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COMPARATIVE EVALUTION OF NUTRITIONAL COMPOSITION AND ACCEPTABILITY OF CEREAL- BASED COMPOSITE PORRIDGE SUPPLEMENT WITH SOY AND ALMOND MILKS.

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Abstract

Traditional complementary foods are with limiting nutrient quality and can be fortified using protein rich crops like soy beans and almond seeds. This research thus aimed at investigating nutritional quality of infant formulated diet from locally underutilized almond seeds, soybeans and coconut. The milks were produced from locally accessible plant –based vegetable. The energy was supplied from cereals. This finding was set to evaluate the formulation of weaning food from cereal-based composite porridges that supplement with soy-milk and almond milk as an alternative source for breast milk. The mixture of malted rice, powdered carrot, date and almond milk were mixed to slurry (formulation I) and boiled for 3-4mins. The same procedure was repeated for formulation II. The formulations and commercial based meal (control) were fed to experimental animals (white albino rat) for the period of three week (21-days). The performance in term of protein efficiency ratio, nitrogen retention and tissue weights were comparable with those of similar commercial weaning food (cerelac) sold in the market. The proximate and sensory analyses were also determined on new baby food as well. The results showed that the study successfully produced two different formulated diets of rice, carrot, date palm and using soy and almond milk as alternative sources for breast milk with acceptable sensory characteristic as well as excellent nutritional quality.

Key words: Supplement, cereal-based, composite porridge, soy and almond milk

1.0 Introduction

The weaning period is the most crucial and vulnerable period for developing children under nutrition. This is because after breastfeeding for six months, additional food and nutrients may be required to continue and maintain the child's growth and development. Unfortunately, during this period, mothers/caregivers give food only to prevent the child from being hungry with little regard to the nutritional quality of the weaning food (WHO/UNICEF, 1998).

   This situation worsens if economic challenges exist in the family. During this critical period children develop illnesses and multiple deficiencies such as protein, energy and micronutrient deficiencies. The key limiting nutrients identified during the weaning period are iron, zinc,

vitamin B6 and, in some populations, riboflavin, niacin, thiamin, calcium, vitamin A, folate and vitamin C. Vitamin D is also of concern in populations with low exposure to sunshine or at high latitudes (WHO, 2006). The highest burden of micro-nutrient malnutrition including vitamin A deficiency (VAD), iron and other diseases associated with hidden hunger among children under five is found in sub Saharan Africa (WHO, 2009).

Protein-energy malnutrition and micronutrient deficiency among children, especially those living in rural communities, is estimated to be very high. This is because during this period the traditional weaning food (maize porridge, often referred to as 'Koko', 'Akamu' or 'Ogi') given to the child lacks adequate nutrients for growth and development (Treiche *et al.,* 2004).

According to the (WFO, 2010), the surface of land for growing rice represents only 11% of the world arable land. But the rice is the first cereal grown in the world, just after wheat and maize (Benkadri, 2010). It also the basic foodstuffs of more than the half of the world population according to Benkadri, 2010. In Ivory Coast, rice can be grown in every region and precisely in the western, center and south-western side where unfortunately malnutrition raged (EDSCI, 2012).Rice is usually used as powder in infants food to produce complementary food (Laureys and Geeroms, 2002); it is also different from the other cereals because of its high quantity of gluten and less quantity of prolamine. Although rice contains important quantities of micro nutriments and aroma (Laignelet, 1998), it is devoiced of some nutriments useful for the growth such as proteins and it is weak in energy. As the stomach of a child is small (30 ml/kg of his total weight) (Sawadogo *et al.,* 2003), he seems satiated when he eats few quantity but he misses essentials nutriments. The power of rice doesn't correspond to the internationals institutions' alimentation standard (Bengaly, 2010).

Rice (Oryza sativa) is a major staple food all over the world including Africa. It may be a good carbohydrate alternative in weaning food blends. In Nigeria, though the production of local rice has been increasing lately, patronage of this local rice is, however, low. This is because the inadequate and inappropriate post-harvest practices currently used by farmers and other rice value- chain actors make the quality of the locally milled rice variable. The level of broken grains after milling usually exceeds 30% and the product contains unhusked grains as well as bran and husk fractions (Appiah *et al.,* 2011). This broken rice fraction which otherwise may be used as animal feed or left unused could potentially be an alternative source of carbohydrate for novel infant feed formulations (Appiah *et al.,* 2011).

Soybean (Glycine max) is known for its high quality protein and fat content. Soybeans are the most important plant source because it contains an excellent balance of indispensable anti-nutrient factor such as antigens, lectins, trypsin and oligosaccharide. (Suite, 2007). Its application in weaning formulation improves their protein, fat and iron contents (Goto et al., 1999).

An almond (Prunus dulcis) is associated with some positive health benefits such as antioxidant capacities, anticancer and antiatherogenic actions as well as the regulation of immune and inflammatory responses (Rabadan, A., *et al*., 2019). The health benefits of almond are related to the availability of unsaturated fatty acid (Berryman, C., *et al*., 2011) and polyphenols which are known to improve human health (Garrido, I., *et al*., 2008).

In developing countries, one of the greatest problems affecting millions of people, particularly children, is lack of adequate protein intake in term of quality and quantity. As cereals are generally low in protein, supplementation of cereals with locally available legume that is high in protein increases protein content of cereal-legume blends. Childhood nutrition remains a major health problem in Nigeria. Approximately one-third of children less than five years of age in developing countries are stunted (low height – for age), and large proportions are deficient in one or more micronutrients (WHO, 2001).Weaning food supplemented with high protein content, high digestibility and high energy density can be prepared from readily available low cost materials (such as rice, soybeans, coconut, carrot, date palm). This weaning food can be used to meet the needs of growing children (especially those within the age bracket of 6-36 months), thereby reducing malnutrition in developing countries like Nigeria (Satter *et al*., 2013). Therefore, this study aim to investigate the nutritional composition, consumer acceptability with emphasis on protein quality of cereal-based composite porridge complements soybeans almond fruits.

2.0 Materials and methods

2.1 Sources of raw materials

Local rice, almond, soybeans, carrot, date palm were purchased from Muda lawan market in Bauchi metropolis, Bauchi State, Nigeria.

2.2 Samples preparation

2.2.1 Local rice

Processing of malted rice – Sorted clean grains of rice weighing 1000 g were steeped in water (1:3 w/v, grain: water) for 4 h. The steeped grains were then transferred to a wide container with cotton wool to allow for germination at room temperature (30°C) for 3 days. The washed germinated grains were dried in the oven at 35°C for a total of about 10 to 12 h. The grains were then cleaned of sprouts and hulls by hand rubbing and winnowing, after which they were dried in a forced-air oven at 50°C to a uniform colour. The dried grains were ground to fine flour and passed through a 0.5 mm sieve (Elemo *et al.,* 2011).

2.2.2 Preparation of almond milk:

Almond seed was prepared using the method described by Preeti *et al*., (2018). Almond seeds were cleaned and soaked in 100ml of distilled water for 12h followed by draining and dehulling to reduce the level of oxalic. The dehulleds almonds were ground with water in a blender. The obtained slurry was strained through a two layer muslin cloth to obtain filtrate (almond milk). The almond milk was boiled (100℃) for 10mins, package and cooled at temperature 4℃.

2.2.3 Soybeans

Processing of Soybeans milk –using the method described by Nyagaya (2008). The method of soaking, 25g of soybeans was soaked in 100ml of water for 12 hours at room temperature (25°C). After draining the soaking water and rinsing with cold water, the beans were ground with 200ml of water using a warring laboratory electric blender and filtered through muslin cloth. The filtrate (soymilk) was boiled in a beaker for 10min.

2.2.4 Preparation of carrot powder

Carrot tubers were prepared using the method described by Mohammed and Hussein (1994). The carrots were trimmed, scrapped, washed and cut into 1cm cube and thoroughly

mixed. The carrot cubes were blanched in a water bath (Precision stainless steel, model- 184) at 70^OC for 20mins with solution of 2% glycerol, 1% calcium chloride and 0.1% sodium metal bisulphate which were dissolved in distilled water (to prevent loss of carotenoid). Immediately after blanching, the carrot were soaked in distilled water contain ice cubes for 0^oC for 15mins to prevent further cooking. The blanched carrot cubes were placed in a stainless pan and dried in oven at 72^oC for 48hrs.After drying, the cubes removed and blend with food processor (Cuisinart, Smart powder Duet [(R)] BFP-703). The powder was later dried in food dehydrator at temperature of 70^oC for 15mins. It was dried until moisture content below 0.34%. The powdered carrot was sieved and package in cellophane bag for subsequent used.

2.2.5 Preparation of date powder

The dried date fruits were sorted, graded, cleaning and opened to remove the seeds. The dates were poured in the stainless pan and dried in the cabinet drier at temperature of 72^OC for 48hrs. .After drying, the dates were removed and blend with food processor (Cuisinart, Smart powder Duet [(R)] BFP-703). The powder was later dried in food dehydrator at temperature of 70^oC for 15mins. It was dried until moisture content below 0.34%. The powdered carrot was sieved and package in cellophane bag for subsequent used.

2.2.6 Preparation of composite porridge

2.2.6.1 Formulation composite porridge I: The malted rice meal powder was mixed with dried powder of carrot together with date powder and almond milk was mixed together into slurry. The slurry was boiled at temperature of 100^OC for 3-4mins in sauce pan and transfer into serving bowl for further evaluation. The same procedures were repeated for composite porridge II.

2.3 Sensory Evaluation

Sensory evaluation for the 3 product samples was carried out. The samples were presented before the panelist who was asked to rate the samples based on the following quality attributes; appearance, taste, flavor, color, texture and general acceptability. The panelists were randomly chosen among the lactating mothers that were familiar with weaning foods. They were to indicate their acting by scoring the samples using the samples using the scores on the nine Hedonic scale presented to them. The scores were analyzed using analysis of variance (ANOVA)in order to establish the degree of difference according to Ihekoronye and Ngoddy, (1985).

2.4 Proximate Composition

The nutrient composition of the food samples was determined using the standard procedures of AOAC (2006). The total carbohydrates were calculated as the difference of 100-(% moisture + crude protein + crude fat + ash + crude fibre). The gross energy was determined with a bomb calorimeter.

2.5 Biological Assessment

White rats weighing between 39 g – 50 g at the beginning of the experiment were weighed, randomly distributed into metabolic cages, and subjected to laboratory conditions for a period of five days. During this period, the animals were fed normal pellet foods as they had been previously fed during the breeding period. At zero day of the experiment, the animals were reweighed and re-grouped such that the average weight of animals in each group was approximately the same. One group of animals served as baseline control for the experimental

groups, which was sacrificed at zero day and tissue samples from liver, kidney, heart and spleen were removed, weighed, and frozen (-10 ${}^{\circ}$C) until nitrogen content was determined. The remaining animals were placed on the experimental foods for a period of 21 days. The feed intakes and growth were recorded during the period. At the expiration of the experimental period, the animals were anaesthetized and sacrificed. Tissue specimens from liver, kidney, and spleen were obtained, weighed, and frozen (-10 ${}^{\circ}$C) until nitrogen was determined by the modified micro- Kjedhal method. The body weights of the animals were measured at three-day intervals. The total faeces and urine voided during the last five days of the experiment were collected, weighed, and preserved. The urine collected was preserved by adding H_2SO_4 to prevent any ammonia loss, while the corresponding feed consumed was also recorded for nitrogen determination. The information collected during the feeding experiment was used in determining the following parameters (Ijarotimi and Keshiro, 2012).

2.6 Nitrogen retention

The nitrogen retained in the experimental animal was calculated as the algebraic difference between the foods and the sum of both the fecal and urinary nitrogen for the collection period by kjeldhal method (AOAC, 2005).

NR $= N_i - (FN + UN)$

Where;

NR = Nitrogen retained;

N_i = Nitrogen intake in foods;

FN = Fecal nitrogen;

UN = Urinary nitrogen

2.6.1 Protein efficiency ratio (PER)

Protein efficiency ratio (PER) was calculated according to the method described by AOAC, (2000) as follows:

PER $= Weight\,gain / protein\,consumed$

3.6.2 Biological value (BV)

Biological value (BV) was calculated according to the method described by AOAC, (2000):

$BV = (N_i - NF2) + (NU1 - NU2) \times 100 / N_i - (NF1 - NF2)$

Where,

N_i = Nitrogen intake of animals that were fed test food

$NF1$ = Nitrogen excreted in the faeces of animals that were fed test food

$NF2$ = Nitrogen excreted in the faeces of animals that were fed protein - free food

NU1 = nitrogen excreted in the urine of animals that were fed test food

NU2 = nitrogen excreted in the urine of animals that were fed protein - free food

3.6.3 True digestibility (TD)

True digestibility (TD) was determined according to the method described by AOAC, (2000):

TD= [(Nutrient in – Nutrient out) / (Nutrient in)] x100

2.6.4 Net protein utilization (NPU)

Net protein utilization (NPU) was determined according to the method described by AOAC, (2000):

NPU = BV × TD/100

2.7 Lipid profile analysis

On the last day of the experimental period, all rats were starved for about 3 hours and weighed. The rat was sacrificed and the blood was collected into bottles. The blood sample were analyzed by using cardio check cholesterol analyzer, Strip method was used to determine total cholesterol, High Density Lipoprotein (HDL) cholesterol, Low Density Lipoprotein (LDL) cholesterol, Triglyceride (TG) cholesterol. Tissues were carefully removed from the sacrificed animals using a pair of gloves, dissecting set and collected in 15 ml 0.25 N sucrose and then homogenized. 1 g each of tissue (liver, kidney, heart and spleen) was weighed and homogenized in ice-cold 10 ml trios' buffer (pH 7.8). The homogenates were centrifuged at 2000 rpm for 10 minutes. The supernatant was carefully decanted into specimen bottles, kept frozen overnight to ensure maximum release of the enzymes in the tissue cells (Oyedemi, *et.al.,* 2011).

2.8 Statistical Analysis

Data were analyzed using analysis of variance (ANOVA), standard deviation and percentages. All chemical analysis on the samples was done in triplicate.

Table 2.1: Formulation Table for Weaning Food from 6-36 Months

MATERIALS	FORMULATION I	FORMULATION II
LOCAL RICE	60g	60g
ALMNOD MILK	25ml	-
SOYBEANS MILK	-	25ml
CARROT	5g	5g
DATE PALM	10g	10g

3.0 Result and discussion

Table 3.1: Proximate and Energy Content Values of Samples

Parameters	Control	RCC	RSC
Moisture (%)	5.00 ± 0.50^b	7.20 ± 0.20^a	8.02 ± 0.24^a
Protein (%)	15.75 ± 0.01^b	15.88 ± 0.5^c	16.20 ± 0.5^a
Fat (%)	10.53 ± 0.02^a	9.51 ± 0.1^{ab}	9.47 ± 0.3^{ab}
Ash (%)	3.16 ± 0.01^a	2.99 ± 0.01^a	3.07 ± 0.02^a
Fibre (%)	2.11 ± 0.01^a	2.35 ± 0.04^a	2.76 ± 0.02^a
Carbohydrate (%)	68.42 ± 0.01^a	64.55 ± 0.02^a	62.41 ± 0.04^{ab}
Energy (kcal)	431.58 ± 0.02^a	445.64 ± 0.12^a	453.21 ± 0.10^a

Mean values with the same superscript in a row are not significantly different ($P>0.05$)

KEY

Control – Cerelac

RCC – Rice, carrot, date palm with Almond milk

RCS – Rice, carrot, date palm with soybeans milk

Table 1, shows the proximate analysis and also the energy content of the samples. The moisture content ranged from 5.00-8.02%. The control has the least moisture content of 5.00% followed by RCC (7.2%) and RCS (8.02%). There was a significance difference in the protein content of the control, RCC, RCS samples which have 15.75%, 14.15% and 16.20% respectively. RCC and RCS samples have a comparable value for fat content (9.51% and 9.47%) while control has a fat value of 10.53%. The ash and fibre contents have comparable values for all the samples. The carbohydrate content has 68.42% for the control, 64.55% for RCC and 62.41% for RCS. Nevertheless, RCS has the highest energy value of 453.21 kcal/100g followed by 445.64 kcal/100g for RCC and 431.55 kcal/100g for the control sample. The proximate and energy content of the samples was shown table 4.2. Poor protein quality and low energy density of complementary food is the major factor affecting infants and young children feeding practices in Nigeria and other developing countries (Bennett *et al.,* 1999). Complementary food in developing countries contains high levels of carbohydrate with very low or no protein due to the high cost of protein rich food and poor knowledge of locally available food materials by nursing mothers (Amakwash *et al.,* 2009). From the production of these complementary foods from locally available cereals and legumes, the findings showed that the protein and energy density of the formulated samples are comparable to the commercial formula (cerelac). The energy values of the formulated food sample were higher than the minimum desirable level (370kcal/100g) for infant complementary food as recommended by Walker (1990). Also, the ash, fibre, fat and

protein content for infant complementary food tallies with the recommended value according to FAO/WHO (1991). Adequate quality of complementary food is important for infants during normal growth and development (McGuire, 1991). The protein and energy density of complementary foods must be sufficient to meet protein and energy needs of the growing infants.

Table 3.2: Organoleptic properties of cereal-based composite porridge

Parameters	Control	RCC	RCS
Appearance	7.50 ± 0.21^a	6.30 ± 0.44^b	6.00 ± 0.20^a
Taste	7.20 ± 0.10^c	6.00 ± 0.50^a	6.30 ± 0.23^a
Flavor	7.50 ± 1.20^a	7.00 ± 0.20^c	7.30 ± 0.44^b
Color	7.60 ± 0.24^b	6.30 ± 0.86^a	7.00 ± 0.68^c
Texture	6.80 ± 023^a	6.30 ± 0.10^b	6.50 ± 0.88^a
General Acceptability	7.70 ± 0.01^c	6.30 ± 0.04^a	6.50 ± 0.42^c

Means with the same superscript in the same column are not significantly different (P≤ *0.5*).

KEY

Control – Cerelac

RCC – Rice, carrot, date palm with almond milk

RCS – Rice, carrot, date palm with soybeans milk

Table 3.2 shows the sensory properties of all the samples with respect to appearance, taste, flavor, color, texture and general acceptability using a 9-point hedonic scale. The sensory properties of the formulated and commercial products (Control) indicate that all the complementary food formulations were significantly different (p<0.05) from the Control in all the sensory attributes. The sensory properties of the formulated and commercial product shows the mean scores of the attributes evaluated ranging from appearance (6.0 – 7.5), taste (6.0 – 7.2), flavor (7.0 – 7.5), color (6.3 – 7.6), texture (6.3 – 6.8) and general acceptability (6.3 – 7.7).

Color has a prominent effect on sensory scores of complementary foods (Chukwu *et al*., 2000) as shown in table 4.7. The color of the formulated diets were not different (p>0.05) from each other while the color of the Control was significantly different (p<0.05) from the formulated diets. The major complaint of the mothers was the light brown color of the formulated diet after reconstitution which was quite glaring when compared to the control which had a milky color. This was so because mothers are accustomed to the milky color of the commercial complementary foods and so it was not strange that they were hesitant to score high a product with a different color (Chukwu et al., 2000). The product might be appealing and having high energy density but without good taste, such a product is likely to be unacceptable. Sample RCC received the lowest mean score while the control received the highest score. The formulated diets were significantly different (p>0.05) from the control. The inclusion of legume flour with a characteristic beany flavour may have informed the panelists' decision to return lower scores for

the formulated diets. The favourable taste of the formulated diets was probably enhanced by the addition of date palm. The flavour of the formulated diets were not significantly different (p>0.05) from each other while the flavour of the control was significantly different (p<0.05) from the formulated diets. This may be due to the similar flour composition of the formulated diets and additional flavouring added to the control (Nzeagwu and Nwaejike, 2005). The disparity between flavour of the control and formulated diets may be attributed to the characteristic beany aroma of the legume (Ijarotimi and Famurewa, 2003). The sensory scores of texture revealed that no significant differences (p>0.05) were observed in mouth-feel by all panelists between the formulated diets but there was a significant difference (p<0.05) between the formulated diets and the control. The mean score for the texture was above average indicating that from this test parameter, the formulated diets were liked moderately by the panelists. The low texture (compared to the control) might be presumably due to the processing method of the commercial brand that involved drum drying with improved the texture and also taste of the product (Okafor *et al.*, 2008). The lower ratings of the formulated diets samples in terms of colour, taste, flavour, texture and general acceptability compared with the control could also be attributed to the familiarity of the panel of judges to the taste, flavour, and colour of the control and also because the control was industrially prepared with additional sweetener and flavoring.

Table 3.3: Weight of Experimental Animals for the Period of Feeding Days

Days	Samples		
	Control(g)	RCC(g)	RCS(g)
1	45.00	44.00	45.00
2	48.00	45.50	45.00
3	49.00	45.50	45.50
4	49.20	45.80	46.10
5	49.70	46.00	46.50
6	50.60	46.20	47.30
7	50.80	46.30	47.50
8	50.90	46.40	48.00
9	51.00	46.45	48.05
10	51.00	46.50	48.10
11	51.20	46.53	48.30
12	51.25	46.56	48.50
13	51.28	46.58	48.55
14	51.30	46.59	48.58

15	51.30	47.05	49.10
16	51.31	47.15	49.10
17	51.33	47.18	49.12
18	51.35	47.30	49.15
19	51.40	47.50	49.40
20	51.45	47.55	49.50
21	51.50	47.60	49.58

KEY

Control – Cerelac

RCC – Rice, carrot, date palm with almond milk

RCS – Rice, carrot, date palm with soybeans milk

Table 3.3 shows the weights of the experimental animals which were fed for the period of 21days (3 weeks). It was observed that all the experimental animals gained weights but those experimental animals that were fed with the commercial complementary food (control-cerelac) gained more weights than those that were fed with the formulated samples.

Table 3.4: Evaluation of Quality Of Protein cereal-based composite porridge.

Parameters	Control	RCC	RCS
Nitrogen Retention (NR) %	1.24[a]	0.63[b]	0.65[b]
Protein Efficiency Ratio (PER) %	4.29[a]	2.78[b]	2.53[b]
Biological Value (BV) %	50.43[a]	41.20[c]	44.24[b]
True Digestibility (TD) %	69.89[a]	41.00[c]	43.78[b]
Net Protein Utilization (NPU)%	50.40[a]	41.21[c]	44.23[b]

Mean values with the same superscript in a row are not significantly different ($P>0.05$)

KEY

Control – Cerelac

RCC – Rice, carrot, date palm with almond milk

RCS – Rice, carrot, date palm with soybeans milk

Table 3.4 shows that BV of control (50.43%) was higher than those of RCC (41.20%) and RCS (44.24%). The NPU value of the control (50.40%) was higher than those of RCC (41.21%) and RCS (44.23%). True digestibility of the control (69.89%) was also higher than other samples. Similarly, the nitrogen retention (NR) as well as protein efficiency ratio (PER) was higher than other samples. There was no significance difference in the value of nitrogen retention and protein efficiency ratio for RCC and RCS samples.

Table 3.5: Effect of samples on organ development in experimental rat

Parameters	Control	RCC	RSC
Kidney	0.76^a	0.64^b	0.61^b
Liver	3.95^a	3.60^b	3.53^c
Heart	0.58^a	0.46^b	0.44^b
Spleen	0.68^a	0.58^b	0.55^b

Mean values with the same superscript in a row are not significantly different (P>0.05)

KEY

Control – Cerelac

RCC – Rice, carrot, date palm with almond milk

RCS – Rice, carrot, date palm with soybeans milk

The influence of the sample on the organs of the experimental animals is shown in table 3.5. The weight ranges of the organ in animal fed the formulated sample were as follows: The kidney value was 0.64g for RCC and 0.61g for RCS; for spleen, 0.58g for RCC and 0.55g for RCS; for heart, 0.46g for RCC and 0.44g for RCS. The weight of the liver of all the animals is significantly different from each other samples (3.95g for control, 3.60g for RCC and 3.53g for RCS).

Table 3.6: Lipid profile result for samples

Parameters	Control	RCC	RCS
Totalcholesterol (TC)	2.80^a	2.50^c	2.30^a

Triglyceride (TG)	1.50^a	1.30^c	1.40^c
HDLC	1.20^c	1.00	1.00^c
LDLC	0.90^b	0.80^a	0.80^a

Means with the same superscript in the same column are not significantly different (P≤ *0.5*).

KEY

Control – Cerelac

RCC – Rice, carrot, date palm with almond milk

RCS – Rice, carrot, date palm with soybeans milk

Table 3.6 shows the lipid profile result of all samples. Laboratory analysis showed difference in total cholesterol, control-2.8mmol/L, RCC-2.5mmol/L, RCS-2.3mmol/L in the lipid profile. The experimental rats that fed on sample RCC showed minimal triglyceride and also low density lipoprotein cholesterol (LDLC). The total cholesterol was different in all the samples. Also, high density lipoprotein (HDLC) showed little difference within the samples. The laboratory analysis showed little comparison of the different samples. There was a decrease in the value of triglyceride of all samples (1.5mmol/L for control, 1.3mmol/L for RCC and 1.4mmol/L for RCS). The HDLC and LDLC of the control was slightly higher than sample RCC and RCS.

The weight of experimental rats as shown in table 3.3 indicates that the experimental rat was fed with the commercial complementary food (cerelac) and as well as the formulated samples. It was observed that all the animals gained more weights in each other's capacity. The animals fed with the commercial complementary food (cerelac) gained more weights than those that were fed with the formulated samples and this could be attributed to the fact that the control, a commercial complementary food was fortified with nutrients during its production and such was not applied to the formulated diet.

The weight of some vital organs of animals fed with the formulated and control diet are shown in table 3.5. The liver is one of the major organ of the body that has enzymes to metabolize amino acids and it acts as the body's chemical factory. It regulates the levels of most of the main blood chemicals and acts with the kidney to clear the blood of drugs and toxic substances. Therefore, it can be said that the weight and general appearance of liver and other body organs could tell a lot on the health status of the experimental animals fed with the formulated samples. The results obtained in the relation of organs weight of the experimental rats agree with the findings of Ibironke *et al.,* (2012).

The presence of HDLC is beneficial to maintaining organ health and providing the body with necessary energy, the presence of LDLC can lead to blockages that may lead to problems with the heart and lungs. As shown in tabled 3.6 the level of total cholesterol and triglyceride in the present study were between 2.3-2.8 and 1.3-1.5 respectively. All the animals fed with all the samples, the values were within the accepted clinical range of <5.00mmol/L (cholesterol) and <1.70mmol/L (triglyceride). However, it confirms the report of Greger (1995) that foods with

healthy fats such as mono-saturated fat and omega-3 fatty acids can improve the serum cholesterol levels when in the correct ratio with omega-6 fatty acids.

4.1 Conclusion

This study was investigated the proximate composition and energy content, quality of protein, effect of the samples on organ development using experimental rat (animal bioassay), lipid profile of the control as well as the formulated samples used for the study. Among the samples, RCS gave the highest protein content and it can be used as home based complementary food. The formulated diets in this study are strongly recommended for use, particularly by rural and poor urban mothers to feed their infants and children during the wearing period. The study successfully produced two different formulated diets of rice, carrot, date palm and using soy and almond milk as alternative sources for breast milk with acceptable sensory characteristic as well as excellent nutritional quality. Therefore the objectives of the study as aforementioned are achieved.

4.2 Recommendation

Further studies should be carried out to find the effect of cooking treatment on the level of nutrients on the formulated samples. Shelf-life studies should also be carried out on the formulated diet to determine their keeping quality. Finally, human study should be carried out to determine the effect of the formulated diet on the growth and development of under nutrition taken into consideration.

5.0 References

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