridge composites increased quantity and quality of essential amino acids in porridge composites, consequently leading to better growth and tissue synthesis among children in experimental groups. A study by [35] found that fortification of maize flour with 30% soy flour resulted to a composite of Digestibility Corrected Amino acid Scores (PDCAAS) of 70%. Composites of 70% PDCAAS meets World Health Organization (WHO) threshold endorsed index for evaluating protein quality in diets. In addition, the porridge supplemented the energy intakes of the children. Energy density is one of the important determinants of the nutritional adequacy of diets fed to children and its deficiency has been implicated to poor growth in children [44].

4. Conclusion

The study results shows that fortification of maize and sorghum with soybean improved nutritional qualities of the diet, which in turn led to improved growth and reduction of malnutrition among children. This demonstrates that porridge made from staple cereal grains and legumes such as soybean can be one of the sustainable ways of reducing the prevalence of malnutrition in developing countries.

5. Recommendation

The study revealed that porridge flour blends formulated from cereals (maize and sorghum) fortified with soybean promoted growth better as compared to unfortified maize flour. In line with pre-school feeding policy in Kenya, to ensure children are fed with nutritionally adequate diet, policies on fortification of commonly consumed staples with soybeans should be made. This is to improve the nutritional qualities of children's diets. Towards reduction in prevalence of malnutrition among pre-school children in Western Kenya, awareness of the nutritional benefits of soybean should be raised to increase its utilization in the households. This can be done through nutrition education programs in the study area. Sensitization of farmers in soybean farming towards improved production of soybean in the study area should be made a policy in the agricultural sector.

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