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Research Article

Formulation and Nutritional Evaluation of Cereal Based Complementary Food

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Abstract

Globally, study revealed that, Nigeria loses about 2,300 under-five year olds and 145 women of child-bearing age, making the country the second largest contributor to under-five and maternal mortality rate in the world. The purpose of the study is to formulate and determine Nutritional composition of Cereal based complementary food that will have adequate nutrient to prevent children and infants mortality. The Cereal based complementary food composed of Sorghum 70% Soybean 30% (SS), Millet 70% Soybean 30% (MS), Sorghum 35% Millet 35%, Soybean 30% (SMS); Basal Dietary (BD); and Commercial Food (CF). The result revealed that that bioassay of the experimental animal Biological value (BV %)-ranged from 66 - 75% Net protein utilization (NPU%) 64 - 72, Protein Efficiency Ratio (PER) 1.2 - 4.2 and NPR 1.7 - 3.3 were compared favourably with commercial samples. Chemical composition in the sample dietary met the recommended daily requirement. In conclusion raw material to produce cereal based complementary food is available for baby and infant in most part of the developing countries. Millet grain containing dietary promoted the growth response next to commercial diet. It contains alkaline content which could improve human health; it is gluten-free, rich in micronutrients that play certain roles in the body immune system. Millets containing dietary is reported to act as antioxidants which can prevent deterioration of human health, also noted for some ailment prevention, like lowering blood pressure, risk of heart disease, prevention of cancer, cardiovascular diseases, diabetes, decreasing of tumor.

Keywords: *Cereal; Millet; Sorghum; Soybean; Complementary Food*

Introduction

Infant deaths accounted for Ten per cent (10%) of new-born deaths in the world last year occurred in Nigeria, a new report by the United Nations Children Fund; (UNICEF), has revealed. World Health Organization [1,2]: confirmed that five countries accounted for half of all new-born deaths last year, with Nigeria third in the list. According to the report, India is ranked (24%), Pakistan (10%), Nigeria (9%), the Democratic Republic of the Congo (4%) and Ethiopia (3%) [3]. Alarming report, new-born deaths occurred in two regions: Southern Asia (39%) and sub-Saharan Africa (38%) respectively. The report showed that 15,000 children died globally before their fifth birthday in 2016, with 46 per cent of the deaths (7.000) occurring in the first 28 days of life [1,2]. In a new study of World Health Organization entitled: "Levels and Trends in Child Mortality 2017 (WHO) 2018". The study revealed that although the number of children dying before the age of five is reduced to 5.6 million in 2016 compared to nearly 9.9 million in 2000 - the proportion of under-five deaths in the new-born period has hiked up to 41 per cent to 46 per cent during the same period [1]. Similar report by UNICEF also said though the lives of 50 million children under-five have been saved since 2000 through increased level of commitment by governments and development partners to tackle preventable child deaths, more still needs to be done to stop babies from dying the day they are born, or days after their birth. Joint report released by UNICEF, the World Health Organization, the World Bank and the Population Division of UNDESA, which make up the Inter-agency Group for Child Mortality Estimation (IGME), speculated that at current trends, 60 million children, will die before their fifth birthday between 2017 and 2030, half of them new-borns [1,2,4]. The Nigerian Minister of Health confirmed the high mortality rate of under-five in the country as frustrating and unacceptable and significant effort are made in reducing the rate of new-born deaths in the country as it has declined from 201/1000 live births to 128/1000 live births in 2013 [3]. The best measure of success for Universal Health Coverage is that every mother should not only be able to access health care easily, but that it should be quality, affordable care that will ensure a healthy and productive life for her children and family [3]. Preventable child deaths can be achieved by improving access to skilled health-professionals during pregnancy and at the time of birth; lifesaving interventions, such as immunization, breastfeeding and inexpensive medicines; and increasing access to water and sanitation giving adequate and balance dietary [3]. In most part of Africa, cereals supplies are amount to 80% of the energy requirements. Major cereals cultivate in Nigeria include rice, sorghum, maize, and pear millet; they are rich in carbon-hydrate but comparatively low in protein and naturally deficient in calcium and vitamin [5,6]. However many scenario are attribute to infant mortality such as poor distribution of food in the family, taken poor protein, seasonal or severe shortage of food, poor supply of legumes, taboos and cultural practice, poor infant feeding practice (breast) and poverty [7-11], Hence, the need for this research to formulate and determine Nutritional composition of Cereal based complementary food as a succor to reduce child and maternal mortality rate in Nigeria.

Materials and Methods

Some of the cereals used as source of energy in this experiment include maize, sorghum and millet. Source of protein include soybean, milk based commercial food were purchased from urban market in Ile-Ife, Nigeria.

Chemical analysis

The chemical analysis included Protein (nitrogen x 6.25), moisture, fat, crude fibre and carbohydrate of the ingredients, formulated diets and the nitrogen contents of the internal organ were determined according to AOAC (2005). Energy value was determined using Combustion calorimeter, model e2K [12-14].

Experimental animal procedure

Fifty white Wister strain albino rats were procured from animal breeding centre they were ranged from 46.55 - 47.68-g. They were four weeks old. The experimental animals were weighed randomly selected and distributed into five groups of ten per group and was housed in a metabolic cage [15,16]. They were fed on animal feeds (finisher) for seven days to acclimatize them to the new environment. The experimental animals were again reweighed and distributed into five groups of ten per group. 10g of supplements dietary were supplied daily. Remnants of the dietary samples were carefully recorded and the weights were noted. Weight gain/loss of the experimental animals was taken every three days and graphically sketched as in figure 1. At the end of the experiment, which was twenty-eight days, the experimental animals were anesthetized sacrificed. The organs collected from the animal were spleen, heart lungs kidney liver and small intestine were fixed immediately in 10% formyl saline for further experiment such as Nitrogen retention [7,8,15-23].

The food efficiency ratio (FER), Protein efficiency ratio (PER), the net protein retention (NPR) and protein retention efficiency (PRE) were calculated using the formula given below.

$$\text{The food efficiency ratio (FER)} = \frac{\text{Gain in body weight (g)}}{\text{Food intake (g)}}$$

$$\text{Protein efficiency ratio (PER)} = \frac{\text{Weight gain of test animal (g)}}{\text{Protein consumed by the test animal (g)}}$$

$$\text{Net protein retention (NPR)} = \frac{\text{Weight gain of test animal (g)+Average Weight Loss of Animal}}{\text{Protein consumed by the test animal (g)}}$$

Protein retention efficiency (PRE) = NPRX16

$$\text{Feed Conversion ratio was determined by} = \frac{\text{Feed Consumed (g)}}{\text{Gain in body weight (g)}}$$

Ethical consideration

Fifty white albino rats were approved for the experiment by the Animal Ethical Welfare Review Committee of the Obafemi Awolowo University, Osun State, Ile-Ife, Nigeria.

Results and Discussion

Figure 1 represented experimental Animal growth response for 28 days. The growth responses by experimental Animal were progressive by weight gained for dietary CF is 42.2g, MS is 32.2g, SMS is 19.22g and SS is 16.36g, but BD is declining by 3.2g. This shows that dietary experimental Animal growth contain essential nutrient such as complete amino acid profile [7,8,17-21,24-26].

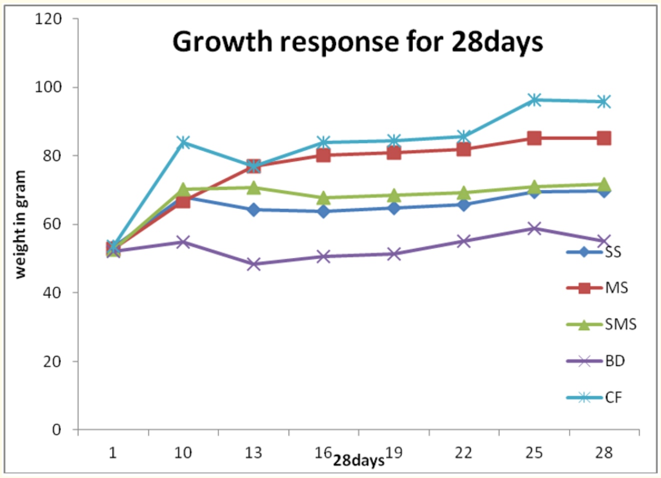

Figure 1: *Animal experimental growth for 28 days.*
Sorghum 70% Soybean 30% (SS), Millet 70%, Soybean 30% (MS), Sorghum 35%, Millet 35%, Soybean 30% (SMS), Basal Dietary (BD) and Commercial Food (CF).

Table 1 showed the proximate composition of the Formulated Dietary samples such as protein, it ranged from 15.34 - 16.01% moisture ranged from 2.5 - 5.68%, fat ranged from 0.50 - 10%, ash ranged from 11.45 - 2.30%, crude fibre ranged from 0.76 - 2.30%, dry matter ranged from 94.32 - 97.50% and Energy ranged from 364 - 413 Kcal%. The dietary formulation met the recommended daily intake and support animal growth fed with formulated sample dietary but BD could not support growth for lack of essential protein as earlier reported for lack of essential amino acid such as lysine and tryptophan hence could not support growth [7,8,19-21,24,27].

Dietary	Protein%	Moisture%	Fat%	Ash%	Crude Fibre %	CHO%	Dry matter %	Kcal (Kcal)
SS	15.87 ± 01	5.53 ± 00	2.4 ± 02	1.45 ± 03	1.50 ± 01	73.25 ± 00	94.47 ± 02	383 ± 01
MS	15.30 ± 01	4.86 ± 01	0.35 ± 01	2.36 ± 02	0.80 ± 01	76.33 ± 03	95.14 ± 03	398 ± 01
SMS	15.34 ± 00	3.50 ± 03	0.56 ± 02	1.80 ± 01	0.78 ± 02	78.02 ± 02	96.50 ± 02	378 ± 02
BD	-	5.68 ± 01	0.50 ± 01	2.10 ± 00	0.76 ± 01	90.96 ± 01	94.32 ± 01	364 ± 03
CF	16.01 ± 02	2.50 ± 03	10 ± 01	4.30 ± 00	2.30 ± 00	64.89 ± 00	97.50 ± 00	413 ± 01

Table 1: *Proximate composition (%) of the formulated Dietary sample and basal Dietary*

Mean ± SD values of five replicates ($p \geq 0.05$); Sorghum 70% Soybean 30% (SS), Millet 70%, Soybean 30% (MS), Sorghum 35%, Millet 35%, Soybean 30% (SMS); Basal Dietary (BD) and Commercial Food (CF).

Table 2 is a portrait of the nitrogen retention in various tissues of the internal organ of the experimental animal; liver, kidney and muscle. They are ranged from 18.34 - 72.04, 18.36 - 72.08 and 64.66 - 72.06 respectively. Commercial Food (CF) promoted the highest growth rate, followed by millet containing dietary such as Millet 70% Soybean 30% (MS), Sorghum 35% Millet 35%, Soybean 30% (SMS) also promoted the growth response similar to commercial diet. This is because Millet grain reported contains alkaline content it is gluten-free, rich and micronutrients that play certain roles in the body immune system. Millets is also reported to contain high amount of antioxidants which can prevent deterioration of human health [26,28]. Millets is noted for some ailment prevention like lowering blood pressure, risk of heart disease, prevention of cancer, cardiovascular diseases, diabetes, decreasing of tumor. Alkaline based diet is often recommended to achieve optimal health. In developing countries, cereal-based foods have low bioavailability of minerals like iron, zinc initiate critical problem for infants and young children. Food processing techniques are used to enhance nutritional quality, improve the digestibility and bioavailability of food nutrients with reducing anti-nutrients [24,28,29].

Dietary	Kidney mg/g	Liver mg/g	Muscle mg/g
SS	65.30 ± 02	66.56 ± 01	64.66 ± 00
MS	70.66 ± 01	70.64 ± 02	70.68 ± 03
SMS	68.30 ± 02	64.56 ± 03	65.66 ± 04
BD	18.34 ± 01	18.36 ± 02	18.30 ± 01
CF	72.04 ± 01	72.08 ± 04	72.06 ± 03

Table 2: *The nitrogen retention in various tissues of the internal organ,*

Mean ± SD values of five replicates (p ≥ 0.05); Sorghum 70% Soybean 30% (SS), Millet 70%, Soybean 30% (MS), Sorghum 35%, Millet 35%, Soybean 30% (SMS); Basal Dietary (BD) and Commercial Food (CF).

Dietary	Liver (g)	Kidney (g)	Body weight (g)	Gained (g)/loss
SS	2.80 ± 01	0.63 ± 02	70.86 ± 01	16.36 ± 02
MS	2.86 ± 00	0.73 ± 03	84.36 ± 01	32.2 ± 03
SMS	3.43 ± 03	0.66 ± 00	79.63 ± 02	19.22 ± 04
BD	2.8 ± 02	0.45 ± 01	58.25 ± 02	3.2 ± 02
CF	5.1 ± 01	0.80 ± 01	104.06 ± 00	42.2 ± 01

Table 3: *Nitrogen retention of the experimental animal.*

Mean ± SD values of five replicates (p ≥ 0.05); Sorghum 70% Soybean 30% (SS), Millet 70%, Soybean 30% (MS), Sorghum 35%, Millet 35%, Soybean 30% (SMS), Basal Dietary (BD) and Commercial Food (CF).

Table 4 reflected the Bioassay of the experimental animal Bioassay BV 75 - 66%, NPU 64 - 72%, PER 1.6 – 42, FER 1.6 - 4.2 and NPR 1.7 - 4.3, BD lacked biological value hence could not promote growth but Commercial food (CF) had the highest value, a bit lower than of white egg. It was followed by millet based dietary (MS) and SS and SMS [7,8,15-2124,30].

Diet	BV %	NPU%	PER	NPR	Gained/loss
SS	66 ± .01	64 ± 0.2	1.6 ± 0.2	1.7 ± 0.3	16.36 ± 0.3
MS	73 ± 00	70 ± .1	3.2 ±	3.3 ±	32.2 ±
SMS	66 ± 00	65 ± .01	1.9 ± .02	2.0 ± .02	19.22 ± 01
BD	-	-	-	-	-3.2 ± 01
CF	75 ± 0	72 ± .0	4.2 ± 01	4.3 ± 02	42.2 ± 0

Table 4: *Bioassay of the experimental animal Bioassay BV % NPU% PER and NPR*

Mean ± SD values of five replicates (p ≥ 0.05); Sorghum 70% Soybean 30% (SS), Millet 70%, Soybean 30% (MS), Sorghum 35%, Millet 35%, Soybean 30% (SMS), Basal Dietary (BD) and Commercial Food (CF).

Conclusion

In conclusion cereal based complementary diet are produced from staple food are available for baby and infant in most part of the country. Millet grain containing diets promoted the experimental animal growth response similar to commercial diet. It contains alkaline content which could improve human health; it is gluten-free, rich in micronutrients that play certain roles in the body's immune system. Millets containing diet is reported to act as antioxidants which can prevent deterioration of human health and also noted for some ailments prevention, like lowering blood pressure, risk of heart disease, prevention of cancer, cardiovascular diseases, diabetes, decreasing of tumor.

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