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School Feeding Programme in Nigeria: The Nutritional Status of Pupils in a Public Primary School in Ile-Ife, Osun State, Nigeria

Olumuyiwa S. Falade[1], Israel Otemuyiwa[1], Oluwemimo Oluwasola[2], Wale Oladipo[3], Steve A. Adewusi[1]

[1]Department of Chemistry, Obafemi Awolowo University, Ile-Ife, Nigeria; [2]Department of Agricultural Economics, Obafemi Awolowo University, Ile-Ife, Nigeria; [3]Center for Energy Research and Development, Obafemi Awolowo University, Ile-Ife, Nigeria.
Email: sadewusi@oauife.edu.ng

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ABSTRACT

About 7.3 million children are estimated to be out of school in Nigeria; majority of them are girls. The Federal Government school feeding programme is to provide one meal per school day to all primary school pupils in Nigeria with the objectives of improving the health of school age children, increase their enrolment, retention and completion rate in the primary school. The nutritional status of 160 pupils (80 boys and 80 girls) of a selected public primary school in Ile-Ife, Osun State, Nigeria was assessed using anthropometric parameters. Meals were collected and analyzed for nutrient composition and compared to the requirement for their age group. The mid-arm circumference (MAC) ranged between 15 and 21 mm and the body mass index, (BMI) was within the WHO reference standard for healthy children. The crude protein (CP) content of the served foods varied between 12% and 28%. The average intake of amino acids per meal ranged between 122 and 684 mg, vitamins from 0.1 to 0.8 mg while mineral intake varied from 2.7 to 85 mg. The protein digestibility corrected amino acid score varied between 50% and 114%. These results indicated that the feeding programme has greatly improved the nutrition status of these children. The continuation of the programme would go a long way to preventing malnutrition among the public school children.

Keywords: Anthropometry; Amino Acids Intakes; Body Mass Index; Macronutrients; School Feeding Programme

1. Introduction

School feeding programme has been adopted in many countries throughout the world to fight short-term hunger by ensuring at least one daily nutritious meal to support access to education. The high level of food insecurity, significant incidence of malnutrition and economic meltdown all combine to make school feeding relevant [1]. In the poorest pockets of the world, this simple strategy can double primary school enrolment in one year, as is happening in Nigeria. For a child suffering from hunger, going to school is not important; having enough food to eat is. Among the poor, there is often not enough food at home, and most schools in the developing countries do not have a canteen or cafeteria. On empty stomach, children become easily distracted and have problems concentrating on the school lessons [2].

The majority of the estimated 7.3 million children out of school in Nigeria are girls. In 2005, the Federal Government of Nigeria launched the School Feeding Programme with the assistance of the United Nations' Children Education Fund (UNICEF) and the New Partnership for Africa's Development (NEPAD). The objective is to provide one meal per school day to all primary school pupils in Nigeria with the objectives of improving the health of school children, increase their enrolment, retention and completion rate. Since then the enrolment rate had increased while the attendance of pupils in school is stable especially among girls who used to leave school for street trading and house-help jobs [3].

So far, no empirical research has been carried out on the quality of the school meals in terms of nutrient content per serving to these pupils, yet it is important to ascertain that the food can achieve at least 30% of daily nutrient requirement target of the programme. Childhood is an important stage for both physical and mental development and it is believed that overweight children are more likely to be overweight adults and vice versa [4]. A suitable diet should therefore ensure that all nutrient requirements are met in order to protect current and future health in addition to being palatable. Nutrient requirement during childhood is at their highest for many nutrients, due to extreme physical changes including increase in height, bone and muscle growth and also active participation in sports and exercises, which result in increased demand for energy and specific nutrients.

The objective of this research is to carry out the anthropometric measurements of the pupils; predict the nutritional status of the school children; carry out the nutrient analysis of the school meals; calculate the nutrient intake therefrom and then compare it with Recommended Dietary Allowance (RDA) for children.

2. Materials and Methods

2.1. Anthropometric Measurements

This study was conducted according to the guidelines laid down in the Declaration of Helsinki and all procedures involving human subjects were approved by the Ethics committee of the College of Health Sciences of the Obafemi Awolowo University, Ile-Ife, Osun State, Nigeria. Verbal informed consent was obtained from the head teacher and all the teachers standing *loco parentis* for the subjects.

Anthropometric indices of 160 pupils (80 boys and 80 girls) of a selected public primary school in Ife East Local Government area of Osun State, Nigeria were measured. The weight of each subject was measured without shoe to the nearest 0.1 kg, using a standardized digital scale. Height was measured to the nearest 1 mm using a portable Stadiometer. Body Mass Index (BMI) was calculated as weight (kg) divided by the square of the height (m^2) (kg/m^2) and BMI percentiles for age were calculated using BMI calculator developed by Halls [5]. This was compared to America's weight and used to classify the subjects into underweight, normal weight, overweight or obese [5,6]. The mid-arm circumference (MAC) was taken at the left hand side of the body of all the subjects. All measurements were carried out according to the standard WHO [7] techniques.

2.2. Experimental

The samples of the meal prepared for the primary school pupils on a daily basis were collected in plastic containers and treated within four hours of preparation. The samples were weighed, dried in the oven (Gallenkamp oven Model SA 9059 B) at 50˚C, ground into powder and then sieved with No 72 mesh size (Griffin and George Ltd., London). The samples were stored in plastic containers with screw cap and kept in the freezer until analyzed.

Analysis of moisture, ash, crude protein, crude fibre and fat content was carried out by the method of AOAC [8]. The ash was solubilised and its content of iron, zinc, calcium and magnesium was determined by the Atomic Absorption Spectrophotometer (Alpha 4 Model, Fisons Chem-Tech, Analytical, UK). The amino acid profile of the samples was determined using the Technicon Sequential Multi-Sample Amino Acid Analyzer (TSM) (Technicon Instruments Corporation, New York, USA) with nor-leucine as the internal standard. Digestibility corrected amino acid and amino acid score were calculated using egg as reference protein according to FAO/ WHO [9] method. The equation for the Amino acid score is given below:

$$\text{Amino acid score} = \frac{\text{mg of amino acid in 1.0 g of test prot}}{\text{mg of amino acid in 1.0 g of ref. prot}}$$

The content of water soluble vitamins—thiamin, pyridoxin, folic acid, nicotinc acid and ascorbic acid in the samples was determined simultaneously by the modified method of Khor and Tee [10] using High Performance Liquid Chromatography (Agilient Technologies Model 1200, Germany). The calorific value of the samples was estimated from the proximate data based on 17 kJ/g carbohydrate, 17 kJ/g protein and 37 kJ/g fat [11].

2.3. Nutrient Intake

The nutrient data were used to calculate the nutrient intake from the weight of the composite meals and the result compared with the Recommended Dietary Allowance (RDA).

2.4. Statistical Analysis

Results were expressed as mean and standard deviation of three determinations except for anthropometric parameters. Data on food composition were subjected to one way analysis of variance to determine the levels of significant difference by performing a multiple comparison post test (Tukey) and considered significant at $p < 0.05$. The computer program used for these analyses is GraphPad InStat version 3.06 for Windows 2003.

3. Results and Discussion

3.1. Anthropometric Measurements

The result of anthropometric measurements of the sampled population is presented in **Table 1**.

The weight of the subjects ranged from 13 to 33 kg, height from 1.0 to 1.4 m and the Mid Arm Circumference from 15 to 21 mm. The Body Mass Index (BMI), which is widely used to measure adiposity [12], associated with increased morbidity and mortality in adults and adolescents [13] ranged from 12 to 17 kg/m^2. When the determined BMI percentile for the specific age of the pupils was compared with the National Health and Nutrition Examination Survey reference data 1 (NHASES 1 Annex 3) adapted by WHO [6], it was observed that most

Table 1. Anthropometric measurement* of school children.

Age Group (yr)	Mean Age (yr)	Weight (kg)	Height (m)	MAC (mm)	BMI (kg/m^2)
			Male n = 80		
3 - 4	3.5 ± 0.5^{e}	13 ± 2.0^{e}	1.0 ± 0.04^{e}	15.0 ± 0.8^{c}	12 ± 2.0^{c}
5 - 7	6.0 ± 0.6^{d}	20 ± 3.0^{d}	1.1 ± 0.1^{d}	16.0 ± 1.0^{c}	15 ± 2.0^{b}
8 - 10	9.0 ± 0.9^{c}	23 ± 2.0^{c}	1.2 ± 0.04^{c}	17.0 ± 0.8^{b}	15 ± 0.9^{b}
11 - 12	12.0 ± 0.5^{b}	27 ± 3.0^{b}	1.3 ± 0.1^{b}	17.0 ± 1.5^{b}	16 ± 0.9^{ab}
13 - 15	14.0 ± 0.8^{a}	33 ± 5.0^{a}	1.4 ± 0.1^{a}	20.0 ± 2.4^{a}	16 ± 1.2^{a}
			Female n = 80		
3 - 4	3.7 ± 0.5^{e}	14 ± 1.8^{c}	1.0 ± 0.1^{c}	15.0 ± 0.5^{d}	14 ± 0.9^{b}
5 - 7	6.0 ± 0.7^{d}	18 ± 2.6^{c}	1.1 ± 0.1^{c}	15.0 ± 0.8^{d}	15 ± 2.0^{b}
8 - 10	9.0 ± 0.8^{c}	25 ± 5.0^{b}	1.2 ± 0.1^{b}	17.0 ± 0.2^{c}	15 ± 1.6^{b}
11 - 12	11 ± 0.5^{b}	28 ± 6.0^{b}	1.3 ± 0.1^{a}	19.0 ± 2.0^{b}	16 ± 2.0^{ab}
13 - 15	14 ± 1.1^{a}	33 ± 5.0^{a}	1.4 ± 0.1^{a}	21.0 ± 2.2^{a}	17 ± 0.8^{a}

*Mean ± standard deviation; Values with the same superscript were not significantly different at $P < 0.05$.

of the pupils had BMI percentile between 5th to 85th percentile which, according to the Centre for Disease Control and Prevention rating, indicated a healthy growth among the school children (**Table 2**).

There were more underweight school children whose BMI was below the 5th percentile (13% male and 15% female) compared to overweight children (6% male only) whose BMI was equivalent to or above the 95th percentile.

Table 2. BMI Percentile for age (%).

Age (Y)	<5th	5th - 85th	95th
	Underweight	Normal weight	Overweight
		Male (n = 80)	
3 - 4	30	70	-
5 - 7	5	70	25
8 - 10	-	100	-
11 - 12	-	100	-
13 - 15	20	80	-
Total	13	81	6
		Female (n = 80)	
3 - 4	40	60	-
5 - 7	10	85	5
8 - 10	20	80	-
11 - 12	10	90	-
13 - 15	-	100	-
Total	15	64	1

Although there was no established cut-off point for childhood overweight, an expert committee convened by the Maternal and Child Health Bureau of the Department of Health and Human Services recommended that children with BMI greater than or equal to the 95th percentile for age and sex should be referred for evaluation and possible treatment for overweight [14,15]. Harris *et al.* [16] have pointed out that the percentile used in the developed countries cannot be used for children and adults in developing countries like Nigeria. This is because BMI is dependent only on net weight and height, with a simplistic assumption about distribution of muscle and bone mass, and thus over-estimate adiposity on those with more lean body mass (e.g. athlete) while underestimating adiposity on those with less lean body mass [17]. Thus, it was shown that the depiction of nutritional status in terms of BMI alone could be seriously deficient. For example, Deurenberg-Yap *et al.* [18] showed that for Chinese, Malays and Indians in Singapore, several people with low BMI had indeed such high body fat that they should appropriately be classified as obese. Chadha *et al.* [19] advocated the use of anthropometric parameters like waist-to-hip ratio and % body fat in addition to BMI in the assessment of nutritional status, therefore, the use of percentile BMI may not give the overall picture of nutritional status of the school children in Nigeria. In developed countries like the United States of America, childhood obesity is almost becoming epidemic [20-22] due to unhealthy eating, but stunted and impaired body growth and development resulting from malnutrition and hunger is still the bane of children especially in Nigeria.

3.2. Nutrient Intake

The type of food served to the pupils as school meal, the serving size and the proximate composition, were presented in **Table 3**. In addition to the mid-day meal, a cocoa-based beverage drink was given every Wednesday. The proximate composition (**Table 3**) indicated that moisture content ranged from 20% to 40% with the highest reported for Thursday meal.

Protein, an important component of food essential for growth and maintenance, ranged from 12% to 28%, fat (14% to 24%) ash (1.3% to 3.8%), crude fiber from (0.5% to 0.8%) and carbohydrate (4.4% to 50.7%). Thursday's meal had the highest content of all the parameters analyzed. The results of amino acid and vitamin content of the foodstuffs are reported in **Table 4**. The result indicated that beans is limiting in sulphur amino acids (methionine and cysteine) and rice in lysine and isoleucine while threonine, lysine, isoleucine are the limiting amino acids in yam in that order. This observation is consistent with the findings of Meredith and Caster [23].

Thiamin was not detected in rice, corroborating the published report that polished rice is a poor source of thiamin [24]. The result of this analysis compared favourably with the values reported on the food composition table for vitamin [25].

3.3. Energy

The energy intake from the meal (**Table 5**) ranged from 604 to 889 kJ with the average intake of 772 kJ, translating to about 33% of 2200 kJ required by a ten year old child per day [26]. The macronutrients' contribution to energy was 21%, 44% and 33% but the pattern fell short of the US standard of a high protein diet, which suggested 30% energy contribution from protein, 30% from fat and 40% from carbohydrate [27]; this menu could be considered as a nutritious protein diet in the Nigerian context, where root and tuber, predominantly carbohydrate, form the staple diet [28].

3.4. Vitamins

The vitamin intake from the meal is presented in **Table 5**. The result indicated that Tuesday and Thursday meals recorded higher water soluble vitamin content except for ascorbic acid. The average daily intake of thiamin, ascorbic acid, niacin, pyridoxine and folate was 0.87, 0.67, 0.20, 0.1 and 0.08 mg, respectively. Apart from thiamin and folate, which could respectively meet 95% of 0.9 mg and 40% of the 200 µg required per day, other vitamins fell far short of the daily requirements for school-age children.

The rice menu recorded low thiamin content due to the low level of thiamin in rice, therefore care has to be taken to balance rice with high thiamin-containing foodstuffs, otherwise *beriberi*, a noticeable deficiency disease of thiamin which has been reported to be endemic in areas where rice was the staple diet [24], could become prevalent among the children. Niacin, though very low in the meals, could be spared by tryptophan, from which niacin could be synthesized at the rate of 60 mg of the amino acid for every one mg of niacin. This way, the body could synthesize about 50% of the needed niacin. The use of tryptophan in this manner could therefore jeopardize the protein nutriture of the diets, making tryptophan a major limiting amino acid. Fruits and vegetables, which are rich sources of vitamins, are not included in the school menu. Unfortunately, parents too may not deem it necessary to give fruits to their children at home because of the cost and lack of enough knowledge of nutritional importance of incorporating fruits and vegetables in diets.

3.5. Minerals

Minerals are known to play vital roles in the maintenance

Table 3. Proximate composition of the school menu (% of each meal).

Weekday	Type of Food	Weight (g)	Moisture content	Ash	Crude fibre	Fat	Crude Protein	CHO*
Monday	Rice & fish	38 ± 3	21 ± 1.5^c	1.8 ± 0.2^b	0.5 ± 0.2^a	14 ± 2^b	12 ± 3^b	50.7
Tuesday	Porridge**	55 ± 10	29 ± 2^b	3.8 ± 0.3^a	0.6 ± 0.1^a	18 ± 3^{ab}	19 ± 0.9^b	29.6
Wednesday	Rice & cowpea	45 ± 6	30 ± 1.3^b	1.3 ± 0.1^b	0.8 ± 0.1^a	15 ± 4^b	17 ± 2^b	35.9
Thursday	Cowpea & egg	62 ± 4	41 ± 2.0^a	3.4 ± 0.2^a	0.6 ± 0.1^a	24 ± 2^a	28 ± 3^a	4.4
Friday	Rice & fish	40 ± 5	21 ± 2^c	1.8 ± 0.3^b	0.5 ± 0.2^a	14 ± 2^b	12 ± 3^b	50.7

*CHO—carbohydrate by difference; **The food was prepared from yam, cowpea and palm oil; Values with the same superscript were not significantly different at $P < 0.05$.

Table 4. Essential amino acid and vitamin content of foods.

	Rice	Cowpea	Yam	Fish
	Amino acid (g/100g Protein)			
Lys	3.2(0.5)	5.7 (0.8)	2.7 (0.4)	6.2 (0.7)
His	3.18	3.11	3.01	2.63
Arg	5.26	6.21	4.00	5.80
Asp	8.56	10.10	5.70	9.10
Thr	3.5 (0.7)	2.9 (0.6)	2.6 (0.6)	3.9 (0.8)
Ser	2.98	3.40	3.02	4.05
Glu	11.20	13.85	9.11	12.85
Pro	2.74	3.18	2.80	4.25
Gly	4.46	3.50	3.06	5.59
Ala	4.93	3.61	4.36	6.00
Val	4.2 (0.6)	4.5 (0.7)	3.8 (0.6)	5.0 (0.8)
Cys**	1.5 (0.7)*	1.1(0.4)*	1.2 (0.3)*	0.9 (0.6)*
Met	2.47	1.35	0.80	3.10
Ileu	3.6 (0.7)	3.5 (0.6)	3.0 (0.6)	3.4 (0.6)
Leu	6.2 (0.7)	6.9 (0.8)	4.9 (0.6)	6.7 (0.8)
Tyr**	3.7 (0.9)	3.2 (0.9)	3.1 (0.7)	3.2 (0.8)
Phe	4.96	4.82	3.72	4.50
Trp[1]	12.1 (0.7)	12.3 (0.7)	6.9 (0.4)	11.4 (0.7)
Ser	2.98	3.40	3.02	4.05
Glu	11.20	13.85	9.11	12.85
	Vitamins (mg/100g)[2]			
Thiamin	ND[3]	2.35	1.41	1.76
Folate	0.14	0.17	0.06	0.31
Niacin	0.35	0.44	0.18	0.42
Pyridoxin	0.06	0.29	0.16	0.47
Vitamin C	2.10	0.76	0.27	1.58

[1]Tryptophan—not determined, values were obtained from literature [26]; [2]Coefficient of variation was 5%; [3]ND—Not detected; Values in parenthesis are amino acid scores; *and **are amino acid scores for Cys/Met and Phe/Tyr, respectively.

of human health [29]. For example, iron is an important component of blood and enzymes, calcium is an essential macronutrient, which is critically important in the maintenance of optimal bone mass, proper functioning of soft tissues, blood clotting, regulation of muscle contraction and for many enzymatic processes. Zinc is essential for protein and nucleic acid synthesis and magnesium is important for structural stability of nucleic acid and intestinal absorption of nutrients [30-34]. The mineral content of the composite meals is also presented in **Table 5**. The result indicated that the average intake of iron, zinc, magnesium and calcium from the school meals in mg were 2.7, 4.7, 64 and 85, respectively. The recommended dietary allowance for iron is 10 mg, zinc 10 mg, magnesium 170 mg and calcium 800 mg [25]. This indicated that the school meal could provide less than 30% of the daily requirement of the minerals assayed. The WHO considers iron deficiency the number one nutrition disorder in the world. As many as 80% of the world's population may be iron deficient, while 30% may have iron deficiency anaemia [35]. It is therefore important to take care of mineral nutrition in the school feeding programme by supplementing with milk or the parents could be adequately counselled to provide mineral-rich foods at home.

Table 5. Macro-nutrients, vitamin and mineral Intake/day[1].

Nutrients	Mon	Tues	Wed	Thurs	Frid	Average
			Macronutrients (g/serving)			
Protein	5.0	11	8.0	17	5.0	9 ± 5.0
Fat	5.3	10	7	15	6	8.6 ± 4
Ash	0.68	1.54	0.58	1.24	0.72	0.8 ± 0.6
Crude fibre	0.20	0.33	0.36	0.37	0.20	0.3 ± 0.1
CHO	19	16	16	2.7	20	15 ± 7.0
Energy (kJ)	604	829	667	874	889	772 ± 129
			Vitamins (mg/serving)[2]			
Thiamin	0.22	1.24	0.47	1.85	0.56	0.87 ± 0.6
Folate*	69	83	74	97	88	82 ± 10
Niacin	0.15	0.21	0.17	0.28	0.20	0.20 ± 0.04
Pyridoxin	0.05	0.16	0.06	0.15	0.08	0.10 ± 0.05
Ascorbic acid	0.86	0.38	0.82	0.41	0.91	0.67 ± 0.25
			Minerals (mg/serving)			
Iron	1.66	2.8	2.13	3.4	3.4	2.7 ± 0.7
Zinc	3.3	5.9	3.8	6.0	4.6	4.7 ± 1.2
Calcium	80	95	68	94	90	85 ± 10
Magnesium	33	119	49	71	47	64 ± 33

*µg/serving; [1]Mean ± standard deviation for each day; [2]Coefficient of variation was 5%.

3.6. Proteins

The intake of protein from the meals (**Table 6**) over a one-week period was an average of 10 g of protein, equivalent to 8 g digestibility-corrected protein per day

Table 6. Amino acid intake and amino acid score/day.

Amino Acid (g/serving)	Mon	Tues	Wed	Thurs	Fri	Average	RDA*
Protein	4.68	10.6	7.9	17.8	8.1	10 ± 5	18
DCP	4.24	8.6	6.7	15.2	6.9	8 ± 4	
Digestibility-corrected Amino acid (mg/g protein)							
Ileu	148	294	173	651	240	201 ± 203	666
Leu	270	578	441	1158	453	580 ± 341	1008
Lys	192	483	336	947	342	460 ± 291	1350
Met/Cys	166	234	223	575	252	290 ± 164	612
Phe/Tyr	345	676	542	1302	557	619 ± 418	612
Thr	155	267	225	555	232	287 ± 155	792
Trp	49	101	80	297	82	122 ± 99	162
Val	192	392	303	817	310	403 ± 242	738
Digestibility-corrected Amino acid score of the meals (%)							
Ileu	65	63	48	79	65	64 ± 11	
Leu	74	78	77	88	77	79 ± 5	
Lys	64	80	72	89	71	75 ± 9	
Met/Cys	69	50	59	66	64	62 ± 7	
Phe/Tyr	87	85	87	92	87	87 ± 2	
Thr	78	66	72	78	72	73 ± 5	
Trp	69	69	70	114	70	78 ± 19	
Val	68	69	69	81	69	71 ± 5	

*Recommended Daily Allowance-Calculated based on protein requirement of 0.8 g/kg body weight of a 10 year old child, body weight 22 kg; **(DCP) Digestibility Corrected Protein.

from the school meal. The protein requirement of a ten year old child, whose body weight is 22 kg, has been estimated to be 0.8 g per kg body weight [26]; this child would require approximately 18 g protein per day.

Ingestion of 10 g protein intake from the school meal would therefore translate to an average ingestion of about 45% of protein required for a day. Though school feeding is an intervention programme at ensuring fair intake of nutrients by the pupils, protein intake through the school meal may be regarded as sub-optimal, considering the fact that not all protein ingested in the food would be utilized. Much more important is the fact that the school meal could be the child's best and most nutritious meal of the day, due to the level of poverty in most homes where cassava meal is the staple diet. Protein is crucial to the regulation and maintenance of the body, especially for growth and cognitive development of the individual, body functions such as blood clotting, fluid balance and cells and tissue repairs [24] and should be provided to the school children in adequate level.

The quality of the protein in the meals was investigated in terms of the essential amino acid content and protein digestibility-corrected amino acid score (PDCAAS), which is a method of evaluating the protein quality based on the amino acid requirement of humans adopted by the US. Food and Drug Administration (FDA) and the FAO/WHO [9]. The result, presented in **Table 6**, indicated that the average intake of the essential amino acid from the meals ranged from 122 mg tryptophan to 619 mg phenylalanine/tyrosine. When the requirement for amino acid was estimated, based on the 18 g protein required by a 10 year old child with body weight of 22 kg, and compared with amino acid intake; the school meal could meet a range of 30% to 75% of the requirement, depending on the amino acid. From the average intake of amino acids (**Table 6**), it was revealed that isoleucine, lysine and threonine were in short supply making them the first, second and third limiting amino acids, respectively, based on RDA of these amino acids. Sulphur amino acids have been reported as the limiting amino acid in legume products [36]. The amino acid score of the meal compared with egg protein, as reported in **Table 6**, indicated that the score ranged from 50% to 114% with the meal of cowpea and egg provided on Thursday having the highest score. It would therefore be essential to complement cereals and grains with legumes and animal protein. A survey of daily food intake by the school children revealed that many of them eat rice worth twenty naira (₦20.00) as breakfast, *gari* (a cassava product) and groundnut or groundnut cake (*Kulikuli*) as lunch while *eba* (another cassava meal) or *amala* (yam flour meal) with okra soup served as supper. Thus, the school meal seems to be the best and most nutritious food for the child throughout the day and any shortfall in the nutrient requirement (especially essential amino acids) may not be provided by any other meal. It is therefore suggested that the quantity of food given to these pupils be increased in order to meet at least 50% of the protein and vitamin requirement per day. The cost of the school meal was thirty naira (₦30.00 or US$0.20) per child per day. Hypothetical mixing of foodstuffs; rice and cowpea, yam and cowpea were carried out to see the composite that would give highest nutrients and possibly at minimum cost. The result presented in **Table 7**, indicated that the protein content and therefore the amino acid profile of the composite meals increased as the content of the cowpea increased while the cost decreased. Rice and cowpea meal of 15:35 g recorded the highest protein and amino acid content. A similar trend was observed for all the vitamins except ascorbic acid. It is therefore sug-

Table 7. Cost analysis and nutrient content of rice and cowpea combinations.

Parameters	Cowpea	Rice	Fish	Ratio of rice and cowpea without fish					RDA[*]
	Alone			As served	Hypothetical combinations				
DW of meal (g)	35	15	5	35:15	30:20	25:25	20:40	15:35	
Protein (g/serving)	2.4	3.4	2.1	5.8	6.58	7.37	8.14	8.93	18
DCP[**] (g/serving)	2.09	2.64	1.94	4.73	5.31	5.89	6.47	7.05	
Meal Cost (N)	20.00	5.00	5.00	25.00	23.60	22.30	21.40	20.10	
Equivalent in US$	0.13	0.03	0.03	0.16	0.15	0.14	0.14	0.13	
Digestibility-corrected Amino acid (mg/serving)									
Ileu	76.1	91.8	66	168	188	207	227	246	666
Leu	129	182	130	312	354	396	439	481	1008
Lys	65.8	150	121	216	256	297	338	378	1350
Met/Cys	82	63	77.6	145	155	164	173	182	612
Phe/Tyr	180	212	150	392	437	482	527	572	612
Thr	72.5	765	76.4	149	164	179	194	209	792
Trp	25.3	33	22	58	65	72	79	86	162
Val	87.4	118	97	206	233	260	287	314	738
Vitamins (mg/serving)									
Thiamin	0.0	0.35	0.88	0.35	0.47	0.59	0.70	0.82	0.9
Folate[***]	50.5	25.2	15.4	75.2	76	77	79	80.2	200
Niacin	0.12	0.06	0.21	0.18	0.19	0.20	0.20	0.26	1.5
Pyridoxin	0.02	0.04	0.02	0.06	0.07	0.08	0.09	0.11	1.2
Ascorbic acid	0.73	0.11	0.08	0.85	0.78	0.71	0.65	0.58	35

gested that rice and cowpea in ratio 30:70 be served to the school children as this combination will provide maximum nutrient intake at minimum cost. Since the estimated cost of the 30:70 rice: cowpea meal was ₦20.10 or \$0.13; the remaining fund could be better utilized to provide a bigger fish portion, a beverage drink or fruits that complement the vitamin and mineral intake of the school children.

The result presented in **Table 8** for cowpea and yam composite meal indicated that the increase in the proportion of yam (the cheaper food component) resulted in lower overall protein and therefore amino acid content, though the cost also reduced. The vitamin content in the combinations followed the same trend as observed for the essential amino acids. Thus, the cowpea and yam meal at 70:30 or 60:40 ratios will be the best for protein, amino acid and vitamin nutriture. It is, however, well known that a combination of two protein sources often give better nutritive value because of the complementation of their protein content [37-39]. Thus, mixing food from different food groups together at a meal could go a long way in solving diet related health diseases. It is therefore important to ensure that the meal combination that would give the pupil the highest nutrient intake and possibly at minimum cost is provided.

4. Conclusions

The findings from this study revealed that the food combinations in the school meals tend towards providing adequate nutrients for the pupils and thus could provide a balanced diet. Cost and nutrient analysis indicated that the yam-cowpea composite meal as served provided the best nutrient composition for the pupils while the rice and cowpea combination would give better nutritional value at 30:70 and at lower cost. Analysis indicated a high nutrient content; however, the size per serving to the pupil seems inadequate; for instance, 2 to 4 gram fish on dry weight basis per serving seems to provide nutrients

Table 8. Cost analysis and nutrient content of cowpea and yam combinations.

Parameters	Cowpea	Yam	Fish	Ratio of cowpea and yam without fish						RDA*
		Alone		As served	Hypothetical combinations					
DW of meal (g)	35	30	5	35:30	45:20	40:25	32.5:32.5	25:40	20:45	
Protein (g/serving)	7.91	0.63	2.1	8.54	10.53	9.50	7.92	6.37	5.33	18
DCP** (g/serving)	6.16	0.46	1.94	6.62	8.22	7.42	6.21	4.92	4.05	
Meal Cost (₦)	15.00	8.00	5.00	23.00	24.60	23.70	22.20	21.30	20.50	
Equivalent in US$	0.10	0.05	0.03	0.15	0.16	0.15	0.14	0.14	0.13	
Digestibility-corrected Amino acid (mg/serving)										
Ileu	214	13.8	66	228	283	255	213	168	138	666
Leu	426	22,6	130	449	563	506	420	334	270	1008
Lys	351	12.6	121	363	458	411	351	265	215	1350
Met/Cys	148	9.2	77.6	158	196	176	147	116	95	612
Phe/Tyr	495	31.4	150	527	657	590	493	389	319	612
Thr	179	12	76.4	191	237	214	179	141	116	792
Trp	76	3.2	22	79	100	89	74	58	47	162
Val	277	17.6	97	294	368	331	276	218	179	738
Vitamins (mg/serving)										
Thiamin	0.82	0.42	0.08	1.25	1.34	1.29	1.22	1.15	1.10	0.9
Folate***	58.8	17.4	15.4	76.2	87.2	81.7	72.3	65.2	59.7	200
Niacin	0.15	0.05	0.02	0.21	0.23	0.22	0.20	0.18	0.17	1.5
Pyridoxin	0.10	0.05	0.02	0.15	0.16	0.16	0.15	0.14	0.13	1.2
Ascorbic acid	0.26	0.08	0.08	0.35	0.40	0.37	0.33	0.30	0.27	35

For **Tables 7** and **8**: *Recommended Daily Allowance—Calculated based on protein requirement of 0.8 g/kg body weight of a 10 year old child, body weight 22 kg; **(DCP) Digestibility Corrected Protein; ***μg/serving.

that were grossly inadequate.

In addition, vitamin intake from the school meal was low; hence the inclusion of fresh fruits and vegetables, which are sources of vitamins, in the menu is recommended.

From the finding of this study, the school meal programme could go a long way in solving short-term problems of hunger and malnutrition and provide a solution to long-term nutrition-related health problems among school children in Nigeria. There is a need for further research on an expanded scope to have a comprehensive outlook of the effect of the school feeding programme on the overall nutrition and cognitive development of Nigerian public school pupils so as to advise government on how to improve their well being. In the meantime, we wish to recommend the adoption of the school feeding programme in all the States of Nigeria.

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