EFFECT OF HOME-MADE FORMULA ONGROWTH PERFORMANCE OF MALNOURISHED PRE-SCHOOL CHILDREN (24-36 MONTHS OF AGE) IN YOBE STATE NIGERIA

Abstract

Aim: The insurgency in the north-east zone of Nigeria has aggravated rate ofmalnourished children and many are roaming the streets unattended. This study determinedthe effect of home-made formula on growth performance of malnourished pre-school children in Yobe State, Nigeria.
Study design: A factorial experiment.
Place and duration of study: Yobe state, Nigeria, 6 weeks.
Methodology: Three local Government Areas (LGA) of Yobe state, Nigeria (Bade, Bursari and Potiskum) used. A formulated home-made formula (HMF) was compared with therapeutic milk powders(TMPs). Twenty malnourished pre-school children were purposefully selectedin each LGA and were grouped into two. Each group was randomly allotted to a dietary treatment, a child stood as replicate.At commencement children with complications were treatedin the hospital. They were fed at 16.88 ml/1kg body weight 8hours daily throughout a 6^{th}week study. Parameters studied included weight, height, mid-upper arm circumference (MUAC) and W/HZ-score. A SPSS statistical package was used to analyze the results.
Results: All the parameters were ($p>0.05$) affected with dietary treatments among districts. However, children fed HMF had higher final MUAC (127.50±2.04mm), higher height gain (3.45±0.18cm) and higher MUAC gain (13.76±0.22mm) among districts while those fed TMPs had higher final weight (10.74±0.25kg), higher final height (83.77±0.16cm) and higher weight gain (2.11±0.01kg). Based on average, the children fed HMF had higher final MUAC (127.50±2.04mm), height gain (3.45±0.18cm) and MUAC gain (13.76±0.22mm) while their counterparts fed TMPs had higher final weight (10.74±0.25kg), final height (83.77±0.83) and weight gain (2.11± 0.01kg). The children fed TMPs had slightly higher daily weight gain (50.23g) than those fed HMF (48.81g); and all the children were discharged with -2<z-score.
Conclusion: It can be concluded that HMF was effective in managing malnutrition in pre-school children. Therefore, it is recommended as alternative therapeutic food.

Keywords: Malnutrition,milk powders, performance, preschool children, therapeutic formula

Introduction

In most regions of the world, progress is made towards the sustainable development goal to end all forms of malnutrition in children below five of age by 2025 (UNICEF/WHO/World Bank, 2018). However, there is likelihood that most Africa countries may not achieve this goal due to high rate of unemployment, poverty, illiteracy, and overcrowding which have direct link with malnutrition (WHO, 2018). According to UNICEF, WHO and The World Bank (2018) the situation in Nigeria is dire with about 44%childrenare stunted, 32% underweight and 11% wasted. Furthermore the recent insurgency bedeviling the north-east region of Nigeria

hasdisplaced many families thereby aggravating the prevalence of malnutrition and many childrenare roaming the streets unattended (Anger, 2010; Nonterah*et al*., 2022). It has been documented that allowing malnourished children unattended adverse effect on labour productivity during adulthood (Ashworth, 2015; Gadanya, 2020; Jesmin*et al*., 2011). In a severe acute malnutrition (SAM) weight for height/length is below ratio < -3 standard deviation, a mid-upper arm circumference (MUAC) is< 11.5 cm (Ubesie and Ibeziakor, 2012; WHO, 2013).

In Nigeria much effort is geared towards control of malnutritionunlike other parts of the world where preventive measures such as birth control, creation of job opportunities and education among other factors are put in place. However, the effort to control malnutrition is not seen at large scale due to scarcity and high cost of therapeutic milk powders(WHO, 2018). The recommended therapeutic milk powders are F75 (Ready-to-use formula for phase 1 of inpatient SAM care) and F100 (Ready-to-use formula for transition and rehabilitation phase of inpatient care) (WHO, 1999)and are virtually imported. Owing to the high prevalence of malnutrition it becomes necessary to developlocal alternative therapeutic formula. Therefore, this study aimed at determining the effect of home-made formula on growth performance of malnourished pre-school children in Yobe State, Nigeria.

Materials and methods

Experimental location

This experiment conducted in Yobe state, Nigeria. Yobe state is located between latitude 11 North and longitude 13.5 East. It has a land area of 47,153 square kilometers. It was curved out from Borno State on August 27, 1991 and the administrative Headquarter is in Damaturu. It shares common boundaries with Borno state to the east and southeast Jigawa state to the northwest, Bauchi and Gombe states to the southwest. It also shares an international border with the Republic of Niger. The population of the State according to the National Head Count conducted in 2006 is about 2.6 million. Yobe state is politically divided into three geopolitical zones namely; Zone A comprising Damaturu, Gujba, Gulani, Tarmuwa, Bursari, Gaidam, Yunusari LGAs; Zone B comprising Potiskum, Fika, Fune and Nangere LGAs while Zone C is made up of Bade, Jakusko, Karasuwa, Nguru, Yusufari and Machina. The state hasa total of 17 local government areas(Wikipedia, 2023a).

Purchase and processing of ingredients

Guinea corn, groundnut, soybean, sugar, milk,vegetable oil and crayfish were purchased from Gashua main market while premix (Multimix) was purchased from Bio-Organics Nutrient Systems Ltd, in Ibadan, Nigeria. The guinea corn, groundnut and soybean were cleaned by sorting out stones, debris, seeds with defect and other impurities. The guinea corn and soybean were separately soaked in water overnight thereafter, dehulledand ground using hammer mill as adopted by Sudik (2016) and Sosanya*et al*. (2018). After milling they were allowed to dry under the roof on clean tarpaulin for two days also as adopted by Sudik (2016). The groundnut was usually milled prior to use.

Formulation of Home-made formula

The home-made food was formulated by thoroughly mixing the grounded guinea corn, groundnut and soybean together with sugar, milk, vegetable oil, crayfish and premix (mineral vitamin mix). The gross composition of the ingredients is shown in table 1. This formula was developed under the supervision of dieticians in the General Hospital Gashua, Yobe State, Nigeria.

The therapeutic milk powders F75 and F100 were obtained from hospitals in Yobe State, Nigeria.

Selection of patients

Of the 17 Local Government Areas of Yobe State, 1 LGA was randomly selected from each geographical zone. Bursari LGA was selected from Zone A, PotiskumLGA from Zone B and BadeLGA from Zone C. In each of the LGA the consents and cooperation of the Local Government Chairman, Amir, the Divisional Police Officer (DPO) and Medical Director (MD) of the General Hospital in the LGA were sought. The goals of carrying this study were explained.

Thirty (30) malnourished preschool children 15 males and 15 females were purposively selected in each of the selected LGA with the help of specialists in the General Hospital, given a total of 90.The childrenselected had heights of between 45 -120 cm, MUAC ≥ 115 mm and < 125mm, W/H - W/L ≥ -3 and <-2 Z-score and BMI of < 16. These values were used to define severe acute malnutrition (SAM) (Wikipedia, 2023b; WHO, 2018). The commonness clinical symptoms observed in the children included oedema, emaciation, enaemia, pneumonia and stunted growth.

Table 1: Gross compositions of the home-made formula

Ingredients	**(g)**	**Reference values in mg/100g (WHO, 1999)**
Guinea corn	75	-
Groundnut	100	-
Soybean	50	-
Milk	100	-
Sugar	104.65	-
Vegetable oil	60	-
Cray fish	10	-
Premix (Multimix)	0.35	-
Total	**500**	
Calculated		
Crude protein	15.21	10-12% total energy
Gross energy (kcal/kg)	531.00	520-550 kcal/100g

The following tests were carried out on each child in the hospital to assess his or her health status.

1. Haemoglobin or packed cell volume, blood glucose, malaria and HIV.
2. Tuberculosis
3. Urinary tract infection
4. Internal parasite
5. Chest X-ray

Those identifiedwith complicationsarising from the tests above were treatment.Administrations of drugs were strictly done health personnel.

Management of patients

In each district the children were divided into two groups (15 each) based on their body weight and each group was randomly allotted to the two test foods (home-made formula and therapeutic milk powders) in a factorial experimental form (3x2) i.e. three LGA and two dietary treatments and a child served as a replicate.
Each child was given an identification code as follows:

a. 1BuHF, 2BuHF…..15BuHF = 1-15 children in Bursari fed home-made formula
b. 1BaHF, 2BaHF…..15BaHF = 1-15 children in Bursari fed therapeutic ~~mikl~~milk powders
c. 1BaHF, 2BaHF…..15BaHF = 1-15 children in Bade fed home-made formula
d. 1BaTM, 2BaTM.…15BaTM = 1-15 children in Bade fed therapeutic ~~mikl~~milk powders
e. 1PHF, 2PHF ……15PHF = 1-15 children in Potiskum fed home-made formula
f. 1PTM, 2PTM…….15PTM = 1-15 children in Potiskum fed therapeutic milk powders

The children given therapeutic milk powders were first fed F75 which contains high carbohydrate to enable complications to be resolved quickly before feeding them with F100 which contains higher protein and fat to rebuild the body fast (WHO, 2018). All the children with diarrhea were administered with ReSoMal (Rehydration solution for malnutrition)also obtained in the hospital to resolve loss of water. The home-made formula was given to the children in the form of pap by mixing with hot water while the therapeutic milk powders were diluted with water as described by the supplier. Caution was taken not to add too much water to avoid being too diluted. All the foods were given at 16.88 ml/1kg body weight at 3hours interval as adopted by WHO (2018). The cups used were washed immediately and sun dried.
The children were provided with mosquito nets, shirts, trousers, soaps and pomades. Before and after every meal they washed their hands. They were not restricted from their family foods. The study lasted for 6 weeks.The services of experts were sought throughout the management.

Data collection
At the beginning of the study initial body weights, height and mid-upper arm circumference (MUAC) of the children were measured using scale and color-coded length-based tapes as described in WHO (2018). Thereafter, the measurements were repeated on a weekly basis. To determine the changes in these parameters, the initial measurements were subtracted from the final measurements. Weight-for-height ratio was determined using the reference standard by WHO (2018).

Data analysis

The data obtained was analyzed using the Statistical Package for Social Science (SPSS) version 25.

Results

Table 2 shows the effect of home-made formula on **growth** performance of malnourished preschool children. There was no significant different ($p>0.05$) in final weight, final height and final MUAC among districts as wellas no significant different ($p>0.05$) in weight gain, height gain and MUAC.

Table 3 shows effect of therapeutic milk powders (F75 & F100) on **growth** performance of malnourished preschool children. Also, there was no significant different ($p>0.05$) in final weight, final height and final MUAC as well as weight gain, height gain and MUAC gain.

Table 4 shows the comparative effect of home-made formula and therapeutic milk powders on **growth** performance of malnourished preschool children. The children fed home-made formula had higher MUAC gain among districts and those fed therapeutic milk powders had lower. However, the values for final weight, final height, final MUAC, weight gain and height gain fluctuated among districts between the dietary treatments.

Table 5 shows the summary of performance of malnourished preschool children fed home-made formula and therapeutic milk powders. The children fed HMF had higher final MUAC (127.50±2.04mm), higher height gain (3.45±0.18cm) and higher MUAC gain (13.76±0.22mm) while those fed TMPs had lower (125.51±0.41mm, 3.22±0.05cm and 13.63±0.57mm respectively). The children fed TMPs had higher final weight (10.74±0.25kg), higher final height (83.77±0.16cm) and higher weight gain (2.11±0.01kg) while those fed HMF had lower (10.39±0.11kg, 83.49±0.16cm and 2.05±0.01kg respectively). Again, those fed TMPs had higher weight gain (50.23g) per day while their counterparts fed HMF recorded lower (48.81g) per day.

Table 6 shows the weight-for-height 2 to 3 years (z-scores). The children were admitted with z-score -3 and after the study they were discharged with z-score 1.

Discussion

The positive growth performance of children fed HMF demonstrated that the formula was balanced and provided the energy and protein needed for rehabilitation of malnourished pre-school children. This is in support of the reports of Essel (2022) and Ghosh-jerath*et al*. (2017) that adequate nutrition is crucial for a child's proper development. The positive performance further demonstrates the possibility of locally production of therapeutic food from guinea corn, groundnut and soybean supplemented with milk, sugar, crayfish and premix. This supports the report of Sudik*et al*. (2019) that the inability of nursing mothers to fortify food meant for children with dense nutrient ingredients causes malnutrition. Kalra*et al*. (2001) and Makonnen *et al*. (2003) reiterated that fortification of cereal and legume foods help in resolving nutrient deficiency.

Table 2: Effect of home-made formula**on growth** performance of**malnourished preschool children**

Parameters	Bade	Bursari	Potiskum	±SEM	P-Value
Initial weight (kg. g)	8.71	8.42	7.9	0.13	0.695
Initial height (cm.mm)	78.9	80	81.2	0.16	0.317
Initial MUAC (mm)	111.3	114.42	115.51	0.07	0.324
Final weight (kg. g)	9.97	10.67	10.54	0.32	0.017
Final height (cm.mm)	84.07	83.22	83.17	0.07	0.245
Final MUAC (mm)	125.27	127.96	129.27	0.45	0.038
Weight gain (kg. g)	1.26	2.25	2.64	0.10	0.145
Height gain (cm.mm)	2.17	1.22	1.97	0.01	0.311
MUAC gain (mm)	13.97	13.54	13.76	1.01	0.097

Values are mean of 15 children**;** SEM= pooled standard error of mean; MUAC = Mid-upper arm circumference.

Table 3: Effect of therapeutic milk powders (F75 &F100)on growthperformance of**malnourished preschool children**

Parameters	Bade	Bursari	Potiskum	±SEM	P-Value
Initial weight (kg)	8.28	7.96	9.65	0.12	0.695
Initial height (cm)	79.04	80.13	82.46	1.06	0.317
Initial MUAC (mm)	112.53	111.01	112.10	0.07	0.324
Final weight (kg)	10.95	9.86	11.41	0.22	0.017
Final height (cm)	84.58	83.29	83.43	0.07	0.245
Final MUAC (mm)	125.91	125.52	125.10	0.15	0.038
Weight gain (kg)	2.67	1.9	1.76	0.30	0.201
Height gain (cm)	5.54	3.16	0.97	0.40	0.019
MUAC gain (mm)	13.38	14.51	13.00	0.61	0.025

Values are mean of 15 children**;**SEM= pooled standard error of mean; MUAC = Mid-upper arm circumference.

Specifically, Kalra*et al*. (2001) and Makonnen *et al*. (2003) reported that zinc supplementation assisted in controlling diarrhea as well as respiratory morbidity, clinical anemia, skin infections, and vomiting in children.To Shaaban*et al*. (2012) supplementing vitamin E improves neurological defeats in children.The weight gain of 48.81g/day recorded in children fed HMF was slightly close to 50.23 g/day by those fed TMFs. This further demonstrates that the high nutrient quality of the home-made formula. This gain/day was higher than 6.8 g/kg/day (Friday, 2023), 8.9 ± 4.3 g/kg/day (Zongo*et al*., 2013) and 9.3 g/kg/day (Pietravalle*et al*., 2021).On the basis of weight gain WHO (2013) reported that a food is considered poor when gain is <5 g/kg per day, moderate food when weight gain is 5–10 g/kg per day and good when gain is above 10 g/kg per day.However, Tandon*et al*. (2019) reported a weight gain of 11.6% body weight in only 10.7 ± 3.5 days. The increased in mid upper-arm circumference observed in this study is also an evident that HMF food met the nutrient requirements of the malnourished pre-school children. At the close of the study a 127.50±2.04mm MUAC was released which was higher than ≥125 mm (WHO, 2013). Again, the realization of z-score -2 in the children fed HMF further confirmed the nutritional potential of the formula.

Table 4: Comparative effect of home-made formula **and therapeutic milk powderson growth** performance of**malnourished preschool children**

Parameters	Foods	Bade	Bursari	Potiskum	±SEM	P-Value
Initial weight (kg. g)	HMF	8.71	8.42	7.9	0.13	0.695
Initial weight (kg. g)	TMPs	8.28	7.96	9.65	0.12	0.695
Initial height (cm. mm)	HMF	78.9	80	81.2	0.16	0.317
Initial height (cm. mm)	TMPs	79.04	80.13	82.46	1.06	0.317
Initial MUAC (mm)	HMF	111.3	114.42	115.51	0.07	0.324
Initial MUAC (mm)	TMPs	112.53	111.01	112.10	0.07	0.324
Final weight (kg. g)	HMF	9.97	10.67	10.54	0.32	0.017
Final weight (kg. g)	TMPs	10.95	9.86	11.41	0.22	0.017
Final height (cm. mm)	HMF	84.07	83.22	83.17	0.07	0.245
Final height (cm. mm)	TMPs	84.58	83.29	83.43	0.07	0.245
Final MUAC (mm)	HMF	125.27	127.96	129.27	0.45	0.038
Final MUAC (mm)	TMPs	125.91	125.52	125.1	0.15	0.038
Wei gain (kg. g)	HMF	1.26	2.25	2.64	0.10	0.145
Weight gain (kg. g)	TMPs	2.67	1.9	1.76	0.30	0.201
Height gain (cm. mm)	HMF	5.17	3.22	1.97	0.01	0.311
Height gain (cm. mm)	TMPs	5.54	3.16	0.97	0.40	0.019
MUAC gain (mm)	HMF	13.97	13.54	13.76	1.01	0.397
MUAC gain (mm)	TMPs	13.38	14.51	13.00	0.61	0.025

Values are mean of 15 children**;** SEM= pooled standard error of mean; HMF = home-made formula; TMPs = therapeutic milk powders; MUAC = Mid-upper arm circumference.

Conclusion

It can be concluded that when food ingredients such as guinea corn, soybean and groundnut are carefully fortified with dense nutrient ingredients such as milk, sugar, vegetable oil, crayfish and multimix a high quality HMF will be obtained. The HMF has positive effect in rehabilitating malnourished children. Therefore, it is recommended as alternative to therapeutic milk powders.

Ethical approval

The home-made formula was approved by dieticians in the General Hospital Gashua, and the management of the children was done according to the specification design experts in the hospital.

Table 5 and 6 are better moved to the results instead of after the conclusion

Table 5: Summary of performance of malnourished preschool children fed home-made formula **and therapeutic milk powders**

Indicator	Foods	Mean±standard deviation
Initial weight (kg. g)	HMF	8.34±0.11
Initial weight (kg. g)	TMPs	8.63±0.25
Initial height (cm.mm)	HMF	80.03±0.33
Initial height (cm.mm)	TMPs	80.54±0.62
Initial MUAC (mm)	HMF	113.74±2.19
Initial MUAC (mm)	TMPs	110.55±0.85

Final weight (kg. g)	HMF	10.39±0.11
Final weight (kg. g)	TMPs	10.74±0.25
Final height (cm.mm)	HMF	83.49±0.16
Final height (cm.mm)	TMPs	83.77±0.83
Final MUAC (mm)	HMF	127.50±2.04
Final MUAC (mm)	TMPs	125.51±0.41
Weight gain (kg. g)	HMF	2.05±0.01 (48.81g/day)
Weight gain (kg. g)	TMPs	2.11±0.01 (50.23 g/day)
Height gain (cm.mm)	HMF	3.45±0.18
Height gain (cm.mm)	TMPs	3.22±0.05
MUAC gain (mm)	HMF	13.76±0.22
MUAC gain (mm)	TMPs	13.63±0.57

Values are Mean±standard deviation of 45 children, HMF = home-made formula; TMPs= therapeutic milk powders; MUAC = Mid-upper arm circumference.

Table 6: Weight-for-height boys/girls 2 to 3 years (Z-scores)

Parameters	Foods	Weight	Height	Z-score
Initial	HMF	8.34±0.11	80.03±0.33	-3
Initial	TMPs	8.63±0.25	80.54±0.62	-3
Final	HMF	10.39±0.11	83.49±0.16	-2
Final	TMPs	10.74±0.25	83.77±0.83	-2

Values are Mean±standard deviation of 45 children.

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