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Nutritional evaluation of formulated *Arachis hypogea* L. and *Anacardium occidentale* L. supplemented feeds in weaning albino rats

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Abstract

Malnutrition is still a serious public health problem in developing countries including Nigeria. This may be attributed to the deficiency of vital nutrients, especially in weaning foods for infants. The current study evaluated the nutritional importance of two formulations: *Arachis hypogea* and *Anarcardium occidentale* supplemented feeds in weaning rats. The proximate composition analysis of the formulated *Arachis hypogea* and *Anarcardium* supplemented feeds contained significantly (P<0.05) high amounts of carbohydrates, lipids and proteins. There were also significantly (P<0.05) high levels of amino acids; lysine, arginine, methionine, histidine, leucine, tryptophan and phenylalanine, compared to the control. A total of 15 weaned albino rats were used in the experiment. The animals were divided into three groups; A, B and C. Group A was fed with standard feed while Groups B and C were fed with *Arachis hypogea* and *Anarcardium occidentale* supplemented feeds respectively, for 21 days, after which the blood samples were collected for biochemical and hematological assays using standard methods. The level of glucose, total proteins, albumin and globulin were significantly higher (P<0.05) compared to the control. The results of hematological parameters indicated significantly (P<0.05) increased packed cell volume (PCV), red blood cells (RBC), hemoglobin (HB) and platelets (PLT), when compared to the control. These results indicated the nutritional significance of the two formulated feeds for complementation in weaning foods and infants' nutrition.

Keywords: Nutritional evaluation, Weaning, Feed, *Arachis hypogea, Anarcardium.*

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INTRODUCTION

Malnutrition refers to deficit or imbalance of nutrients' requirement for growth and development of the body. Body mass index (BMI) is used as an indicator of risk of an individual being over or under nourished (Stratton *et al.*, 2003). Malnutrition is the major cause of multiple illnesses commonly observed in children in developing countries (Michael *et al.*, 2022). Ground nut and cashew are leguminous cash crops widely cultivated and well known for their high protein contents. Consumption of food products obtained from cashew nut and groundnut has positive effect on lipoprotein and total cholesterol (Polmann *et al.*, 2022). Nutritionally, peanut contains high amount of protein, fatty acid, essential amino acid, micronutrients and essential oil (Abubaker *et al*., 2021).

Protein - energy malnutrition is the nutritional deficiency resulting from either inadequate protein or carbohydrate intake which may lead to manifestation of either Marasmus or Kwashiorkor. Kwashiorkor occurs due to protein-calorie deficiency while marasmus occurs due to calorie-energy deficiencies. Marasmus can be characterized by wasting of body tissues, particularly muscles and subcutaneous fat, and usually occurs because of severe restrictions in energy intake (Pollit *et al.*, 1995). Kwashiorkor affects mainly children and is associated with |oedema, usually a result of severe restrictions in protein intake (Walker, 1990). Kwashiorkor and marasmic children experience profound immune impairment, reduced protein levels and catabolism, compromised intestinal barrier, uncontrolled oxidative stress and exhaustion of anaerobic commensals (Michael *et al.*, 2022). However, both the two types of malnutrition can be present simultaneously (marasmic - kwashiorkor) due to oedema (Latham *et al.*, 2011). At the local level, causes of under-nutrition are complex and could be due to inadequate weaning diets, poor nutritional status of a child, diseases or illness caused by improper timing of weaning foods (Walker, 1990). Economic status, poverty and food insecurity of a society immensely prevent accessibility of nutritious diets. Dietary formulation has been highly effective in the treatment and management of various forms of acute malnutrition such as kwashiorkor and marasmus (Latham *et al.*, 2011). To the best of our knowledge, the relevance of the formulated *Arachis hypogeal* and *Anarcardium occidentale* complemented feeds in weaning rats has not been reported. The present study, therefore, evaluated the nutritional value of *Arachis hypogaea* and *Anarcardium occidentale* based food formulations, supplemented to the weaned albino rats.

MATERIALS AND METHODS

Sample Collection

Arachis hypogaea and *A. occidentale* were obtained from Central market and Kwalkwalawa village, Sokoto State on 15th March, 2019. The two samples were authenticated and voucher Nos; UDUH/ANS/01 and UDUH/ANS/0263 for *A. hypogaea* and *A. occidentale* were obtained. Samples were deposited in the Herbarium unit, Department of Biological Sciences, Usmanu Danfodiyo University Sokoto for record purposes.

Chemicals and Reagents

Chemicals of analytical grade were used for the study. Nitric acid was obtained from CICA Tokyo, Japan while Ferric Chloride was purchased from East Anglia Chemical Company Limited U.S.A.

Samples Preparation

Three kilograms (3 kg) of *Arachis hypogea* sample was washed, roasted and husks separated before being pulverized with an electric grinding machine to form the pellets. *Anarcardium occidentale* (3 kg) was sundried for the period of 2 days to remove excess moisture, stew roasted, shell cut, and the roasted cashew kernel was ground into powder using sterile electric grinding machine.

Proximate Composition Analysis

The percentage crude moisture, crude protein, fat, fibre and ash were determined using the methods of the Association of Official Analytic Chemist (AOAC, 1980).

Amino Acid Composition Analysis

The Amino acids profile of the samples was determined using methods described by (Benitez, 1989). The samples were dried to constant weight, defatted, hydrolyzed, evaporated in a rotary evaporator, and loaded into the Applied Biosystems PTH Amino Acid Analyzer. Amino acids concentration was determined in gram/100g protein.

Experimental Animals

The study was conducted in accordance with the international best practices for the care and use of laboratory animals. Fifteen (15) weaned albino rats aged 3 weeks (21 days) were obtained from Department of Biological Sciences, Usmanu Danfodiyo University Sokoto. The rats were allowed to acclimatize for 7 days in well ventilated cages prior to the experiment.

Animal study

The animals were randomly divided into three groups of 5 rats each. Group A served as the control, and was given 100% commercial rat feed, Group B were fed with 50% pelleted groundnut, Group C were fed with 50% pelleted cashew nut. The experiment was conducted for a period of 3 three weeks (21 days), after which the animals were sacrificed, and the blood samples were collected and centrifuged at 4000 rpm for 5 min, serum was then collected using sterile Pasteur pipette for biochemical and hematological indices assays.

Analysis of Biochemical Parameters

Total protein was analyzed according to Henry and Stobel (1957). Serum albumin concentration was determined by BromoCresol Green (BCG) method (Doumas and Biggs, 1972). Globulin was determined by taking the difference between total protein and albumin (Turnwald and Barta, 1989).

Hematological Parameters Assay

Packed cell volume was analyzed by hematocrit method (Linne and Ringsrud, 1999). Hemoglobin and white blood cells were determined by Cyanmethemoglobin method (Drabkin and Austin, 1932) and Neubauer Hemocytometer (Turgeon, 2016).

Statistical Analysis

The results were analyzed using Analysis of Variance (ANOVA) with INstat3 software (SanDiago, USA). Values were expressed as mean ± standard deviation (SD). Differences in mean (±SD) were considered significant at $p<0.05$.

RESULTS

The results of proximate composition of formulated groundnut and cashew nut feeds are presented in Table 1. The result indicated significantly low levels ($P< 0.05$) of moisture content and crude fiber in feeds B and C when compared with Control feed A. Also, significant amount of lipid content was observed in B and C in comparison with the control. There was a significantly higher ash content in B while crude protein was not significant between the feeds. Crude carbohydrate content was significantly high in the two supplemented feed formulations.

Table 1: Proximate composition of formulated *Arachis hypogaea* and *Anarcardium occidentale* supplemented feeds.

Feed	Moisture content (%)	Lipid content (%)	Ash content (%)	Crude fiber (%)	Crude protein (%)	Crude carbohydrate (%)
Control	$9.3±0.14^{b}$	$17.4±0.09^{b}$	$6.9±0.02^{b}$	$46.4±0.04^{d}$	$13.8±0.67^{a}$	$5.8±1.04^{d}$
A. hypogea	$0.9±0.35^{c}$	$48.1±0.07^{c}$	$18.1±0.04^{c}$	$1.5±0.02^{e}$	$16.2±1.25^{a}$	$15.2±2.13^{a}$
A. occidentale	$1.2±0.56^{c}$	$48.2±0.04^{c}$	$3.2±0.02^{d}$	$9.7±0.02^{f}$	$16.71±1.12^{a}$	$21.0±1.25^{b}$

Mean values with different superscript in a row are significantly different at $P< 0.05$

The result of the amino acid composition of *A. hypogea* and *A. occidentale* feeds is presented in Table 2. It was observed that ten (10) essential amino acids were present in all the feeds with discernable difference in concentrations among the groups.

Body Weight changes of rats fed with the formulated *Arachis hypogaea* and *Anarcardium occidentale* complemented feeds.

The result of the body weight changes in rats fed with groundnut and cashew nut complemented feeds is presented in Table 3. When compared with their initial body weight at week 0, it appeared that there is significant increase ($p < 0.05$) in body weight progressively from week 1 to 3 among the groups.

Biochemical Profile

The result of some biochemical parameters in rats fed with the formulated *Arachis hypogaea* and *Anarcardium occidentale* complemented feeds are presented in Table 4. The results show that there is significantly high ($P<0.05$) total protein among groups B and C compared with the control. Similarly, Albumin and glucose were significantly high ($P<0.05$) while Urea content was not significant as compared with the control.

Haematological Indices

The result of hematological indices of rats fed with the formulated *Arachis hypogaea* and *Anarcardium occidentale* complemented feeds is presented in Table 5. The result indicated significantly high levels ($P< 0.05$) of Red Blood Cells (RBC), Packed Cell Volume (PCV), Hemoglobin (HB) and Platelets (PLT) among the treated groups.

Table 2: Amino acid profiles of formulated *Arachis hypogea* and *Anarcardium occidentale* supplemented feeds.

Amino acids (g/100g protein)	FEEDS		
	A	**B**	**C**
Lysine	3.29	4.14	3.76
Methionine	1.23	1.28	1.44
Leucine	7.00	6.89	6.36
Isoleucine	2.88	2.62	3.40
Arginine	6.02	8.00	8.09
Tryptophan	0.79	0.73	1.21
Cystiene	0.85	0.73	1.33
Histidine	2.04	2.17	2.36
Aspartatic acid	7.38	10.3	8.19
Serine	3.02	3.73	4.00
Glycine	3.18	4.56	3.09
Theorine	2.16	4.05	3.55
Glutamic acid	10.6	15.1	14.2
Alanine	3.41	3.87	3.34
Valine	3.21	2.98	3.57
Phenyalanine	3.37	3.37	3.81
Proline	3.25	3.04	3.65
Tyrosine	3.27	3.27	3.10

Table 3: Body Weight changes of rats fed with the formulated *Arachis hypogaea* and *Anarcardium occidentale* supplemented feeds

Groups	Week 0 (g)	Week 1 (g)	Week 2 (g)	Week 3 (g)
A	52.1±1.95	59.3±5.89^{a}	78.8±3.56^{b}	90.7±2.45^{c}
B	59.7±3.46	91.8±3.80^{a}	111.4±4.96^{b}	128.4±5.79^{c}
C	70.6±2.13	93.1±3.56^{a}	114.8±4.23^{b}	130.6±4.60^{c}

Mean values with different superscript in a row are significantly different at P< 0.05

Table 4: Biochemical parameters of rats fed with the formulated *Arachis hypogaea* and *Anarcardium occidentale* supplemented feeds.

Groups	Total protein (g/dl)	Albumin (g/dl)	Urea (mmol/L)	Glucose (mmol/L)
A	5.7±0.87^{a}	0.5±0.06^{b}	42.8±3.77^{c}	2.2±0.47^{c}
B	7.8±0.08^{b}	0.5±0.04^{b}	43.4±2.59^{c}	2.6±0.25^{c}
C	7.6±0.14^{b}	1.2±0.31^{a}	42.4±2.66^{c}	1.9±0.64^{b}

Mean values with different superscript in a row are significantly different at P< 0.05

Table 5. Plasma hematological indices of rats fed with the formulated *Arachis hypogaea* and *Anarcardium occidentale* supplemented feeds.

Groups	PCV (%)	HB (g/dl)	RBC (10^{6}/µl)	WBC (10^{3}/ µl)	PLT (10^{3}/ µl)
A	39.4±1.23^{b}	9.9±0.71^{b}	5.4±0.34^{b}	9.8±1.31^{d}	436.6±70.0^{d}
B	44.0±1.34^{a}	12.2±0.35^{a}	6.4±0.26^{a}	5.8±1.43^{e}	673.0±46.5^{e}
C	51.6±0.61^{a}	12.7±0.41^{a}	6.0±0.13^{a}	5.1±1.02^{f}	586.4±28.2^{a}

Mean values with different superscript in a row are significantly different at P< 0.05

DISCUSSION

Protein-energy malnutrition (PEM) is a form of malnutrition that describe pathological conditions arising from coincidental lack of dietary protein and/or energy (calories) in varying proportions resulting in the pathogenesis of Kwashiorkor or Marasmus. Moreover, lack of adequate breast feeding or giving inappropriate diluted formulas, improper complementary feeding, poverty, ignorance, infections, and diseases are among the etiological factors that encourage malnutrition. Adequate amounts of amino acids in infants' diets are required for normal growth and maintenance of good health, and that excessive intake may have negative effect on immature kidney and liver (Wickland *et al.*, 2022).

In this study the supplementation of weaned albino rats with groundnut and cashew nut increases crude and total proteins. The quantity and quality of protein in complementary feeding is very vital for rapid growth and development of children. Proteins are essential constituents of all body tissues. They are therefore extremely important in early life, infants and young children should consume about 16g of protein daily, a 150g meal of the complementary foods will satisfy 100% of their protein needs. Therefore, the two nuts under investigation would satisfy the protein demand of infants and young children. The formulated *Arachis hypogea* and *Anarcardium occidentale* feeds showed significantly ($p<0.05$) decreased moisture contents of 0.9% and 1.2% respectively. Low moisture content minimizes microbial growth and ensure better storage stability and shelf life (Walker, 1990).

Consumption of the formulated *Arachis hypogea* and *Anarcardium occidentale* complemented feeds significantly increased the lipid/fat content and this indicated that the two nuts may serve as excellent sources of fats and lipids. The high oil content in foods meant for infants and young children will increase the energy density and facilitate absorption of fat-soluble vitamins as well as play significant role in maintenance and integrity of biological membrane, as well as provide essential fatty acids for optimal neurological and immunological developments in children (Temple *et al.*, 1996).

The supplementation of the formulated feeds to the weaned rats revealed adequate concentration of essential amino acids in comparison with the control. Amino acid content of foods is very important in infant and young children nutrition, particularly in low-income countries where protein energy malnutrition has remained a serious public health problem (Sanni *et al.*, 2008). The progressive increase in body weight of the experimental rats among the treated groups during the feeding period and total protein increase in the experimental rats was due to the ingestion of the solid protein from the *Arachis hypogeal* and *Anarcardium occidentale* complemented feeds. The values of hematological parameters indicated availability of nutrients for synthesis of blood cells. The result indicated significantly high levels of hemoglobin, pack cell volume, red blood cell and platelets.

CONCLUSION

The current study established the nutritional qualities of the *Arachis hypogea* and *Anarcardium occidentale*. The two feeds formulation could serve as the sources of adequate essential amino acids, carbohydrate, protein and fats and oils. These findings, therefore, could provide a basis for the development of acceptable complementary foods that can supplement the required essential nutrients and thereby, minimize protein energy deficiency conditions. A shortcoming with the study is however, failure to combine feeds B and C together in the experimental setup for synergistic effect. Therefore, recommended for future investigation

Conflict of interest

Authors have no conflict of interest to declare

Author contribution

SS contributed in the conception and design of the study, gave final approval of the version to be published. IA contributed in acquisition, analysis and interpretation of data, agrees to be accountable for all aspects of the work for accuracy. AH substantially helped in drafting the manuscript. WRSU critically revised the manuscript for intellectual content. SSS appropriately investigated and resolved questions related to integrity of any part of the work. All the authors have read and agreed on the final manuscript.

REFERENCES

A.O.A.C 1980. Official method analysis. 13th (eds) Association of official Analytical chemist. Washington. D.C.

Abubakar, M.L., Zubair, J. I., Adeyemi, K. D., Kareem, O. L., Zaharadeen, M. L., Usman, A.M., and Sani, D. (2021) Influence of *Moringa oleifera.* L. and *Adansonia digitata l.* leaf meals on performance and egg quality characteristics of Amok layers. *Nigerian Journal of Animal Science,* **23**(1):173- 182

Benetez, L.V. (1989). Amino acid and fatty acid profiles in aquaculture nutrition studies. In S.S. De Silva (Ed). Fish Nutrition Research in Asia: Proceedings of the third Asian Fish Nutrition Network meeting (pp. 23-35). Manila, Philippines: *Asian Fisheries Society*.

Doumas, B.T. and Biggs H.G. (1972) Determination of serum albumin: In standard methods of clinical chemistry (Cooper G.A.) Academic press Inc. New York 1:175.

Drabkin, D.L. and Austin, J.H. (1932) Spectrophotometric Studies: I. Spectrophotometric constants for common haemoglobin derivatives in human, dog, and rabbit blood.

Journal of Biological Chemistry, **98**: 719-733.

Henry, R.J. and Stobel, C. (1957). Determination of serum protein by Biuret reaction. *Analytical Chemistry*. **92:**1391.

Latham, M., Jonsson, U., Sterken, E. and Kent, G. (2011). RUTF stuff. Can the children be saved with fortified peanut paste? World Nutrition. *Journal of the World Public Health. **21**.* 446-452*.*

Linne, J.J., and Ringsrud, K.M (1999) Clinical laboratory science, the basic and routine techniques. 4th ed. Moseby, Saint Louis, pp 279–295.

Michael, H., Vishal, S., Deblais, L., Amimo, J.O., Chepngeno, J., Linda J. S., Rajashekara, G., and Anastasia, N. V. (2022). The combined *Escherichia coli* Nissle 1917 and tryptophan treatment modulates immune and metabolome responses to human rotavirus infection in a human infant fecal microbiota-transplanted malnourished gnotobiotic pig model. *Immunology***, 7**(5): e0027022

Pollit, E., Golub, M., Gorman, K. (1995). A report of the International Dietary Energy Consultative Group (IDECG) workshop on malnutrition and behavior. Davis, California, December 1993. *Journal of Nutrition*. 125(8 Suppl):2211S-2284S.

Polmann, G., Vinicius, B., Danielski, R.,Regina, S., Ferreira, S., and Block, J.M (2022). Nuts and nut-based products: A meta-analysis from intake health benefits and functional characteristics from recovered constituents: Review. *Food Review International.* https://doi.org/10.1080/87559129.2022.2045495

Sanni, O. and Oladapo, F., O. (2008). Chemical, functional, and sensory properties of instant yam bread fruit flour. *Nigerian Food Journal.* **26**:2-12.

Stratton, R. J., Green, C. J., and Elia, M. (2003). An evidence-based approach to treatment. Book review. *Nutrition in Clinical Practice*.**18**: 6.

Temple, V.J., Badamosi, E.J., Ladeji, O. and Solomon, M. (1996) Proximate chemical composition of three locally formulated complementary foods. *African Journal of Biological Science.* **5**:134-143.

Turgeon, M.L. (2016). Linne & Ringsrud's clinical laboratory science: Concepts, procedures, and clinical applications.

Turnwald, G.H and Barta, O. (1989). Immunological and plasma protein disorders. small animal clinical diagnosis by laboratory methods. WB Saunders, eds Philadelphia. Pp 264 –282.

Walker, A.F. (1990). The Contribution of Weaning Foods to Protein – Energy Malnutrition. In: *Nutrition Research Review*. **3:** 25-47.

Wickland, J., Steven Brown, L., Blanco, V., Roy, H., Christy, T., and Charles, R. R. (2022). Persistent high blood pressure and renal dysfunction in preterm infants during childhood. *Pediatric Research*. **6**:104-123.