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Full Length Research Paper

Nutritive evaluation of *Telfairia occidentalis* leaf protein concentrate in infant foods

Johnson Oluwasola Agbede*, Muyiwa Adegbenro, Gbenga Emmanuel Onibi, Christian Oboh and Valentine Ayobore Aletor

Division of Nutritional Biochemistry, Department of Animal Production and Health, Federal University of Technology, P.M.B. 704, Akure, Nigeria.

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Leaf meal (LM), leaf proteins concentrate (LPC) and LPC residues from *Telfairia occidentalis* were produced, chemically characterized and the protein quality of the LPC evaluated using rats. Five infant weaning foods were formulated using varying combinations of *T. occidentalis* LPC and soybean meal. These foods were compared with three coded commercial infant weaning foods (CFF, CFN and CFC) currently in trade in a 28-day performance study. Though fractionation increased crude protein in LPC by 34.8%, the amino acid values were in most cases lower than the FAO/WHO/UNU recommendation. Fractionation led to increase in the gross energy by 22.0% and decrease in the phytate and tannin contents by 60 and 81.3%, respectively in LPC. The LPC, when fed as sole protein source, led to weight loss in rats. The highest final weight was observed in rats fed 100% LPC + 0% soybean meal-based food (105.4 ± 16.4 g) and least in CFN (50.0 ± 4.2 g), a commercial food. The formulated foods had significant (P<0.05) effects on apparent N-digestibility, 'operative' protein efficiency ratio and haematological variables. Inclusion of *T. occidentalis* LPC in food preparations could help to reduce the cost of infant weaning foods.

Key words: Infant weaning food, *Telfairia occidentalis* leaf protein concentrate.

INTRODUCTION

Generally, the first year of life is a time of more rapid growth and development than any other time of life. A baby usually doubles its birth weight within the first four months and triples birth weight by the first birthday (HON foundation, 2004). For this amazing growth, infant requires an adequate intake of calories and essential nutrients which can be found abundantly in breast milk. Although it is best to breast feed babies, this may not be possible for all families as new mothers may want to return to work after three months of birth. Their babies are sometimes not given enough time to suckle the breast and are therefore weaned early by placing them on commercial infant weaning foods. It is therefore necessary to replace the mother's milk with nutritionally adequate but cheap infant weaning food during the weaning periods.

The commercial infant weaning foods in circulation in most developing countries are often not sufficiently available to the resource poor families. This could be attributed to the high cost of the component ingredients. For instance in Nigeria, in 1989 the cost of soybean meal, a major ingredient in infant formula, was $37 per tonne and in 2007 it increased to $511.8 per tonne representing over 1000% price increase. Thus, it becomes compelling to seek for alternative ingredients that could partially or completely replace soybean meal in infant weaning foods in this region.

Telfairia occidentalis (Hook.f.) is an edible vegetable plant belonging to family Cucurbitaceae. It is a tropical vine grown in West Africa as a leaf vegetable and for its edible seeds (Fagbemi et al., 2006). Common names for the plant include fluted gourd, fluted pumpkin, iroko and ugwu. It is a creeping vegetable shrub that spreads low

*Corresponding author. E-mail: joagbede@yahoo.com. Tel: +234 8064840143.

Abbreviations: LM, Leaf meal; **LPC**, leaf proteins concentrate; **LR**, leaf residue; **TOLPC**, *Telfairia occidentalis* leaf proteins concentrate; **CFF**, **CFN** and **CFC**, coded commercial infant weaning foods; **SBM**, soybean meal.

across the ground with large lobed leaves, and long twisting tendrils (Horsfalla and Spiff, 2005). Harvesting of fluted pumpkin takes place 120-150 days after sowing (Agatemor, 2006). The young shoots and leaves of the female plant are the main ingredient of Nigerian edkang ikong soup. Earlier report showed that leaf protein concentrates *(LPC)* from *T. occidentalis* are rich in protein and minerals (Aletor et al., 2002). However, information on the use of TOLPC as component of infant weaning formula is rear. Consequently, this study was designed to evaluate the possibility of substituting LPC from *T. occidentalis* for soybean in infant weaning foods with a view to increasing infant weaning food availability in developing countries.

MATERIALS AND METHODS

Leaf meal preparation

A batch of about 30 kg *T. occidentalis* leaves was purchased fresh from a local farmer in Akure, Ondo State, Nigeria. The leaves were harvested at about 6.00 GMT by the farmer and brought straight to Akure central market where they were purchased. About 1 kg of the leaves was brought to the laboratory and plucked from their stalks. Plucked leaves were placed in a tray and sun-dried outside the laboratory for about four days.

Leaf protein concentrates production

The fresh leaves were plucked, weighed and washed prior to pulping as described by Fellows (1987). In brief, the leaves were pulped using a village scale mill and the juice which contained the proteins was squeezed out. The separated leaf juice was heated in batches to 80-90^{o}C for 10 min. This procedure coagulated the leaf proteins from the whey. The coagulated proteins were thereafter separated from the whey by filtering through muslin cloth and pressed with screw-press to dryness. The leaf protein was then washed with water, repressed and sun-dried.

Leaf residue preparation

The leaf residue is the remaining fibrous fraction after pulping. Representative samples of the leaf residues from each pulping batch were spread in trays and sun-dried. The leaf meal (LM), leaf proteins concentrate (LPC) and leaf residue (LR) were finely milled using a laboratory hammer mill (DIETZ, 7311 Dettingen-Teck, Germany), sieved and packed in labelled air tight containers, and deep frozen at –18^{o}C until needed for analysis.

Proximate composition

The proximate compositions of the LM, LPC and LR were determined for crude fat, ash and crude fibre as described (AOAC, 1990). Thereafter, the nitrogen was determined by the micro-kjeldal method and the crude protein was obtained by multiplying the percentage nitrogen by a factor of 6.25. The nitrogen free extract content was determined by difference.

The details determination of amino acids is as described elsewhere (Agbede and Aletor, 2004). In brief, the LPC (50-75 mg) was hydrolyzed by reflux for 24 h in a heating block previously heated to 110±1^{o}C. The hydrolysate was cooled and quantitatively transferred to 50 mL flask and diluted to volume with water. After filtration, a 10 mL aliquot of the filtrate was heated in a rotary evaporator to remove excess acid before analysis using high-performance liquid chromatography (HPLC) with a Varian HPLC system (Varian Inc., Palo Alto, CA, USA) and a Shimadzu RF-535 Fluorescence detector (GL Sciences Inc., Tokoyo, Japan) set at an excitation wavelength of 325 nm and emission wavelength of 465 nm. Separation was achieved in an adsorbosphere OPA-HR (150 x 4.6 mm) column (Alltech, Carforth, UK). Methionine was determined as methionine sulphone and cysteine as cysteic acid after performic acid oxidation.

Gross energy

The gross energy (GE) contents of the LM, LPC and LR were determined against thermo chemical grade benzoic acid standard using a Gallenkamp Ballistic bomb calorimeter (Cam Metric Ltd., Cambridge, England).

Minerals

Sodium (Na) and potassium (K) were determined by Flame photometry (Jenway Ltd, Dunmond, Essex, UK) while phosphorus was determined by vanadomolybdate method using (Corning colori-meter 253). Other minerals were determined after wet digestion with a mixture of sulphuric, nitric and perchloric acids using Atomic Absorption Spectrophotometer (Buck scientific, East Norwalk, CT 06855, USA).

Phytate

Eight grams (8 g) of finely ground leaf meal, leaf protein concen-trate and leaf residue was soaked in 200 ml of 2% hydrochloric acid and allowed to stand for three hours. The extract was thereafter filtered through two layers of hardened filter papers. 50 ml of the filtrate was pipetted in triplicate into 400 ml capacity beakers before the addition of 10 ml 0.3% ammonium thiocyanate solution as an indicator, and 107 ml of distilled water to obtain the proper acidity (pH 4.5). The solution was then titrated with a standard iron chloride ($FeCl_3$) solution containing 0.00195 gm Fe/ml to determine the phytin and phytin-P (Young and Greaves, 1940).

Tannic acid

200 mg of each sample in 10 ml of 70% aqueous acetone was extracted for 2 h at 30^{o}C in water-bath using Gallenkamp orbital shaker (Electro Ltd, Avon, UK) at 120 revolutions per minute. Fat was first removed from the samples by extracting with di-ethyl ether containing 1% acetic acid. Thereafter, the total polyphenols (as tannic acid equivalent) was determined as described by Makkar and Goodchild (1996).

Protein quality evaluation

A total of thirty (30) weanling albino rats of approximately 3-weeks of age were used for the protein quality evaluation. They were divided into 3 groups of 10 rats each on the basis of initial weight and litter origin. The rats were housed individually in separate cubicles in a metabolic cage. The basal experimental diet contained corn starch 668.0 g; glucose, 50.0 g; sucrose, 100.0 g; non-nutritive cellulose, 50.0 g; groundnut oil, 100.0 g; bone meal, 20.0 g; oyster shell, 5.0 g; vitamin premix, 5.0 g and sodium salt (NaCl) 2.0 g kg^{-1}. The LPC was incorporated in to the basal diet at the expense of

Table 1. Basal composition (g kg^{-1}) of the laboratory-formulated infant weaning foods.

Ingredient	Diet				
	1	2	3	4	5
Maize	606.5	607.0	607.5	608.0	608.5
Soybean	120.0	90.0	60.0	30.0	-
LPC	-	29.5	59.0	88.5	118.0
Milk	190.0	190.0	190.0	190.0	190.0
Groundnut oil	50.0	50.0	50.0	50.0	50.0
Vitamin premix	2.5	2.5	2.5	2.5	2.5
Bone meal	25.0	25.0	25.0	25.0	25.0
Oyster shell	5.0	5.0	5.0	5.0	5.0
NaCl	1.0	1.0	1.0	1.0	1.0
Total Calculated Crude protein (g kg^{-1})	165.2	165.3	165.4	165.4	165.5
% Soybean meal replaced with LPC	0	25	50	75	100

LPC = Leaf protein concentrate.

Table 2. Proximate composition (g kg^{-1} DM) of the laboratory-formulated infant weaning foods and some commercial infant weaning foods.

Diets (foods)	% Soybean meal replaced with LPC	Crude protein	Ether extract	Ash
1	0	162.0±0.1	173.1±0.69	62.2±0.10
2	25	161.5±0.1	164.4±0.65	63.8±0.06
3	50	162.0±0.14	174.7±0.38	68.0±0.07
4	75	161.1±0.01	171.2±0.20	70.5±0.00
5	100	161.0±0.01	181.5±0.25	76.9±0.02
6	CFF	161.3±0.04	162.8±0.03	22.0±0.01
7	CFN	163.5±0.07	184.4±0.03	40.1±0.33
8	CFC	162.0±0.07	161.7±0.29	33.1±0.15

LPC = Leaf protein concentrate; CFF, CFN and CFC = coded names for the commercial infant foods.

maize starch to give 10% crude protein on a dry matter basis. Nutritional casein was used as the reference (standard) protein. One group of ten rats was given the N-free basal diet, and the remaining two were randomly allocated to the test and standard diets. The rats were offered their respective diets *ad libitum* for 10 days. Records of the weight gain/loss and total feed intake were kept. A 6-day faecal and urine collection was done for the rats during the trial. Collections of urine and faeces were done for each rat individually on a daily basis. The urine from each cage was collected in small urine container, which contained about 1 cm^3 of concentrated sulphuric acid. Faecal samples were also collected daily, bulked for each rat, weighed, dried and milled prior to laboratory analysis. Quadruplicate samples of faeces, urine and diets were taken for nitrogen determination by the Kjedahl method (AOAC, 1990). Following the nitrogen balance data, the following definitions were used as the basis for computing the various protein quality indices:

Protein Efficiency Ratio (PER) = gain in body weight (g) / Protein intake (g) (NAS/NRC, 1963)

Net Protein Ratio (NPR) = (Weight gain of test – protein + weight loss of the N-free diet group) / Protein intake (Bender and Doell, 1957)

True digestibility of nitrogen (TD) = [I-(F-M)/I] x 100 (Dreyer, 1968).

Biological Value (BV) = [I – (F - M) – (U - E)]/[I – (F – M)] (Phillips et al., 1981)

Net Protein Utilization (NPU) = [I-(F-M)-(U-E)/I] x 100 (Phillips et al., 1981)

Where I is the nitrogen intake (mg), F the nitrogen excreted in faeces (mg), M the metabolic faecal nitrogen (from basal diet) (mg), U the nitrogen excreted in urine (mg) and E is the endogenous urinary nitrogen (from basal diet) (mg).

Experimental design and animal management for the laboratory-formulated and commercial foods

Five laboratory-formulated foods (diets) were used with the basal composition and proximate compositions as shown on Tables 1 and 2. Three other popular commercial infant weaning foods coded CFF, CFN and CFC were purchased from the supermarket in Akure, Nigeria to serve as foods (diets) 6, 7 and 8, respectively. The experimental design was the completely randomised type. Eighty (80) clinically healthy weanling albino rats at approximately 3-weeks of age were used for the trial. They were divided into eight (8) groups of ten (10) rats each on the basis of initial weights. The rats were individually housed in separate cubicles in a metabolic cage. The foods and water were offered *ad libitum* to the rats for 28

Table 3. Analyzed compositions of the leaf meals, leaf protein concentrates and leaf residues.

Proximate composition (g kg^{-1} DM)	Leaf meal	Leaf protein concentrate	Leaf protein concentrate-residue
Crude protein	362.0±0.3	554.8±1.1	41.9±1.2
Ash	143.0±1.0	120.7±0.5	107.0±1.7
Ether extract	8.8±2.6	12.4±1.1	5.1±1.2
Gross energy ($MJkg^{-1}$)	15.6	20.0	11.6
Mineral content (mg kg^{-1} DM)			
Sodium	270.3	289.0	288.4
Calcium	732.6	762.2	959.7
Magnesium	352.2	393.3	493.1
Phosphorus	266.8	442.4	386.4
Potassium	353.0	336.7	459.4
Iron	275.7	25.2	65.4
Copper	ND	ND	ND
Zinc	79.6	21.5	25.7
Magnesium	18.1	2.33	0.8
Anti-nutrients (mg $100mg^{-1}$ DM)			
Phytate	8.2	3.2	7.5
Phytin-Phosphorus	2.3	0.9	2.1
Tannin	4.0	0.8	1.1

ND = Not detected.

days. Records for food consumption were measured daily and the weight change of each rat was taken at four-day-interval. For the nitrogen studies, the feed consumption for 5 days towards the end of the experimental period as well as the faeces was measured. Nitrogen contents of feed and dried faeces were determined (AOAC, 1990). Apparent nitrogen digestibility was computed by expressing the nitrogen retained as a fraction of the nitrogen intake multiplied by 100. 'Operative' protein efficiency ratio (PER) was computed as the ratio of weight gain and total protein consumed.

Blood collection and haematological studies

On the 28 day of the experimental period, all the rats were starved for about 3 h and weighed. Each rat was anaesthetizes with chloroform inside a dessicator before been sacrificed. Blood was collected into Bijour bottles containing a speck of dried tetracetic ethylenediamine acid (EDTA) powder and the haematological indices determined as described by Lambs (1981).

Statistical analysis

Data on the protein quality evaluation were subjected to t-test analysis while data on the performance were subjected to standard ANOVA procedures using the software package SPSS 11.0 for Windows.

RESULTS AND DISCUSSION

Chemical compositions of *T. occidentalis* preparations and protein quality evaluation

The leaf protein fractionation processes led to enhance crude protein and gross energy by 34.8% and 22% in LPC, respectively (Table 3). While values of the micro minerals were reduced in the LPC, macro-mineral levels were enhanced. Fractionation also led to reduction in phytate and tannin by 60% and 81.3%, respectively. Also the LPC contained lysine 5.02g, histidine 2.35g, arginine 5.08g, aspartic acid 8.95g, threonine 3.39g, serine 3.94g, serine 3.94g, glutamic acid 9.69g, praline 3.56g, alanine 5.22g, cystine + methionine 2.29g, valine 4.55g, isoleucine 7.91g, tyrosine 3.70g and phenlalanine 4.87g 16g-1N.This analytical information further confirms the nutritional potentials of this edible vegetable as source of food in monogastric nutrition. In the main, this study showed that the nutritional values of the LPC compared favourably with those reported for edible (Aletor et al., 2002; Fasuyi and Aletor, 2005) and non-edible (Agbede, 2006) leaves. However, the amino acid profile did not conform to the FAO/WHO/UNU (1985) recommended pattern. Also, the sulphur-containing amino acids were generally limiting and this agreed with earlier report by Laila et al., (1999) that LPC are generally limiting in sulphur containing amino acids. Thus by implication, formulations involving this LPC would either need supplemental methionine/cystine or that it is fed in combination with ingredients high in methionine/cystine, as animals or man tend to eat less of food having imbalance amino acids. This could be the reason for the reduced food intake and the concomitant loss in weight of rats fed solely on LPC (Table 4).

Performance of rats fed laboratory-formulated and commercial foods

The present study showed that rats fed laboratory formu-

Table 4. Protein quality of *Telfairia occidentalis* leaf protein concentrate.

Treatments	Weight gain in 10 days (g)	Feed consumed in 10 days (g)	Protein intake in 10 days	Protein efficiency ratio	Net protein ratio	Net protein utilization (%)	Biological value (%)	Apparent digestibility (%)	True digestibility (%)
Reference diet (casein)	8.2±3.2^{a}	45.0±10.8^{a}	4.5±1.1^{a}	1.7±0.4^{a}	3.2±0.3^{a}	86.6±5.7^{a}	93.4±0.5^{a}	94.4±0.3^{a}	88.0±5.4^{a}
LPC	- 1.5±0.7^{b}	26.6±6.9^{b}	2.7±0.7^{b}	-0.5±0.1^{b}	2.1±0.7^{b}	83.5±3.3^{b}	89.1±0.6^{b}	87.0± 0.2^{b}	84.5±3.4^{b}

LPC = *Telfairia occidentalis* leaf protein concentrate.
Means with different superscripts in the same column are significantly different (P≤0.05).

Table 5. Performance and nutrient utilization of rats fed laboratory-formulated and commercial infant weaning foods.

Parameters	Laboratory-formulated foods (Diets 1-5)					Commercial foods (Diets 6, 7 & 8)		
	Control (0%)	25%	50%	75%	100%	CFF	CFN	CFC
Initial weight (g)	**26.3±5.9**	**25.2±5.1**	**25.6±6.1**	**25.8±5.1**	**25.6±4.7**	**25.6±1.9**	**25.8±4.0**	**25.2±4.6**
Final weight (g)	98.0±20.7^{a}	96.3±11.2^{a}	96.7±15.7^{a}	84.4±2.9^{ab}	105.4±16.4^{a}	51.2±6.4^{b}	50.0±4.2^{b}	94.1±5.6^{a}
Average weight gain (g day^{-1})	2.7±0.4^{a}	2.6±0.1^{a}	2.6±0.3^{a}	2.3±0.2^{a}	3.0±0.4^{a}	1.1±0.2^{b}	1.1±0.1^{b}	2.6±0.1^{a}
Average feed consumption (g day^{-1})	8.22±1.51	8.4±0.6	8.6±0.1	8.8±0.4	9.6±1.2	7.9±0.5	7.4±0.6	7.8±0.5
Feed conversion ratio	3.1±0.2^{b}	3.2±0.1^{b}	3.3±0.1^{b}	4.0±0.7^{b}	3.3±0.2^{b}	7.2±0.7^{a}	6.9±0.1^{a}	3.0±0.1^{b}
Nitrogen retention (g day^{-1})	0.2±0.0	0.2±0.0	0.2± 0.0	0.2± 0.0	0.2±0.3	0.2±0.0	0.2±0.0	0.2±0.0
Apparent nitrogen digestibility (%)	88.6±0.8^{ab}	80.3±1.1^{ab}	79.5±4.8^{ab}	77.7±0.5^{ab}	77.3±3.8^{b}	90.1±7.3^{a}	89.3±0.5^{ab}	89.9±2.5^{ab}
'Operative' Protein efficiency ratio	2.0±0.1^{ab}	1.9±0.1^{abc}	1.9±0.1^{bc}	1.6±0.2^{c}	1.9±0.1^{bc}	0.9±0.1^{d}	1.9±0.0^{d}	2.2±0.0^{a}

Values are mean ± Standard error of mean for 10 rats per diet.
Means with different superscripts in the same row are significantly (P≤0.05) different.
CFF, CFN and CFC = coded names for the commercial infant foods.

lated foods compared favourably and in some cases better than those fed with commercial foods with respect to the weight gain, feed consumption and feed conversion ratio (Table 5). This was clearly demonstrated by rats fed on 100% LPC-based food. This finding is consistent with the previous report that the incorporation of LPC in the diet is as good as milk powder for rats (Oke, 1973). This could be attributed to the high nutrient density and high pro-vitamins in LPC. Previous report showed that green leaves are cheaper source of protein (Aletor et al., 2002; Fasuyi and Aletor, 2005) and the incorporation of LPC with excellent nutrient concentration into weaning foods has the potential to increase intake of some nutrients such as pro-vitamins which are growth promoters.

This study further showed that the rats retained identical nitrogen from either the laboratory formulated foods or commercial foods but utilize it differently, as clearly shown by the apparent N-digestibility (AND) and 'Operative' PER values (Table 5). The highest AND was observed in rats fed CFF (90.1±7.3%) and lowest in 100% LPC-based food (77.3±3.8%). Furthermore, the AND decreased with increased inclusion of LPC in the diets. The 'Operative' PER was highest in rats fed CFC (for the commercial foods) and 0% LPC-based food (for the laboratory-formulated foods). Generally, the higher the LPC in the diets, the lower the AND and this agreed with the report by Agbede and Aletor (2003).

Table 6 shows that of the entire haematological indices measured, only the erythrocyte sediment-tation rate (ESR) and white blood cell (WBC) were not significantly (P≥0.05) influenced by the dietary

Table 6. Haematological variables of rats fed laboratory-formulated and commercial infant weaning foods.

Diet	% SBM replaced with LPC	PCV (%)	WBC (×10^3 mm^3)	RBC (×10^6 mm^3)	Hbc (g 100 ml^{-1})	MCHC (%)	MCH (pg)	MCV (µ^{3}m)	ESR (mm/h)
Laboratory formulated foods									
1	0	32.3±1.5^b	6.0±1.6	4.7±0.4^b	10.7±0.4^b	33.2±0.4^{ab}	22.2±1.8^a	69.2±2.3^{ab}	0.6±0.2
2	25	32.7±2.7^b	7.2±1.2	5.1±0.7^b	10.9±0.8^{ab}	33.5±0.2^{ab}	21.9±1.2^a	65.3±3.3^{ab}	0.4±0.1
3	50	34.3±2.3^{ab}	6.8±0.4	5.9±0.5^{ab}	11.6±0.9^{ab}	33.7±0.2^{ab}	20.0±2.0^{ab}	59.3±5.8^{ab}	1.0±0.3
4	75	34.7±1.5^{ab}	6.1±1.5	5.9±0.6^{ab}	11.4±0.6^{ab}	32.9±0.4^b	19.7±1.4^{ab}	60.0±4.8^{ab}	0.5±0.3
5	100	38.0±1.2^a	7.2±1.2	6.1±0.6^{ab}	12.5±0.5^a	33.0±0.4^{ab}	20.9±1.6^{ab}	63.5±5.5^{ab}	1.0±0.5
Commercial foods									
6	CFF	36.5±0.3^{ab}	4.3±0.5	5.0±0.6^b	12.5±0.1^{ab}	34.1±0.5^a	24.4±3.4^a	74.2±10.1^a	0.6±0.2
7	CFN	35.0±0.6^{ab}	7.4±1.2	7.6±0.4^a	12.3±0.2^{ab}	33.6±0.3^{ab}	15.7±0.6^b	52.0±8.0^b	0.4±0.1
8	CFC	36.7±0.7^{ab}	6.1±1.7	6.1±0.4^{ab}	12.3±0.2^{ab}	33.5±0.1^{ab}	20.2±1.2^{ab}	60.2±3.6^{ab}	0.4±0.1

SBM = Soybean meal, LPC = *Telfairia occidentalis* leaf protein concentrate, SBM = Soybean meal, PCV= Packed cell volume, WBC = White blood cell, RBC = Redblood cell, Hbc = Haemoglobin concentration, MCHC = Mean cell haemoglobin concentration, MCH = Mean cell haemoglobin, MCV = Mean cell volume, ESR = Erythrocyte sedimentation ratio.
Means with different superscripts in the same row are significantly (P≤0.05) different.
CFF, CFN and CFC = coded names for the commercial infant foods.

treatment. Also, the differential counts (%) vary: lymphocytes 53 - 61%, neutrophil 25 - 34%, monocyte 5 - 9%, basophil 0 - 1% and eosinophil 2 - 5%. Though the haematological variables did not follow a definite pattern, the PCV increased with increased inclusion of LPC in the foods. The values of the PCV, RBC, WBC, Hbc were generally high, thus indicating the adequacy of LPC as possible substitute to soybean meal (SBM) in commercial infant weaning foods in a manner that enhanced similar haematopoiesis vis-à-vis health status of the rats.

Conclusion

Leaf protein concentrate from *T. occidentalis* is nutritionally adequate and given the economic situation in most developing countries, it could find use in food formulations. However, the greenish colour of LPC-based foods may reduce its acceptability by the consumers. Consequently, efforts geared towards the removal of the greenish colour are currently receiving research attention.

REFERENCES

Agatemor C (2006). Studies of selected physicochemical properties of fluted pumpkin (*Telfaira occidentalis* Hook F) seed oil and tropical almond (*Terminalia catappia* L.) seed oil. Pak. J. Nutr. 5: 308-309.

Agbede JO (2006). Characterisation of the leaf meals, protein concentrates and residues from some tropical leguminous plants. J. Sci. Food. Agric. 86: 1292-1297.

Agbede JO, Aletor VA (2003). Evaluation of weaning foods from G*lyricidia* and *Leucaena* leaf protein concentrates and some commercial brands in Nigeria. J. Sci. Food. Agric. 84: 21-30.

Agbede JO, Aletor VA (2004). Chemical characterization and protein quality evaluation of leaf protein concentrates from *Glyricidia sepium* and *Leucaena leucocephala.*. Intern. J. Fd. Sci. & Technol. 39: 253-261.

Aletor O, Oshodi AA, Ipinmoroti K (2002). Chemical composition of common leafy vegetables and functional properties of their leaf protein concentrate. Food Chem. 78: 63-68.

AOAC (1990). Official Method of Analysis. 15th edition, Association of Official Analytical Chemists, Washington, D.C.

Bender AE, Doell BH (1957). Biological evaluation of protein; a new aspect. Br. J. Nutr. 2: 140-148.

Dreyer JJ (1968). Biological assessment of protein quality: digestibility of the proteins in certain foodstuffs. South Afr. Med. J. 42: 1304-1313.

Fagbemi TN, Oshodi AA, Ipinmoroti KO (2006). Effects of processing on the functional properties of full fat and defatted fluted pumpkin (*Telfairaia occidentalis*) seed flours. J. Food Technol. 4 (1): 70-79.

FAO/WHO/UNU (1985) Energy and Protein Requirements Report of a joint FAO/WHO/UNU Expert Consultation, Geneva, Switzerland, WHO Technical Report Series No. 724.

Fasuyi AO, Aletor VA (2005). Varietal composition and functional properties of cassava (*Manihot esculenta*, Cranzt) leaf meal and leaf protein concentrates. Pak. J. Nutr. 4: 43-49.

Fellows P (1987). Village-scale leaf fractionation in Ghana. Trop. Sci., 27: 77-84.

HON Foundation (2004). Mother and Child. http://.hon.ch/Dossier/MotherChild/posnatal feeding.html.

Horsfalla M Jr. Spiff IA (2005). Equilibrium sorption study of A^{3+}, Co^{2+} and Ag^{+} in aqueous solutions by fluted pumpkin (*Telfaira occidentalis* Hook f) waste Biomass. Acta Chim. Slov. 52: 174-181.

Laila H, Mohamed M, El-Baz FK, Ghanem SA (1999). Nutritional quality and the presence of anti-nutritional factors

in Leaf protein Concentrate (LPC). Intern. J. Food Sci. Nutr. 50: 333-343.
Lambs GN (1981). Manual of Veterinary Laboratory Technique. CIBA-GEIGY, Kenya, pp. 96-102.
Makkar AOS, Goodchild AV (1996). Quantification of tannins. A laboratory manual. International Centre for Agriculture Research in the Dry Areas (ICARDA) Allepo, Syria IV + pp 25.
NAS/NRC (1963). Evaluation of protein Quality. National Academy of Sciences/National Research Council Press, Washington, DC, Publication No. 1100, 23-37.
Oke OL (1973). Leaf protein research in Nigeria. A review. Trop. Sci. 15: 139-155.
Phillips DE, Eyre MD, Thompson A, Boulter D (1981). Protein quality in seed meals of *Phaseolus vulgaris* and heat-stable factors affecting the utilization of protein. J. Sci. Food. Agric 32: 423-432.
Young SM, Greaves JS (1940). Influence of variety and treatment on phytin contents of wheat. Food Res. 5: 103-105.