

EFFECT OF SUBSTITUTING MAIZE WITH ACHA (*DIGITARIA EXILIS*) IN WEANED ALBINO RATS FOOD IN COMPARISON WITH A COMMERCIAL INFANT FOODS ON REHABILITATION OF SEVERE MALNUTRITION

Mohammed Aishatu Zangina,¹Sudik Samuel David²Shehu Rukayya Aliyu

¹Department of Home Science and Management, Federal University, Gashua, Yobe State,

²Department of Animal Science, Federal University, Gashua, Yobe State

³Department of Home Economic, Faculty of Education, Ahmadu Bello University, Zaria

Email: aishatuzangina1@gmail.com

ABSTRACT

*At the age of six months and above breast milk is not sufficient to meet the nutritional needs of the growing infant. Single cereal usually forms the food for infant without fortification with denser ingredients. This paper aimed at determining the effect of substituting maize with acha (*Digitaria exilis*) in weaned albino rats' food in comparison with a commercial infant food on rehabilitation of severe malnutrition. Two foods were formulated by substituting the content of maize at 0% and 50% which were designated as T1 and T2 respectively. 0% maize as control. Another control was with a standard commercial infant food coded as CFC and was designated as T3. Sixty 4 weeks old albino rats were used and were randomly divided into 3 groups. Each group had 20 rats with 4 replicates of 5 rats. They were supplied with feed and water all the time. The experiment lasted for 4 weeks. The rats had similar loss of weight after fed with depleted protein food for weeks' period. The rats' live weight and daily gain after fed with protein rich foods for another 2 and 4 weeks were significantly different ($p < 0.05$). Rats fed T2 and T3 had similar live weight (110.10 ± 5.69 and $113.05 \pm 5.69g$ respectively) and higher than those fed T1 ($102.37 \pm 5.69g$). however, at 4 weeks feeding with protein rich foods, the rat fed T2 had the highest live weight ($186.00 \pm 5.00g$) while those fed T1 had lowest ($176.37 \pm 5.00g$). again, rats fed T2 had the highest daily weight gain ($6.64 \pm 0.18g$) while those fed T1 had lowest ($6.29 \pm 0.18g$). also feed consumption was also significantly different ($p < 0.05$). rats fed T1 had higher total feed intake and daily feed intake, whereas T2 and T3 had similar and lower. Again, T2 had the best feed conversion ratio (1.57 ± 0.11) followed by T3 (1.61 ± 0.11) while T1 had poor (1.78 ± 0.11). The better feed conversion ratio in T2 than T1 further suggests the better nutrient composition in mixed cereals grains than a single grain. All the organs, haematology and serum biochemical parameters studied were not significantly different ($p > 0.05$). It can be concluded that acha can replace maize in infant weaning foods by 50% without negative effects on rats.*

Keywords: *maize, acha, albino rats, commercial food, rehabilitation.*

INTRODUCTION

According to the report of NNN (2000), poor feeding and short fall of food in infant nutrition are the direct factors responsible for malnutrition and illness in most Nigeria families. This nutrition problem is ascribed to inappropriate complementary feeding practices, low nutritional quality of traditional complementary foods and high cost of quality protein-based complementary foods (FAO, 2013, Sudik *et al.*, 2019; Sudik, 2016). The tragic consequences of inadequate nutrition include death, disability, stunted mental and physical growth, and as a result, retarded national socioeconomic development. It is evidence that high prevalence of deaths each year among children aged less than five years in the developing countries are associated with malnutrition (WHO, 2003). The interaction of poverty, poor health and poor complementary feeding practices has a multiplier effect on the general welfare of children population and contributes significantly towards growth retardation, poor cognitive development, illness and death among children in developing world, including Nigeria

(Anigo *et al.*, 2007). Commercial infant foods are expensive and out of reach of the low- income population in many parts of the developing countries (Agbede, 2000; Agbede and Aletor, 2003, Ijarotimi and Keshinro, 2012); hence many families depend on inadequate process and low quality traditional complementary foods to wean their children (Agbede and Aletor, 2003). Agbede and Aletor (2004) added that food crisis in most African countries, including Nigeria aggravated the susceptibility of weanling, pre-school children and other vulnerable groups, to dietary protein and vitamins inadequacy. That these inadequacies arising from the high cost of animal proteins (milk, egg and meat) and have, in some developing countries, resulted in kwashiorkor, marasmus, infant blindness, mortality and morbidity.

According to Agbede and Aletor (2003) mother's milk, even from poorly nourished mother, usually provides an adequate source of essential nutrients needed for active growth of the infant from birth to approximately 4 months of age. However, at the age of six months and above when the child birth weight is expected to have doubled, breast milk is no longer sufficient to meet the nutritional needs of the growing infant (Solomon, 2005). The nutrition of infants becomes more challenges is when they are deprived of mother milk at weaning phase. In most cases special foods may not be made for weaned infants, they are usually served with foods that are meant for adult. Even when special foods are meant for infants they are of low nutritive values (FAO, 2004; Sudik *et al.*, 2019). Cereal-based diets such as maize pap with less or no animal-based ones are usually served to children which in part predisposing them to malnutrition (Fashakin, 1989). To improve the nutrient requirement of infants it becomes necessary to conduct a feeding trial using albino rats. Therefore, the objective of this paper was to determined effect of substituting maize with acha (*Digitaria exilis*) in weaned albino rats' food in comparison with a commercial infant food on rehabilitation of severe malnutrition

MATERIALS AND METHODS

Infant weaning foods preparation

Two infant weaning foods (designated as T1 and T2) were formulated by substituting the content of maize by 0% and 50% respectively. The 0% served as control (Table 1). A commercial infant weaning foods (coded as CFC) served as another positive control and was designated as T3. T 1 and 2 were developed taken into consideration the Codex Alimentarius Standards for foods for special children (WHO, 1994)

Experimental layout and rat management

Sixty old clinically healthy weanling albino rats of the wistar strain at 4 weeks of age were obtained from a disease free-stock in Jos Nigeria. They were subjected to protein-depletion by being offered a nitrogen-free diet for 14 days. The composition of protein depleted food shown in Table 2. On day 15 they were weighed and randomly distributed to 3 groups, each group had 20 rats with 4 replicates of 5 rats. The experimental design was of completely randomized design (CRD).

The rats were individually housed in separate cubicles in a metabolism cage (25 cm x 12 cm x 10 cm) locally designed and constructed with metals. The rats were offered their respective foods and water *ad libitum* (water available via a low-pressure drinking nipple) for 28 days. All diets were served to the rats in meal form after proper mixing. Records were kept of the weight changes and total food intake. Routine management practices were observed daily.

Table 1: Gross composition of formulated foods and recommended values (RV*)

| Ingredients | T1 | 50 | T3 |
|-----------------------|-------|-------|----|
| Maize | 74.00 | 37.00 | - |
| <i>D. exilis</i> meal | 0.00 | 37.00 | - |
| Soybean meal | 8.65 | 8.65 | - |
| Soy oil | 4.00 | 4.00 | - |

| | | | |
|-----------------------|---------------|---------------|--------|
| Powder milk | 10.00 | 10.00 | - |
| Di-calcium phosphate | 3.00 | 3.00 | - |
| Premix | 0.25 | 0.25 | - |
| Salt | 0.10 | 0.10 | - |
| Total | 100.00 | 100.00 | - |
| Nutrients | | | |
| Moisture | 4.23 | 4.35 | - |
| Total Ash | 2.22 | 2.27 | 3.00 |
| Crude protein | 15.11 | 15.18 | 15.00 |
| Crude Fat | 10.75 | 10.73 | 7.30 |
| Crude fibre | 4.03 | 4.08 | 3.30 |
| Carbohydrate | 63.66 | 63.39 | 71.40 |
| Gross energy[kcal/kg] | 411.83 | 410.85 | 410.00 |

*contained the following: (Univit. 15 Roche) 1500 I.U., Vit. A, 1500 I.U., Vit. D: 3000 I.U., Vit.E, 3.0 g; Vit, B2, 0.3 g; Vit. B6, 8.0 mg; Vit. B12, 8.0 g; Nicotinic acid, 3.0 g; Ca-Pantothenate; 5.0 mg; Fe, 10.00 g; Al, 0.2 g; Cu, 3.5 mg; Zn, 0.15 mg; I, 0.02 g; Co, 0.01 g/kg.

* WHO (2013)

Table 2: Gross composition of protein-depleted food

| Ingredients | % |
|--------------------|----------|
| Cassava starch | 92.75 |
| Premix * | 2.45 |
| Bone meal | 4.00 |
| Oyster shell | 0.50 |
| Salt | 0.30 |
| Total | 100 |

*contained the following: (Univit. 15 Roche) 1500 I.U., Vit. A, 1500 I.U., Vit. D: 3000 I.U., Vit.E, 3.0 g; Vit, B2, 0.3 g; Vit. B6, 8.0 mg; Vit. B12, 8.0 g; Nicotinic acid, 3.0 g; Ca-Pantothenate; 5.0 mg; Fe, 10.00 g; Al, 0.2 g; Cu, 3.5 mg; Zn, 0.15 mg; I, 0.02 g; Co, 0.01 g/kg.

Data collection

Feed utilization and determination of growth rate

Feed consumption was determined daily by subtracting the quantity of feed leftover from the total quantity offered. Each rat was weighed at the beginning of the experiment and subsequently after every four days. Weights were taken in the morning (8.00 - 9.00 am) for uniformity of records. The rats were weighed as replicate groups and the group weight was divided by the number of the rats to obtain the average live weight per rat. Weight gain was calculated as final weight minus initial weight, feed conversion ratio (FCR) as feed intake divided by weight gain. Feed cost per kg weight gain was calculated as FCR x cost/ kg feed.

Collection of blood and serum

At the end of the trial, all the rats were starved for 12 h to remove any residual food from the gastrointestinal tract and their live weights recorded. Before sacrifice, each rat was anaesthetized with mild chloroform vapor inside a desiccator. Blood was drained into two different bottles (i) into bottle pretreated with EDTA, carefully labeled for haematological study and (ii) into test tubes containing no anti-coagulant resulting in clotting after 3 hrs. The clotted blood samples were spun in a bench top centrifuge to obtain sera and stored in a deep freezer (-20°C) until required for the biochemical analysis (Agbede, 2000; Agbede and Aletor, 2003).

Organ weigh and measurement

The heart, lungs, spleen, kidneys and liver were excised, blotted free of blood, weighed and subsequently expressed in g/kg body weight

Statistical analysis

The data generated were analyzed using SPSS (17) software (SPSS Inc., Chicago, USA) and differences between the averages were determined by Duncan's multiple range tests of the same package. The growth of protein-depleted rat was regressed with the number of days to establish the time needed by the rats to regain lost weights.

RESULTS AND DISCUSSION

Table 3 shows the rehabilitative potential of formulated and commercial foods on rats' performance. The rats had similar loss of weight after fed with depleted protein food for weeks' period. The rats' live weight and daily gain after fed with protein rich foods for another 2 and 4 weeks were significantly different ($p < 0.05$). rats fed T2 and T3 had similar live weight (110.10 ± 5.69 and 113.05 ± 5.69 g respectively) and higher than those fed T1 (102.37 ± 5.69 g). however, at 4 weeks feeding with protein rich foods, the rat fed T2 had the highest live weight (186.00 ± 5.00 g) while those fed T1 had lowest (176.37 ± 5.00 g). again, rats fed T2 had the highest daily weight gain (6.64 ± 0.18 g) while those fed T1 had lowest (6.29 ± 0.18 g). also feed consumption was also significantly different ($p < 0.05$). rats fed T1 had higher total feed intake and daily feed intake, whereas T2 and T3 had similar and lower. The increased in weight gain in T2 than in T1 shows that substituting maize with acha gives better gain than maize as single energy source. This better performance may be attributed to the complementary effect where nutrient in acha augments that of maize. This finding is in agreement with Sudik *et al.* (2019) and Sudik (2016) who found better gain in rats fed maize plus acha based foods. The higher weights in T2 than T3 further confirms the rich nutrients when more ingredients are mixed. Feed conversion ratio was also significantly ($p < 0.05$) affected. Again, T2 had the best feed conversion ratio (1.57 ± 0.11) followed by T3 (1.61 ± 0.11) while T1 had poor (1.78 ± 0.11). The better feed conversion ratio in T2 than T1 further suggests the better nutrient composition in mixed cereals grains than a single grain.

Table 4 shows the organs weight of rats fed formulated and commercial infant foods. All the organs studied were not significantly different ($p > 0.05$). Table 5 shows the haematology of rats fed formulated commercial infant foods. Also, all the parameters studied were not significantly different ($p > 0.05$). Table 6 shows the serum biochemical parameters of rats fed formulated commercial infant foods. Also, all the parameters studied were not significantly different ($p > 0.05$). The insignificant different in the organs and blood parameters signifies the wholesomeness of the

Table 3: Rehabilitative potential formulated and commercial infant foods on rats' performance

| Parameters | T1 | T2 | T3 | ±SEM | P- value | LOS |
|--|---------------------|---------------------|---------------------|-------|----------|-----|
| Initial weight (g) | 101 | 101 | 102 | 0.58 | 0.001 | NS |
| Depleted weight (g) | 40.54 | 40.12 | 40.94 | 0.41 | 0.001 | NS |
| weight at 2 weeks (g) | 102.37 ^b | 110.10 ^a | 113.05 ^a | 5.69 | 0.001 | * |
| weight at 4 weeks (g) | 176.37 ^c | 186.00 ^a | 181.00 ^b | 5.00 | 0.001 | * |
| Average weight gain (g/day ⁻¹) | 6.29 ^c | 6.64 ^a | 6.46 ^b | 0.18 | 0.001 | * |
| Total feed consumption (g) | 313.84 ^a | 292.04 ^b | 290.6 ^{b4} | 13.01 | 0.913 | * |
| Average feed consumption(g/day ⁻¹) | 11.2 ^{a1} | 10.43 ^b | 10.38 ^b | 0.46 | 0.914 | * |
| Feed conversion ratio | 1.78 ^a | 1.57 ^c | 1.61 ^b | 0.11 | 0.001 | * |

formulated foods in comparison with the commercial foods. It implies that substituting maize with acha have not negative effect on rats.

Table 4: Organs weight of rats fed formulated and commercial infant foods

| Parameters | T1 | T2 | T3 | ±SEM | P- value | LOS |
|------------|-------|-------|-------|------|----------|-----|
| Heart | 5.11 | 4.92 | 4.95 | 0.10 | 0.981 | NS |
| Lungs | 10.40 | 10.36 | 10.55 | 0.10 | 0.991 | NS |
| Spleen | 4.48 | 4.43 | 4.88 | 0.25 | 0.991 | NS |
| Kidneys | 8.2 | 8.30 | 8.51 | 0.16 | 0.999 | NS |
| Liver | 38.10 | 38.19 | 37.56 | 0.34 | 0.976 | NS |

Values are means for 20 rats /diet, ±SEM = standard error of mean, means with differing superscripts in the same columns are significantly (P<0.05) different.

Table 5: Hamatology of rats fed formulated commercial infant foods

| Parameters | T1 | T2 | T3 | ±SEM | P- value | LOS |
|---|-------|-------|-------|------|----------|-----|
| Packed cell volume (%) | 38.60 | 38.60 | 42.07 | 2.00 | 0.026 | NS |
| Red blood cells (x10 ⁶ mm ³) | 9.39 | 9.39 | 9.84 | 0.26 | 0.021 | NS |
| White blood cells (x10 ³ mm ³) | 6.45 | 6.45 | 6.62 | 0.10 | 0.890 | NS |
| Haemoglobin (g/100ml) | 14.20 | 14.20 | 14.26 | 0.03 | 0.866 | NS |
| Mean cell volume (μ ³ m) | 52.39 | 52.39 | 51.58 | 0.47 | 0.899 | NS |
| Mean cell haemoglobin (pg) | 14.86 | 14.86 | 15.12 | 0.15 | 0.899 | NS |
| Mean cell haemoglobin concentration (%) | 33.45 | 33.45 | 33.32 | 0.08 | 0.899 | NS |
| Lymphocytes (%) | 64.20 | 64.20 | 63.40 | 2.19 | 0.789 | NS |
| Neutrophils (%) | 25.80 | 25.80 | 26.60 | 0.46 | 0.999 | NS |
| Monocytes (%) | 6.60 | 6.60 | 6.60 | 0.00 | 0.899 | NS |
| Eosinophil (%) | 2.00 | 2.00 | 2.00 | 0.00 | 0.999 | NS |

Values are means for 20 rats /diet, ±SEM = standard error of mean, means with differing superscripts in the same columns are significantly (P<0.05) different.

Table 6: serum biochemical parameters of rats fed formulated commercial infant foods

| Parameters | T1 | T2 | T3 | ±SEM | P- value | LOS |
|----------------------------------|-------|-------|-------|------|----------|-----|
| Total protein (g/100g) | 35.46 | 35.60 | 38.53 | 1.73 | 0.781 | NS |
| Albumen (g/100g) | 27.81 | 27.87 | 28.02 | 0.11 | 0.673 | NS |
| Globulin (g/100g) | 7.65 | 7.73 | 10.51 | 1.63 | 0.566 | NS |
| Albumen/globulin | 3.64 | 3.61 | 2.67 | 0.55 | 0.991 | NS |
| Alkaline aminotransferase (μ/DL) | 9.31 | 9.33 | 9.26 | 0.04 | 0.999 | NS |
| Aspartic aminotransferase (μ/DL) | 12.40 | 12.27 | 12.27 | 0.08 | 0.988 | NS |
| Cholesterol (mg/100ml) | 18.68 | 18.16 | 18.20 | 0.29 | 0.014 | NS |

Values are means for 20 rats /diet, ±SEM = standard error of mean means with differing superscripts in the same columns are highly significantly (P<0.01) different.

CONCLUSION

The substitution of maize with acha by 50% improved weight gains and feed conversion ratio. It had no deleterious effect on organs and blood parameters. Therefore, can be suggested that acha can replace maize and also acha based food gives similar results like commercial infant food.

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