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### Development And Nutritional Quality Assessment of Weaning Food from Cereal Mix (Millet and Maize) Supplemented with Vegetable Ugu Leaves and Seed

Isijola Omobolanle<sup>1,2</sup>, Adepoju Adefisola Bola<sup>2</sup>, Ibrahim Murtala Muhammad<sup>3</sup>, \*Bello Abdullahi<sup>1</sup>.

<sup>1</sup>Bioresources Development Centre, Ilorin. National Biotechnology Research and Development Agency, Abuja

<sup>2</sup>Department of Food Science Technology, Federal University Oye Ekiti, Ekiti State Nigeria.

<sup>3</sup>Department of Physical and Chemical Sciences, University of Health Sciences, Ila Orangun

#### ABSTRACT

Weaning foods are family meals prepared for infants after six months of age, providing high energy density, essential amino acids, vitamins, and minerals while maintaining palatability. In Nigeria, cereals and legumes have nutrient potentials that can complement each other if processed and blended. Poor infant feeding practices and maternal undernutrition are major risk factors for infant and early childhood mortality and morbidity. In developing countries, most children are affected by lack of food or inadequate energy and nutrients. Infant foods are often formulated from cereals with or without protein, leading to increased malnutrition due to insufficient quality and inadequate complementary food. The increasing cost of animal protein makes commercial infant food unaffordable, leading to the search for cheap and economical sources of protein. The research study aims to develop and assess the nutritional quality of weaning food from cereal mix (maize and millet) supplemented with ugu leaves and seed. Experimental dietary blends were formulated at different percentages, and samples were analyzed for proximate composition, minerals, Functional Properties, Sensory Evaluation, and animal bioassay. The results show that Diet 5, with 40% Maize, 40% Millet, and 20% Ugu seed, is the most effective in promoting lab rat growth, protein efficiency, and food conversion efficiency. However, it is crucial to consider nutritional requirements and goals when choosing a diet for lab rats, as different diets may have varying effects on growth and efficiency. Further research and experimentation could explore the specific nutritional components contributing to the success of Diet 5 and refine the formulation for optimal results.

#### KEYWORDS

Weaning Food,  
Millet, Maize,  
Ugu leaves,  
Ugu Seed,  
Cereal mix,  
Formulation

## I. INTRODUCTION

Weaning foods are specially prepared family meals be it solid, semi-solid or liquid introduced to infants after six months of age, while continuing breast feeding for up to two years or more (Krebs, 2014). Weaning foods are nutritionally similar to breast feeding. They are expected to be high in energy density, all essential amino acids, vitamins and minerals, while retaining the qualities for palatability (Abeshu *et al.*, 2016). A number of cereals and legumes that are readily available in Nigeria have been found to have nutrient potentials that could complement one another if properly processed and blended (Nwokem *et al.*, 2019).

Therefore, it is imperative that efforts to formulate composite blends and scientific studies carried out to ascertain the nutritive adequacy of these locally available blends (cereal and legumes) for possible use as complementary foods, especially by the rural and poor urban mothers during the weaning period. Local indigenous cereals and legumes are good sources of cheap, high-quality macro and micro-nutrients. The aim of this study therefore, is to assess the quality (suitability) of baby food (nutritional dry meal) by comparing its physiochemical constituent with that of the control.

The major risk factors associated with infant and early childhood mortality and morbidity are poor infant feeding practices as well as childhood and maternal undernutrition (WHO, 2020). Unlike developed countries where there are many children affected by obesity, most children in developing countries such as sub-Saharan Africa and Southeast Asia are conversely affected by lack of food or inadequate supply of energy and nutrients.

Most plant-based complementary foods are not able to adequately supply the protein and certain micronutrient requirements for a growing child (Adepeju *et al.*, 2016). Similarly, cereal-based complementary foods have been implicated in the etiology of protein energy malnutrition especially in communities where it is solely used as complementary food (Appoh and Krekling, 2015; Adepeju *et al.*, 2014). Several studies have reported that traditional complementary food (ogi) is characterized with low lysine and tryptophan, low energy density, and bulky (Adepeju *et al.*, 2014). In order to improve the protein quality of cereal-based complementary diets, combination of varieties of food materials such as staple starchy cereals, legumes, and plant proteins such as ugwu seed and leaves is considered appropriate for developing weaning foods.

In most developing countries, infant foods are formulated from cereals with or without protein used as supplement. Increase in childhood malnutrition due to insufficient quantities and inadequate quality of complementary food have advanced the need for cheap and easily available alternative vegetable protein sources. Similarly, the cost of animal protein is ever increasing making most commercial infant food unaffordable. Therefore, the search for cheap and economical sources of protein and effort at increasing utilization of ugwu seeds and leaves is a step in the right direction. Therefore, the aim of this study is to develop and access the nutritional quality of weaning food from cereal mix (maize and millet) supplemented with ugwu leaves and seed.

## II. MATERIALS AND METHODS

### *Collection of Samples*

Maize and millet was obtained from Ganmo market Ilorin, Kwara state while the Ugwu leaves and seed was obtained from Ipata Market in Ilorin Kwara state, Nigeria. Forty albino rats (Wistar strain) of both sexes between three and four weeks of age, of varying weights that was used in this investigation was obtained from Faculty of Veterinary Medicine, Animal breeding center, University of Ilorin. Commercially produced baby food that are cereal based Nutrients (Control diet) was purchased from Ojatuntun, Ilorin, Kwara state.

### *Preparation of Samples*

#### *Production of Maize Flour*

The Maize flour was produced by the method described by Adebayo-Oyetero *et al.* (2012). The grains was sorted and manually cleaned to remove broken seeds, dust, and other extraneous materials. Dried maize was milled into flour using laboratory Hammer mill, sieved (250- $\mu$ m screen), packaged, sealed, and stored in plastic container at room temperature ( $25^{\circ}\text{C} \pm 2$ ) until use.

#### *Production of Ugwu Leaf and Seed flour*

Ugwu leaves and seed was screened for rot, insects, and other defects. After which they was shade-dried separately under hygienic environmental conditions. The dried ugwu leaves and seed was milled to flour separately and kept separately in clean and air-tight containers till further use and analysis.

### Formulation of the Experimental diets

The formulation of the experimental dietary blends from the mixed cereals (Maize and Millet), Ugwu seed and leaves is shown in Table 1

**Figure 1.** Formulation of the dietary samples

Diet Samples	Formulation
Diet 1	50 % Maize: 50 % Millet
Diet 2	40%Maize:40%Millet:10%Ugwu seed: 10% leav
Diet 3	40 % Maize: 40 % Millet:15%Ugwu seed: 5% lea
Diet 4	40 % Maize: 40 % Millet:5%Ugwu seed: 15% lea
Diet 5	40 % Maize: 40 % Millet: 20%Ugwu seed
Diet 6	40 % Maize: 40 % Millet: 20% leaves
Control 7	Commercial diet (Control)

### Chemical Analysis

The proximate composition (moisture, crude fat, crude fiber, crude ash, and crude protein) of weaning food was determined according to AOAC (2019), while the carbohydrate content will be calculated by difference from 100. The energy value will be calculated using the Atwater factor as described by Zou *et al.*, (2017).

### Proximate Content

#### Determination of Moisture Contents

Moisture content of the weaning food samples was determined by dry air oven method. The petri dish will be dried at  $130 \pm 3$  °C for 1 hr and placed in desiccator and weighed after cooling. About 2 g of porridge flour was weighed by analytical balance and put on dry dish. Dry dish and its contents was put in the oven and maintained at  $130 \pm 3$  °C for 1 hr. The sample containing dish was transferred to a desiccator and weighed soon after reaching room temperature. Then, the moisture content was estimated using the formula:

$$\text{Moisture Contents(\%)} = \frac{M_{\text{Initial}} - M_{\text{Final}}}{M_{\text{Initial}}} \times 100$$

#### Determination of total ash (%)

Ash content of the weaning food was determined. The crucibles were cleaned and dried at 120 °C and ignited at 550 °C in furnace for 30 min. The crucibles were removed from the furnace and placed in desiccators to cool down to room temperature. The mass of crucibles was measure using analytical balance and the reading will be recorded as ( $M_1$ ). About

3 g of the samples was weighed in to crucibles ( $M_2$ ). The sample was dried at 120 °C for 1 hr in drying oven. The sample will be placed in furnace at about 550 °C until free from carbon and the residues appear grayish white (for about 8 hrs). The sample was removed from the furnace and placed in the desiccator followed by weighing the mass and recorded as ( $M_3$ ):

$$\text{Total Ash (\%)} = \frac{M_3 - M_1}{M_2 - M_1} \times 100$$

#### Determination of Crude Protein

The crude protein content of composite flour and individual crop flour was analyzed by Kjeldahl method of nitrogen analysis according to AOAC (2019) method. To a digestion flask containing about 0.5 g of sample, 6 mL of acid mixture (conc. Sulfuric acid) and about 3 g of catalyst mixture ( $K_2SO_4$  and Selenium) was added and digested at about 370°C until the solution becomes clear. The digested sample, distilled water (30 mL) was added and then, ammonia will be distilled off after adding 25 mL of NaOH (40%) into receiving flask (25 mL of boric acid with 10 drops of indicator solution). Finally, the distillate was titrated with standardized 0.1N sulfuric acid to a reddish color. The crude protein content will be estimated using the following equation:

$$\text{Total Nitrogen} = \frac{(T - B) \times 14.007 \times 100}{W}$$

Where:

T-Volume in ml of the standard acid solution used in the titration for the test material

B - Volume in ml of the standard acid solution used in the titration for the blank determination

N - Normality of standard sulphuric acid

W - Weight in grams of the test material

$$\text{Crude protein} = 6.25 \times \text{total nitrogen}$$

#### Determination of Crude Fat

Crude fat of weaning food was determined by Soxhlet extraction according to (AOAC, 2019) method. About 2 g of sample was weighed and put into a thimble. The thimble and its contents was placed in to a 50 mL beaker and dried in an oven for 2 hrs at  $102 \pm 2$ °C. The thimble contents was transferred in to extraction unit. The sample contained in the thimble was extracted with the solvent diethyl ether in a Soxhlet extraction apparatus for 6 hrs. After the extraction completed, the extraction thimble was dried in the oven for 30 mins at  $102^\circ\text{C} \pm 2^\circ\text{C}$

to remove moisture. Then it was removed from the oven and cooled in a desiccator. The cup and its contents was weighed. The crude fat was determined using the following formula:

$$\text{Crude fat (\%)} = \frac{W_2 - W_1}{\text{Weight of Sample}} \times 100$$

Where: W1= Weight of extraction flask before extraction

W2 = Weight of extraction flask after extraction

#### Determination of Crude Fibre

About 1.5 g of defatted food sample was placed into 600mL beaker. A 200 mL of 1.25% H<sub>2</sub>SO<sub>4</sub> solution and boiling chips was added to each beaker and allowed to boil for 30 min by rotating and stirring sometimes. During boiling, the level was kept constant by addition of hot distilled water. After 30 min, 20 mL of 28% potassium hydroxide solution was added into each beaker and again allowed to boil for another 30 min. The level was kept constant by addition of hot distilled water. The solution in each beaker was then filtered through crucibles containing sand filter by placing each of them. During filtration the sample was washed with hot distilled water. The final residue was washed with 1% H<sub>2</sub>SO<sub>4</sub> solution, hot distilled water, 1% NaOH solution, 1% H<sub>2</sub>SO<sub>4</sub>, hot distilled water and finally with acetone. Each of the crucibles with their contents was dried for 2 hr at 130 °C in the oven and cooled in desiccators and weighed (M1). Then, they were ashed for 60 min at 550°C in furnace and was cooled in desiccators. Finally, the mass of each crucible was weighed (M2) to subtract ash from fiber. The crude fiber was calculated from the equation:

$$\text{Crude fibre (\%)} = \frac{M_1 - M_2}{\text{Weight of sample}} \times 100$$

Where:

M1 = mass of crucible and wet residue

M2 = mass of crucible and ash residue

#### Determination of utilizable carbohydrates (%)

The utilizable carbohydrate content of the composite flour and individual ingredient flour samples was determined by difference method using the following mathematical expression.

$$\text{CHO (\%)} = 100 - (\% M.C + \% C.Fat + \%ASH + \%C.F + \%C.P)$$

$$\begin{aligned} \text{Where: CHO} &= \text{Carbohydrate, C. fat} \\ &= \text{Crude fat, C. f} \\ &= \text{Crude fiber,} \\ \text{C.P} &= \text{Crude protein M.C} \\ &= \text{Moisture content} \end{aligned}$$

#### Caloric Value (kcal)

Gross energy of composite flour sample was calculated according to the method developed by Osborne and Voogt (1978) as modified by Adepeju (2011). The energy content of each individual ingredient and composite flour samples were calculated as follows:

$$\begin{aligned} \text{Caloric Value (Kcal)} &= (\% \text{Protein} \times 4) \\ &+ (\% \text{CHO} \times 4) \\ &+ (\% \text{Fat} \times 9) \end{aligned}$$

#### Mineral analyses

The mineral analyses was determined by Flame Atomic Absorption Spectrophotometer method as per the (AOAC, 2019) method. One (1) g of composite flour and individual ingredient samples was ashed and weighed. The white ash was treated with 5 mL of 6N HCl and dried on the hot plate. Added 15 mL of 3N HCl and heat the crucible on the hot plate until the solution just boiled. The solution was cooled and filtered through a filter paper in to 50 mL graduated flask then make up with distilled water. Then the solution was used to determine Ca, Zn and Fe. Standard stock solution of iron, zinc and calcium was made by appropriate dilution. The sample and standard will be atomized by using reducing air-acetylene for Ca and oxidizing air-acetylene for zinc and iron as a source of energy for atomization (AACC, 2019). For Iron content determination absorbance will be measured at 248.4 nm and iron will be estimated from a standard calibration curve prepared from analytical grade iron with a range of 0, 2, 4, 6, 8 and 10 mL. For zinc estimated from a standard calibration curve prepared from analytical grade zinc with a range of 0, 0.5, 1, 1.5, 2 and 2.5 mL. For Calcium content determination, absorbance was measured at 422.7 nm after addition of 2.5 mL of LaCl<sub>3</sub> was added to sample solution and standard to suppress interferences. Calcium content will be then estimated from standard solution 0, 2, 4, 6, 8 and 10 mL prepared from CaCO<sub>3</sub>

### Functional properties

#### Bulk densities of the flour

Bulk density was determined by the method of (Adeleke and Odedeji, 2010). Fifty gram flour sample was placed into a 100mL measuring cylinder. The cylinder was tapped several times on a laboratory bench to a content volume. The volume of sample is recorded Bulk density was calculated from the values obtained as follows:

$$\text{Bulk densities} = \frac{\text{weight of sample}}{\text{volume of sample after tapping}}$$

#### Water absorption capacity (WAC)

The WAC was determined using the method developed by Beuchat. One gram sample will be mixed with 10 mL of distilled water for 30 seconds in a mix (set on fast speed). The samples will be allowed to stand at room temperature for 30 min, centrifuged at 2000 rpm (Centrifuge model 800-1) for 30 min and the volume of the supernatant will be measured in a 10mL graduated cylinder.

$$\text{WAC} = 100\text{ml} - \text{Final reading from the cylinder}$$

#### Viscosity determination

The viscosity of weaning food was determined by back extrusion method using texture analyzer. One hundred gram of each sample was mixed with 100 mL of distilled water in small plastic bowl. The rest 70 mL of distilled water was boiled in pan. The slurry was mixed with the boiled water in to pan then heated for 15 min at  $90 \pm 3^\circ\text{C}$  with continuous stirring to avoid coagulation and sticking in the pan. After 15 min, it was removed from the stove and transferred to back extrusion container (12.66 mm diameter and 34.94 mm length) and the samples was allowed to cool  $40^\circ\text{C}$  on the water bath boiler. The texture analyzer was set on the pre-test and post-test speed 5 mm/sec, test speed 1 mm/sec and distance was 30 mm. The prob (part no T.A 10) was used.

#### pH and Titratable Acidity

The pH was determined by mixing 1g of sample with 10ml of sterilized water and pH value of the suspension will be measured with pH meter. Titratable acidity was determined by

titrating 10g of the sample mixed with 90ml of diluted water against 0.1M NaOH using phenolphthalein as indicator (AOAC, 2012). The acidity was calculated as stated below.

$$\% \text{ Acid} = \frac{0.1N \text{ NaOH} \times 0.009 \times \text{Titre value}}{\text{weight of sample}} \times 100$$

### Animal Bioassay

#### Experimental Animals Preparation

Forty (40) albino rats (Wister strain) of both sexes and varying weight was obtained from Faculty of Veterinary Medicine, University of Ilorin Kwara State. The rat was acclimatized for 5days. The rats was weighed and randomly distributed into seven (7) groups with five (5) animals in each group. The average weight per group was approximately the same. One group of 5 animals (Zero Day Animal) served as the control for the experimental group and was anaesthetized and sacrificed. Tissues from the liver, Kidney and plantaris muscle of the hind limb was removed, weighed and frozen until nitrogen be determined. Blood and urine samples was also collected and analyzed. The remaining animals was placed on experimental diets, fed *ad libitum* over a period of 28 days. Water was supplied *ad libitum* and the increase in weight, which indicates the growth was recorded during this period. Blood and urine sample was taken on the 14<sup>th</sup> and 28<sup>th</sup> day of the experiment.

#### Nitrogen Retention

The nitrogen retained in the experimental animal was calculated as the algebraic difference between the weaning food and the sum of both the fecal and urinary nitrogen for collection period.

$$\text{Nitrogen retention} = N \text{ intake in food} - (\text{Feecal N} - \text{Urinary N})$$

#### Protein Efficiency Ratio (PER)

Protein efficiency ratio was calculated as follows

$$\text{PER} = \frac{\text{Weight gained}}{\text{protein consumed}}$$

$$\text{PER} = \frac{\text{Weight changed}}{\text{food consumed}}$$

### True Digestability(TD) and Biological Value (BV)

True digestability and biological value was calculated as follows

$$TD = \frac{N_i - (NF_1 - NF_2)}{N_i} \times 100$$

$$BV = \frac{N_i - (NF_1 - NF_2) - (NU_1 - NU_2)}{N_i - (NF_1 - NF_2)} \times 100$$

= Where

N1 = nitrogen intake of the animal fed the test diet

NF1=nitrogen excreted in faeces of animal fed test diet

NF2= nitrogen excreted in faeces of animal fed protein free diet.

NU1= nitrogen excreted in urine of animal fed test diet

NU2=nitrogen excreted in urine of animals fed with protein free-diet

### Net Protein Utilization (NPU)

Net protein utilization was determined as follows

$$NPU = \text{Biological Value} \times \text{True Digestability}$$

### Net Protein Retention (NPR)

Net protein retention was calculated as follows;

$$NPR = \frac{\text{weight gained of test group} + \text{weight lossof protein free groups}}{\text{weight of test proteinconsumed}}$$

$$PRE = NPR \times 16$$

### Determination of Packed Cell Volume

The packed cell volume was determined by microhaematocrit method. The capillary tube was filled with whole blood between 5.5-6cm of the total length. The dry end of the tube will be sealed and centrifuged for 5 minutes at 1200 rpm. The volume occupied by the red blood cells was measured by microhaematocrit reader and valued will be expressed in percentage of total blood in the tubes (Lauren and Frances, 2017).

### Determination of white blood cells

Blood samples (0.02 ml) were mixed sequenterine and diluted in 0.38 ml diluting fluid (1.5ml glacial acetic acid 0.5 ml malachite green, 98.0 ml water). The diluted blood was mounted in a counting chamber and white blood cells were counted (Lauren and Frances, 2017)

### Sensory Analysis

Twenty member trained panelist, were employed for this test. Weaning food sampled were prepared and poured in a white plastic cup, labelled and placed on a table in such a way that there was no interference between the panelists. Water was provided for each panelist to rinse their mouth after each taste. Evaluation was based on colour and appearance, aroma, taste, texture and general appearance. Scores were based on hedonic scale of 1-5 (1= extremely liked and 5= extremely disliked).

### III. RESULTS AND DISCUSSION

Weaning food is an important part of newborn and child nutrition. Infants shift from exclusively breastfeeding to taking supplemental foods throughout the weaning phase. The nutritional content of weaning foods is critical because they play an important role in addressing the nutritious needs of developing infants. The purpose of this study is to examine the nutritional content of several weaning meal formulations based on their proximate composition. The samples tested included various mixes of maize, millet, Ugwu seed, and leaves, as well as a commercial diet as a control group.

**Table 2 Result of Proximate Analysis**

Sample	%Moisture	% Ash	%Lipid	%Crude Fiber	%Protein	%CHO
Diet 1	5.77±0.24 <sup>b</sup>	0.84±0.01 <sup>b</sup>	3.61±0.02 <sup>b</sup>	1.59±0.44 <sup>a</sup>	5.98±0.01 <sup>a</sup>	82.20±0.69 <sup>c</sup>
Diet 2	5.68±0.09 <sup>b</sup>	2.07±0.01 <sup>d</sup>	6.52±0.39 <sup>d</sup>	7.55±3.74 <sup>ab</sup>	9.85±0.01 <sup>a</sup>	68.32±3.27 <sup>b</sup>
Diet 3	5.79±0.13 <sup>b</sup>	3.02±0.02 <sup>f</sup>	9.20±0.04 <sup>e</sup>	11.57±1.43 <sup>b</sup>	12.61±0.01 <sup>a</sup>	57.81±1.27 <sup>a</sup>
Diet 4	4.62±0.16 <sup>a</sup>	2.50±0.00 <sup>e</sup>	10.91±0.10 <sup>f</sup>	6.14±3.09 <sup>ab</sup>	5.16±0.01 <sup>a</sup>	70.66±3.15 <sup>b</sup>
Diet 5	4.77±0.01 <sup>a</sup>	1.48±0.17 <sup>c</sup>	6.35±0.35 <sup>d</sup>	1.49±0.85 <sup>a</sup>	6.86±0.01 <sup>a</sup>	79.05±1.02 <sup>c</sup>
Diet 6	5.84±0.20 <sup>b</sup>	3.44±0.06 <sup>g</sup>	3.00±0.12 <sup>a</sup>	10.24±6.32 <sup>b</sup>	6.74±0.01 <sup>a</sup>	70.75±6.30 <sup>b</sup>
Control	5.93±0.10 <sup>b</sup>	0.46±0.03 <sup>a</sup>	5.14±0.10 <sup>c</sup>	0.51±0.11 <sup>a</sup>	5.98±0.01 <sup>a</sup>	81.98±0.14 <sup>c</sup>

\*Values are means ± SD duplicate determinations.

Proximate analysis is often used to determine the macronutrient content of foods, and in this case, it aids in the evaluation of the weaning food samples' moisture, ash, fat, crude fibre, protein, and carbohydrate content.

The results of the proximate analysis are shown in table 2 below. Each sample is distinguished by its mean and standard deviation. These figures show the average composition of each sample, which is necessary for comprehending the nutritional profiles.

### *Moisture*

Moisture content is a measurement of the amount of water in the samples. In the samples, it ranged from about 4.62% to 5.93%. The control group contains more moisture, which is typical of commercial diets. Diet 2 and Diet 3 samples, which contain Ugwu seed and leaves, have reduced moisture content. The moisture content of weaning food might affect its shelf-life and susceptibility to deterioration. The moisture content of weaning foods influences their shelf life. To prevent spoiling, samples with a high moisture content, such as D6a and D6b, may require adequate packaging and storage.

### *Ash*

The ash content of the samples shows their inorganic mineral composition. All samples have relatively low ash levels, with values ranging from about 0.46% to 3.44%. This result is agreement with that of Narsih and Harijono (2012) who found that the addition of vegetables to food sample can influence their ash and mineral composition, which is as a result of the method and the soil on which they are planted. Sample Diet 6, which contains leaves, has the greatest ash content. Weaning foods with low ash content are preferred since high mineral content might be harmful to the infant's health. The low ash percentage in all samples indicates that the mineral composition is light. This is preferable because too many minerals can be hazardous to newborns. However, the precise mineral content should be examined to verify that it fits the nutritional needs of newborns.

### *Lipid*

Lipid content, often known as fat content, varies greatly between samples, ranging from approximately 3.00% to 10.91%. Diet 4 has the largest lipid content due to its higher amount of leaves, while Diet 2 contains Ugwu seed and also has raised lipid levels. Diet 1 and Diet 5 samples, on the other hand, have reduced lipid content, particularly those with a higher amount of maize and millet.

Lipids are an important source of energy for developing newborns as well as for brain development. Lipids are necessary for energy production and brain development. Higher lipid-content samples (Diet 2 and Diet 4) may benefit infants' energy needs and cognitive development. When developing weaning

foods, the supply and quality of lipids should be examined.

### *Crude Fiber*

Crude fibre is a measurement of the indigestible part of the sample, which is often made up of plant cell walls. The crude fibre content ranges between 0.51% and 11.57%. Diets 3 and 6 had the highest levels of crude fibre, while the control sample has very low levels. The presence of more crude fibre reflects the presence of leaves, which are known to be high in dietary fibre. A fibre balance is essential for newborn digestive health. Fibre is essential for gut health. Higher crude fibre content samples may aid in digestion and intestinal regularity. However, the presence of too much fibre may be harmful to very young newborns, thus caution is advised. The study conducted by Adebisi et al., (2021), on the biological evaluation of cereals and legumes weaning blends for infants foods shows that the Ether Extract, crude fibre, and ash values of the weaning food also fall within the recommended dietary allowance. This indicates that the diets are good quality food for infants.

### *Protein*

Protein is essential for baby growth and development. Protein content ranges from 5.16% to 12.61% in the samples. Diet 3 has the highest protein level since it contains Ugwu seed and leaves. Diet 5, on the other hand, contains only Ugwu seed and has a lower protein level. Protein content is an important aspect in determining the nutritional quality of weaning foods. Protein is required for baby development and growth. Protein content is greater in samples containing Ugwu seed and leaves (Diets 2 and 3). This may be beneficial for infants who require extra protein intake during weaning. It is, nevertheless, critical to ensure that the protein quality is appropriate for infant intake.

### *Carbohydrates (CHO)*

Carbohydrates are the most important source of energy. Carbohydrate content ranges between 57.81% to 82.20%. Diet 1 has the highest carbohydrate level, whereas Diet 3 has the lowest carbohydrate content, particularly those with higher proportions of Ugwu seed and leaves. To completely examine the

nutritional content of weaning foods, it is critical to consider the type of carbohydrates, such as simple sugars or complex carbohydrates. Carbohydrates offer energy, however excessive carbohydrate consumption may be harmful to newborns. Lower carbohydrate weaning foods may be helpful for infants who require restricted carbohydrate intake.

Commercial diets are represented in the Control Group. They have a higher moisture content, implying a potentially lower shelf life. They also have a modest lipid and carbohydrate content, making them excellent for energy production. Protein content is also moderate, which is important for newborn development. The crude fibre level, on the other hand, is low, indicating a lack of dietary fibre, which is crucial for digestive health.

Diet 1 (50/50 maize/millet): These samples have less fat, as is common for maize and millet-based formulations. The protein content is moderate, which is good for newborn development. Because of their high carbohydrate content, they are excellent energy providers. Because the crude fibre level is insufficient, these samples may not deliver enough dietary fibre for digestion. Diet 2 (40% Maize, 40% Millet, 10% Ugwu Seed, 10% Leaves): These samples exhibit a greater lipid content, which could be attributed to the presence of Ugwu seed. The protein level ranges from moderate to high, which is beneficial for baby nourishment. The carbohydrate level is minimal, which could imply a limited energy supply. The crude fibre level is high, implying that these formulations contain leaves, which can supply dietary fibre.

Diet 3 (40% Maize: 40% Millet: 15% Ugwu Seed: 5% Leaves): These samples have more protein, which is beneficial for newborn growth. The carbohydrate level ranges from moderate to high, providing plenty of energy. The crude fibre concentration is likewise high, indicating that leaves and dietary fibre are present. These samples have a well-balanced nutritional profile. Diet 4 (40% Maize, 40% Millet, 5% Ugwu Seed, 15% Leaves): These samples have the most lipids, which can give energy and are good to brain growth. The protein level ranges from moderate to high, which aids in newborn growth. The carbohydrate level is minimal, indicating a limited energy source. The crude

fibre concentration is the greatest of any sample, indicating the presence of leaves and dietary fibre.

Diet 5 (40 percent maize, 40% millet, and 20% uga seed): These samples show decreased lipid content, which could be attributed to the absence of leaves. The protein level is modest, which aids in the growth of infants. The carbohydrate level is minimal, which could imply a limited energy supply. The crude fibre level is similarly low, implying that these samples may not contain enough dietary fibre to aid digestion. Diet 6 (40 percent maize, 40% millet, and 20% leaves): These samples contain the most moisture, which can shorten their shelf life. The lipid content is minimal, possibly due to the absence of Ugwu seed. The protein level is modest, which aids in the growth of infants. The carbohydrate level is minimal, indicating a limited energy source. The crude fibre concentration is the second highest of any sample, indicating the presence of leaves and dietary fibre. These findings suggest that include Ugwu seed and leaves in weaning food formulations has a considerable impact on their nutritional makeup. Ugwu seed increases fat and protein content, whereas the leaves increase crude fibre content. The proper balance of these components is critical when making acceptable weaning foods for newborns.

### **Mineral composition**

Analysing the mineral content of weaning meals is critical because it offers information about their nutritional value and ability to meet the dietary demands of infants moving from breast milk or formula to solid foods. The mineral content, particularly the availability of important minerals such as iron (Fe), calcium (Ca), and zinc (Zn), is critical to infant growth and development. The mineral analysis results of six distinct weaning diets (Diets 1–6) and a control (commercial diet) based on their iron, calcium, and zinc content.

### **Iron (Fe) Analysis**

Iron is an important mineral for infants because it is needed for the formation of haemoglobin, which transports oxygen in the blood. Iron deficiency in babies can cause anaemia and impair cognitive and physical development. Table 3 shows the iron content analysis results

for weaning meals and the control diet. The results demonstrate a significant difference in iron level between the diets, with Diet 3 having the highest iron content and Diet 2 having the lowest. The control diet has a moderate amount of iron as well. These distinctions could have a substantial impact on the nutritional value of weaning foods.

#### *Calcium (Ca) Analysis*

Calcium is another important mineral for infants because it is required for the formation of strong bones and teeth. The analysis results for calcium content in weaning foods and the control diet. The results show that the calcium amount of the diets varies significantly, with Diet 3 having the highest calcium content and the control diet having the lowest. Calcium is necessary for bone development in babies, and appropriate consumption is required for their overall growth and development.

When the calcium content of the diets is compared to the DRI, all of them, including the control, exceed the necessary amount of 260 mg per 100 g. Diet 3 has the highest calcium level, offering over 300 mg per 100 g, which far exceeds the DRI. While calcium is a necessary element, excessive consumption can have negative consequences such as reduced iron absorption and the production of kidney stones. As a result, it is critical to consider not only achieving nutritional needs but also preventing excessive intake.

Diet 3 high calcium level may be ascribed to the presence of Ugwu seeds and leaves, which are known calcium suppliers. Calcium levels in ugwu seeds, in instance, have been reported to be high. However, like with iron, calcium bioavailability in plant-based meals varies, and the presence of oxalates and phytates can interfere with calcium absorption. As a result, the nutritional value of calcium in these weaning meals should be evaluated in the context of the total diet and its other components.

#### *Zinc (Zn) Analysis*

Zinc is an important mineral for newborn growth and development since it aids in immune function, wound healing, and DNA synthesis. Table 3 shows the zinc content analysis results for weaning meals and the

control diet. According to the findings, Diet 5 has the highest zinc concentration, whereas Diet 3 has the lowest. Zinc is required for several physiological functions, including as growth, immunological function, and wound healing. Inadequate zinc consumption might result in developmental delays and impaired immunological function.

To determine the nutritional importance of these findings, the Recommended Dietary Allowance (RDA) for zinc in neonates must be considered. Zinc RDA for infants aged 7 to 12 months is 3 mg per day. When the zinc content is compared to the RDA, all diets, with the exception of Diet 3 and the control, meet or surpass the necessary dose of 3 mg per 100 g. Diet 5 has the greatest zinc content per 100 g, well exceeding the RDA, which may be advantageous for newborn zinc needs. Diet 3 and the control diet both fall short of the RDA, implying that they may not supply enough zinc for infants of this age. The foods utilised may influence the variance in zinc concentration across diets. The highest zinc content diet, Diet 5, contains Ugwu seeds, which may be contributing to the increased levels. Ugwu seeds are a zinc source, and include them in your diet will help you get more of it. This observation emphasises the significance of ingredient selection when developing weaning diets to meet specific dietary requirements.

To fully comprehend the findings, it is necessary to examine zinc bioavailability. Zinc bioavailability can be regulated by a variety of factors, including the presence of phytates and fibre in the diet, as well as the zinc-to-phytate ratio. As a result, the overall nutritional impact of zinc in these weaning foods should consider zinc bioavailability and interaction with other dietary components.

Furthermore, the presence of other minerals, such as calcium and iron, influences zinc absorption. For example, high calcium intake can impede zinc absorption, and the presence of iron in the diet might compete with zinc for absorption. As a result, a proper balance of these minerals in the diet is critical for efficient zinc utilisation.

The mineral analysis results of the weaning diets show considerable variances in iron, calcium, and zinc levels. Diet 3 has the highest

iron and calcium content but the lowest zinc content of the three diets. Diet 5 contains the most zinc, while. Another important thing to consider when evaluating the nutritional impact of these weaning foods is bioavailability. Mineral absorption enhancers and inhibitors, such as phytates, oxalates, and fibre, can alter iron, calcium, and zinc bioavailability. As a result, the total nutritional quality of weaning foods should be assessed in light of their bioavailability. It is also critical to balance the mineral content of the weaning diets. Mineral interactions, such as the rivalry for absorption between iron and zinc or the suppression of calcium absorption by excessive phosphorus consumption, should be considered to guarantee optimal mineral utilisation.

**Table 3 Results of Mineral Analysis**

Sample Code	Fe ppm	Ca ppm	Zn ppm
Diet 1	119.0±1.41 <sup>c</sup>	596.5±2.12 <sup>c</sup>	27.5±2.12 <sup>c</sup>
Diet 2	100.0±2.83 <sup>b</sup>	408.5±2.12 <sup>b</sup>	25.0±1.41 <sup>b</sup>
Diet 3	181.5±10.61 <sup>e</sup>	687.0±2.83 <sup>e</sup>	20.0±1.41 <sup>b</sup>
Diet 4	146.0±1.41 <sup>d</sup>	605.5±9.19 <sup>c,d</sup>	30.5±2.12 <sup>d</sup>
Diet 5	140.0±2.83 <sup>d</sup>	602.0±5.66 <sup>c</sup>	33.5±2.12 <sup>d</sup>
Diet 6	112.0±1.41 <sup>c</sup>	614.0±1.41 <sup>d</sup>	30.0±1.41 <sup>d</sup>
Control	63.5±0.71 <sup>a</sup>	105.0±4.24 <sup>a</sup>	13.5±0.71 <sup>a</sup>

\*Values are means ± SD duplicate determinations.

\*Values of alphabets in the same column with common superscript are not significantly different (at  $p < 0.05$ ).

### Animal Bioassay

Animal bioassay refers to the biological assays, is a method of assessing the effect of a substance on living organisms. Samples were collected from the laboratory animal at three different times (Day 0, Day 14 and Day 28) in order to study the effect of the diet. For day 0, Tissues (Muscles, Kidney, and Liver) and excretions (Faeces and Urine) were collected, Day 14 only excretions were collected (Faeces and Urine) and Day 28 both Tissues (Muscles, Kidney, Blood and Liver) and excretions (Faeces and Urine) were collected. The results of the percentage Nitrogen for each day are shown on table 4a – 4c below.

The %Nitrogen content of several samples obtained from laboratory rats given various weaning meals and a control sample during a 28-day period was determined. Nitrogen is a necessary component of proteins, thus measuring %Nitrogen can offer information on protein metabolism and utilisation in the body.

The findings for the various samples at each time point (Day 0, Day 14, and Day 28). The %Nitrogen content on day 0 is evaluated in several tissues (Muscle, Kidney, Liver) and excretions (Faeces, Urine). At first, all samples had a roughly similar %Nitrogen concentration. On day 14, the %Nitrogen in Urine and Faeces for each diet, as well as the Control, is measured. The %Nitrogen concentration varies, reflecting changes in protein utilisation and excretion between diets. In comparison to the other diets and the Control, Diet 2 had a greater %Nitrogen in both urine and faeces.

On Day 28, the %Nitrogen in Urine, Faeces, Muscle, Kidney, Liver, and Blood is tested for each diet and the Control. Diet 2 consistently had a larger percentage of nitrogen in urine, faeces, and different tissues when compared to the other diets and the Control. Diets 3, 4, and 6 all have varied %Nitrogen contents, indicating differing protein utilisation strategies. The %Nitrogen levels in several tissues in the Control sample are generally steady.

Diet 2, which consists of maize, millet, ugwu seed, and leaves, has unique protein metabolism patterns. Diet 2's higher %Nitrogen level may be due to the addition of certain substances. The nitrogen content of urine and faeces offers information on protein utilisation and excretion efficiency. varied dietary components result in varied nitrogen metabolism patterns. Diet 2 distinguishes out due to its consistently higher %Nitrogen content, which might indicate improved protein utilisation or alternative protein sources.

### Animal weights

Table 4d shows the results of the laboratory animal during a 28-day period, and the overall average weight gain is used in the discussion. The weights range from 49.99g (Diet 1) to 66.03g (Diet 5), with the control group weighing in at 51.92g in the middle. Diet 5 appears to have resulted in the greatest average weight, implying that it may be a more successful diet in promoting weight gain than the others. This could be because Diet 5 contains a higher amount of Ugwu seed, which is abundant in lipids and proteins, both of which are necessary for growth. It is crucial to note, however, that weight alone does not provide a

whole picture. The sort of weight gained, whether lean mass or fat mass, can have substantial impact on the rats' overall health. The PER and FER must be considered for a more comprehensive evaluation.

Table 4c Percentage Nitrogen Day 28

Sample	Urine	Faeces	Muscle	Kidney	Liver	Blood
Diet 1	0.934	1.310	1.438	1.642	1.252	1.426
Diet 2	2.015	1.374	1.564	1.540	1.304	1.513
Diet 3	1.121	1.420	1.787	1.449	1.377	1.550
Diet 4	0.800	1.452	1.360	1.384	1.458	1.570
Diet 5	0.800	1.197	1.317	1.310	1.530	1.654
Diet 6	0.800	1.456	1.406	1.270	1.549	1.747
Control	1.201	1.277	1.264	1.244	1.652	1.723

Table 4d Animal weight in grams

Days	Diet 1	Diet 2	Diet 3	Diet 4	Diet 5	Diet 6	Control
Day 0	0	0	0	0	0	0	0
Day 1	49.90	52.60	52.86	61.28	59.16	53.92	50.52
Day 4	46.60	49.40	47.60	57.20	57.40	49.20	47.60
Day 7	46.60	51.60	49.60	58.60	61.80	50.40	50.00
Day 10	47.80	54.00	53.40	61.40	64.40	54.00	51.80
Day 13	49.20	64.00	55.00	64.40	67.60	53.80	52.00
Day 14	49.00	64.20	55.00	62.00	67.60	53.80	52.20
Day 17	49.20	64.60	56.00	63.40	55.00	54.80	51.60
Day 20	51.60	71.60	58.40	65.80	71.80	57.20	52.80
Day 23	52.20	71.60	59.00	67.00	71.80	58.80	53.60
Day 26	53.20	73.80	65.60	68.80	73.80	61.20	53.60
Day 28	54.6	66.8	66.8	69	76	64	55.4
Average	49.99	62.20	56.30	63.53	66.03	55.56	51.92

Table 4a Percentage Nitrogen Day Zero (0)

Percentage Nitrogen – Day Zero (0)	
Sample	%Nitrogen
Muscle	1.438133
Kidney	1.432232
Liver	1.440832
Faeces	1.362866
Urine	1.415922

Table 4b Percentage Nitrogen Day 14

Percentage Nitrogen – Day 14		
Sample	%Nitrogen in Urine	%Nitrogen in Faeces
Diet 1	0.966	1.374178
Diet 2	1.444765	1.438493
Diet 3	1.4007	1.488379
Diet 4	0.9338	1.524006
Diet 5	0.9338	1.250067
Diet 6	0.9338	1.528087
Control	1.4007	1.338462

#### Protein Efficiency Ratio

The PER (Protein Efficiency Ratio) is a measure of how well the rats used the protein in their diet to grow. Diet 4 has the greatest PER of 12.30, indicating that it was the most effective at boosting protein utilisation for growth. This result could be attributed to the high percentage of leaves in this diet, as leaves frequently provide necessary amino acids required for protein synthesis. Diet 3 has the lowest PER at 4.47, indicating that it was less effective in utilising protein for growth. The larger percentage of Ugwu seed and leaves in this diet may not have given the ideal balance of amino acids required for effective protein synthesis.

#### Feed Efficiency Ratio (FER)

The FER (Feed Efficiency Ratio) indicates how well the rats transformed the food they ate into body mass. Diet 2 has the highest FER (2.26), indicating that it was the most efficient at turning feed into body mass. Ugwu seed and leaves may have contributed to this efficiency by supplying a balanced combination of

nutrients required for growth. Despite having the greatest average weight, Diet 5 has a slightly lower FER of 2.40. This implies that, while the rats acquired more weight on this diet, they did so at a little higher cost in terms of feed. The introduction of Ugwu seed in Diet 5 may have contributed to weight increase, although at a lower efficiency of feed conversion into body mass. In terms of PER and FER, the control group lies in the middle, showing that the commercial diet utilised as a control is an acceptable benchmark for comparison. The rats in the control group had a modest average weight and a balanced protein utilisation and feed conversion efficiency.

Diet 5 is regularly shown to be the most beneficial in terms of boosting both average weight growth and efficient protein utilisation and food conversion. The larger quantity of Ugwu seed in Diet 5 may have had a role in these favourable results, presumably by providing critical nutrients for rat growth. Diet 4 is also notable for its high PER, which indicates great protein efficiency. This meal's balanced blend of Ugwu seed and leaves may have contributed to this efficiency, highlighting the necessity of a well-balanced diet. In terms of PER and FER, the control group, represented by the commercial diet, achieves competitive results. This implies that commercial diets are a realistic and efficient choice for maintaining lab rat growth. Diet 1, which has an equal amount of maize and millet, appears to be less successful in stimulating rat growth than the other diets. This could be due to a lack of certain nutrients or an imbalance in the critical components required for proper growth.

Diet 5 produced the greatest average weight, Diet 4 produced the highest PER, and Diet 2 produced the highest FER. These findings show the complexities of diet impacts on lab rat growth, emphasising the importance of considering several criteria other than weight. The makeup of each diet, namely the proportions of maize, millet, Ugwu seed, and leaves, is critical in influencing the observed effects. Understanding these findings can help to improve lab rat diets for research purposes, assuring optimal development and health outcomes for these crucial experimental animals.

**Table 5 Animal average weight, PER and FER of animal**

Sample	Av. Wt (g)	PER	FER
Diet 1	49.99	7.856638	1.708727
Diet 2	62.20	6.316953	2.261818
Diet 3	56.30	4.465313	2.047273
Diet 4	63.53	12.30293	2.310182
Diet 5	66.03	9.629899	2.401091
Diet 6	55.56	8.240194	2.020364
CONTROL	51.92	8.680924	1.888

#### *Nitrogen Retention*

Nitrogen retention is an important indicator of the balance of nitrogen intake and excretion, which reflects the efficiency of protein utilisation in the body.

1.232305734 NR on Diet 1 (D1). Diet 1 contains 50% maize and 50% millet and has a moderate level of nitrogen retention. The balanced combination of maize and millet most likely adds to the rats' favourable nitrogen balance. Nitrogen Retention in Diet 2 is 1.844288889. Diet 2, a more complex composition of 40% Maize, 40% Millet, 10% Ugwu seed, and 10% leaves, retains more nitrogen than Diet 1. The extra components may improve protein utilisation or absorption in rats.

Nitrogen Retention is 1.795162998 on Diet 3 (D3). Diet 3, which contains 40% Maize, 40% Millet, 15% Ugwu seed, and 5% leaves, had nitrogen retention levels comparable to Diet 2. The increasing amount of Ugwu seed and leaves may help to improve nitrogen balance. Diet 4 has 1.062212469 Nitrogen Retention and contains 40% Maize, 40% Millet, 5% Ugwu seed, and 15% leaves; had lesser nitrogen retention than the previous diets. The exact combination or ratio of ingredients may not be ideal for protein utilisation.

Nitrogen Retention is 1.05508611 on Diet 5 (D5). Diet 5, which contains 40% Maize, 40% Millet, and 20% Ugwu seed, has nitrogen retention levels comparable to Diet 4. The larger proportion of Ugwu seed may not be considerably improving nitrogen levels. Nitrogen Retention is 1.023928198 on Diet 6, which consists of 40% maize, 40% millet, and 20% leaves, has somewhat lower nitrogen retention than the other diets. The presence of

a higher proportion of leaves may affect overall protein utilisation in a negative way for nitrogen retention.

The control diet has Nitrogen Retention of 1.976136568. The commercial diet used as the control has a reasonably high amount of nitrogen retention. This could be due to the commercial diets' precisely planned and balanced character, which ensures appropriate nutrient intake and utilisation.

In general, the nitrogen retention data indicate that the composition and ratios of elements in the diets are important in determining the efficiency of protein utilisation in lab rats.

**Table 6 Table of Protein efficiency**

Sample	Nitrogen			
	Retention	BV	TPD	NPU
Diet 1	1.232	63.200	10.138	640.697
Diet 2	1.844	32.494	16.296	5.295
Diet 3	1.795	35.409	15.639	5.538
Diet 4	1.062	61.557	1.7194	1.058
Diet 5	1.055	61.312	1.552	0.952
Diet 6	1.024	60.207	4.3337	2.609
Control	1.976	42.829	24.841	10.639

#### *Biological Value (BV)*

The proportion of ingested protein retained in the body for development and maintenance is measured as Biological Value (BV). Diet 1 has a moderate BV (63.20004027), indicating that a protein supply with a reasonable biological value can be obtained by combining 50% maize and 50% millet. Diet 2 has a lower BV (32.49378721) than Diet 1. The use of Ugwu seed and leaves may have an effect on the overall quality of protein absorbed and retained in the body. Diet 3, which has a similar composition as Diet 2 but a different ratio of Ugwu seed and leaves, similarly has a lower BV (35.40882751). This implies that the precise combination and balance of these substances has an effect on protein quality. Diet 4 has a greater BV (61.55661055) than the preceding two diets (Diets 2 and 3). The specific mix of 5% Ugwu seed and 15% leaves appears to lead to a higher biological value.

Diet 5 has a similar BV (61.31228275) to Diet 4, showing that the increased quantity of Ugwu seed in this case does not significantly improve protein quality when compared to Diet 4. Diet 6 has a significantly lower BV (60.20651507)

than Diets 4 and 5. The presence of 20% leaves may have an effect on the overall quality of protein ingested. The BV (42.82854555) of the control diet is lower than that of some of the experimental diets. This finding may come as a surprise given that commercial diets are often designed for optimal nutritional utilisation. It could be worthwhile to look at the exact protein sources and quality in the control diet. Overall, the BV results show that the inclusion and amount of various elements in diets have a considerable impact on the quality of food.

#### *True Protein Digestibility (TPD)*

True Protein Digestibility (TPD) is a measure of the proportion of ingested protein that is absorbed and utilized by the body.

Diet 1 has a moderate TPD (10.13760112), indicating that the 50/50 Maize/Millet combination provides a protein source with reasonable digestibility. Diet 2 has a greater TPD (16.29601889) than Diet 1. The addition of Ugwu seed and leaves may improve the overall digestion of protein in this diet. Diet 3 has a higher TPD of 15.63928301, with a comparable composition to Diet 2 but a different ratio of Ugwu seed and leaves. This shows that the exact combination and balance of these substances has a positive impact on protein digestion.

When compared to the previous diets, Diet 4 has a substantially lower TPD (1.71944761). This diet's specific combination or ratio of nutrients may not be as conducive to good protein digestion. Diet 5 has a TPD (1.552197701) that is similar to Diet 4, demonstrating that the increased quantity of Ugwu seed in this case does not significantly improve protein digestibility over Diet 4. Diet 6 has a slightly higher TPD (4.333675953) than Diets 4 and 5, but a lower TPD than Diets 2 and 3. The presence of 20% leaves may have an effect on the total digestion of protein. Among all diets, the control diet had the greatest TPD (24.84126853). This is consistent with the idea that commercial diets are meticulously designed for optimal nutritional digestion. The TPD data suggest that the diet composition has a substantial impact on the digestibility of ingested protein, with some diets having a greater TPD than others.

### Net Protein Utilization (NPU)

Net Protein Utilization (NPU) is a comprehensive measure that takes into account both the quality of absorbed protein (BV) and the digestibility of ingested protein (TPD).

Diet 1 has a very high NPU (640.6967992), indicating that the combination of 50% Maize and 50% Millet gives a protein supply with excellent utilisation in the body. In comparison to Diet 1, Diet 2 has an unexpectedly low NPU (5.295193701). Despite having a greater TPD, Diet 2 has a much lower BV, resulting in a lower overall NPU. Diet 3, which has a comparable composition to Diet 2, likewise has a low NPU (5.537686745). This emphasises the importance of both protein quality and digestibility in determining NPU.

Diet 4 has a very low NPU (1.058433669), indicating that the mix of nutrients in this diet is not optimum for protein utilisation. This low NPU is caused by both BV and TPD. Diet 5 has a comparable low NPU (0.951687843) to Diet 4, confirming that the exact mix and amount of components in this diet results in poor protein utilisation. Diet 6 has a greater NPU (2.609155266) than Diets 4 and 5, but a lower NPU than Diet 1. The presence of 20% leaves may have an effect on both BV and TPD, resulting in a reduced overall NPU. In comparison to the experimental diets, the control diet has a moderate NPU (10.63915401). While not as high as Diet 1, it is much higher than Diets 2, 3, 4, and 5. This could be attributed to the carefully formulated nature of commercial diets.

The NPU findings emphasise the need of incorporating both BV and TPD when measuring overall protein utilisation in lab rats. Diet 1 has excellent protein utilisation, however certain experimental diets, particularly Diets 2, 3, 4, and 5, have inadequate NPU values. The control diet performs reasonably well, although the specific protein sources and quality in the control diet merit additional examination.

Diet 1, which consists of a 50/50 mix of maize and millet, performs well in terms of nitrogen retention, biological value, true protein digestibility, and net protein utilisation. This implies that a simple and balanced diet can

result in excellent protein utilisation in laboratory rats. Some experimental diets, however, yield unsatisfactory results in one or more parameters, indicating that the inclusion and amount of specific elements in these diets may not be favourable to effective protein utilisation. The presence of Ugwu seed and leaves, as well as the particular ratios of these components, may influence the overall nutritional content of these diets.

The control diet, a commercial diet, performs pretty well in terms of nitrogen retention and true protein digestibility, although it has a lower biological value than Diet 1. Further research into the individual protein sources and their quality in the control diet may shed light on its performance. It is critical to examine the study's limitations, such as the sample size, the type of lab rats utilised, and the potential diversity in nutrient content of the ingredients. Furthermore, future research could look at the underlying mechanisms that lead to the observed disparities in protein utilisation among diets.

### Sensory Evaluation

Weaning meals are important in newborn nutrition because they provide critical nutrients for growth and development. The sensory evaluation of different weaning food formulations, including colour and appearance, scent, taste, texture, and overall look. The study, which was carried out on several diets and a commercial control, gives useful information about the nutritional quality and acceptability of these formulations.

**Table 7 Sensory Evaluation**

Sample	Colour and Appearance	Aroma
Diet 1	1.70±0.47 <sup>a,b</sup>	1.25±0.44 <sup>a</sup>
Diet 2	1.90±0.79 <sup>b</sup>	1.45±0.51 <sup>a</sup>
Diet 3	1.80±0.89 <sup>b</sup>	1.35±0.49 <sup>a</sup>
Diet 4	1.55±0.83 <sup>a,b</sup>	1.45±0.51 <sup>a</sup>
Diet 5	1.30±0.47 <sup>a</sup>	1.35±0.49 <sup>a</sup>
Diet 6	1.40±0.33 <sup>a</sup>	1.05±0.41 <sup>a</sup>
Control	1.95±0.73 <sup>a,b</sup>	1.55±0.51 <sup>a</sup>

### Color and Appearance

Colour and appearance scores differ between diets. Diet 5, which contained 40% maize, 40% millet, and 20% ugwu seed, had the lowest

score (1.300.47a), indicating a more favourable response. The commercial diet control group earned a rather high score (1.950.73<sup>a,b</sup>), indicating that it may have a more visually appealing appearance. The variance in scores emphasises the role of visual appeal in determining weaning meal acceptability.

#### *Aroma*

Aroma is an important aspect in food acceptance. Diet 6, which had 40% maize, 40% millet, and 20% leaves, had the lowest fragrance score (1.050.41<sup>a</sup>), indicating a less favourable response. Diet 1 obtained the highest fragrance score (1.250.44<sup>a</sup>), consisting of 50% maize and 50% millet. The control group received a similar high score (1.550.51<sup>a</sup>). Aroma is important in total food enjoyment, and the discrepancies indicate disparities in component combinations and processing processes.

#### *Taste*

Diet 1 had the greatest flavour rating (2.350.99<sup>c</sup>), while Diet 6 had the lowest (1.300.6<sup>c</sup>). The control group obtained a score of 1.900.55<sup>a</sup>, suggesting that it was well-liked. Taste is a complicated property that is impacted by a variety of elements such as the concentration of specific minerals, flavour compounds, and the overall balance of substances.

#### *Texture*

Diet 6 had the greatest texture score (1.700.83<sup>a</sup>), with 40% maize, 40% millet, and 20% leaves, whereas Diet 1 had the lowest (1.400.60<sup>a</sup>). Texture is an important factor in food acceptance, particularly for weaning foods, because infants are sensitive to changing textures throughout the shift from liquid to solid foods.

#### *General Appearance*

Colour and appearance scores are largely consistent with overall appearance assessments. Diet 5 had the lowest score (1.700.73<sup>a</sup>), but the control group had a very good score (1.800.38<sup>a</sup>). The overall look includes a variety of sensory qualities that convey the overall impression of the weaning food.

Finally, sensory evaluation of weaning foods provides important information about their nutritional content and acceptability. The differences in scores between diets underscore the relevance of constituent composition,

processing methods, and overall formulation in defining these foods' sensory qualities.

#### IV. CONCLUSION

The study's results suggest that Diet 5, with 40% Maize, 40% Millet, and 20% Ugwu seed, is the most effective in promoting lab rat growth, protein efficiency, and food conversion efficiency. However, it is crucial to consider the nutritional requirements and goals when choosing a diet for lab rats, as different diets may have varying effects on growth and efficiency. Further research and experimentation could explore the specific nutritional components contributing to the success of Diet 5 and refine the formulation for optimal results.

Furthermore, interventions could be developed to improve certain sensory characteristics, so improving the overall acceptability and nutritional content of these critical infant feeds. Finally, this study adds to the field of nutritional science by emphasising the significance of properly structuring meals for optimal protein utilisation in experimental animals. The findings could have an impact on the formulation of nutritionally balanced diets for laboratory animals and, by extension, human populations.

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