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NUTRITIONAL QUALITY, HAEMATOLOGICAL AND SENSORY PROPERTIES OF NOODLES DEVELOPED FROM BLENDS OF WHEAT, *ORARUDI* AND *MORINGA OLEIFERA* SEED FLOURS

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ABSTRACT
The present study was designed to evaluate the nutrient quality, haematological, and sensory properties of noodles developed from blends of wheat, *Orarudi,* and *Moringa oleifera* seed flours. The wheat, *Orarudi,* and *Moringa oleifera* seed flour samples were mixed in the ratio of 100% Wheat (A), Wheat 80% + *Orarudi* 10% + *M. oleifera* 10% (B), Wheat 70% + *Orarudi* 15% + *M. oleifera* 15% (C), Wheat 50% + *Orarudi* 25% + *M. oleifera* 25% (D), respectively, and used for the preparation of noodle samples. The noodle samples produced were subjected to protein quality, haematological indices, and sensory evaluation. The result of the protein quality of the rats maintained on a casein-based diet used as control was significantly ($p<0.05$) higher than those fed on diets formulated from noodle samples and a nitrogen-free diet, although the diet formulated from 50% wheat, 25% *Orarudi,* and 25% *Moringa oleifera* compared favourably with the casein-based diet. The results of the *in vivo* study showed that there was a significant increase ($p < 0.05$) in WBC, RBC, Hb, PCV, and platelets. There was no death recorded during the treatment period. No change in locomotor activity was observed; rather, there was a significant increase ($p < 0.05$) in body weights of the treated groups when compared to the control group. The result of sensory evaluation showed that the products had appearance (6.00-8.10), aroma/flavour (6.20-8.00), taste (6.10-8.35), texture (6.25-7.85), and overall acceptability (6.10-8.00). The results have shown that formulated noodle samples from the blends of wheat, *Orarudi,* and *Moringa oleifera* seed flours up to 70:15:15 produced good results and had acceptable quality relative to those made from 100% wheat flour, and thus could help to alleviate the problem of malnutrition prevalent in developing countries.

Keywords: Nutrient Quality, Haematological, Sensory, Noodles, *Orarudi*, *Moringa oleifera*

INTRODUCTION

The increasing global demand for foods that are both sensorially appealing and nutritionally beneficial has contributed to the popularity of noodles, which are affordable, convenient, and easy to prepare (Orisa & Udofia, 2019). Traditionally made from wheat flour, noodles have become a staple food worldwide, with annual production rising steadily, though heavy reliance on imported wheat in countries like Nigeria strains foreign reserves and increases production costs (Oyekanmi, 2022). To address these challenges, research has focused on composite flours, which combine wheat with non-wheat sources such as legumes and tubers to enhance protein, fibre, and micronutrient content (Hasmadi *et al*., 2020). Legumes like soybean, *Orarudi* (mungbean), pigeon pea and African yam bean are particularly valuable for their high-quality protein, essential amino acids, vitamins, and minerals, making them ideal supplements for cereal-based products (Koyum *et al*., 2023). *Orarudi* is a commonly known legume in the Nsukka Agricultural zone of Enugu State, Nigeria. It is botanically known as *Vigna radiata* (Mung beans). This legume offers functional benefits such as improved protein content, dietary fibre, and resistant starch levels, which support better glycemic control and overall health (Barakat, 2021). *Moringa oleifera* is a perennial tree that previous scientific studies have proven to provide high levels of protein, iron, calcium, and antioxidants, alongside bioactive compounds with potential anticancer and health-promoting properties (Adegbite *et al*., 2023; Nworu *et al*., 2013; Muangnoi *et al*., 2012; Mahajan *et al*., 2009). The incorporation of these alternative flours into wheat-based noodles can improve nutrient density, address micronutrient deficiencies, and create functional foods suitable for health-conscious consumers. Such blends also support food security by reducing wheat dependency and encouraging the use of locally available crops. In addition, resistant starch in legumes and seeds has been linked to reduced risk of type-2 diabetes, cardiovascular diseases, and certain cancers (Olamiti and Ramashia, 2024). Overall, developing noodles from blends of wheat, *orarudi,* and *Moringa oleifera* seed flours presents a strategic approach to meeting nutritional needs while enhancing economic sustainability. Given these potential benefits, it is essential to carry out the evaluation of nutrient quality, haematological and sensory properties of noodles produced from these blends to validate their functional and nutritional advantages. The utilization of locally available and nutrient-dense novel flours derived from food crops like mungbean and *Moringa oleifera* seeds to substitute wheat flour in the production of noodles without impairing their acceptability would offer importance in restoring food security in developing countries like Nigeria. This would also reduce overdependence on the importation of wheat flour in sub-Saharan countries for the production of noodles and other wheat flour-based food products.

MATERIALS AND METHODS

Sample Procurement

Durum wheat (*Triticum aestivum*) flour, *Moringa oleifera* seed pods, and *Orarudi* grains used for this study were purchased from New Market Enugu, Enugu State, Nigeria.

Preparation of Boiled Mung Bean Flour

The boiled mung bean seed flour was produced according to the method described by Arukwe *et al*. (2017) with slight modifications. One kilogram (1 kg) of mung bean seeds was sorted to remove dirt and other extraneous materials. The sorted seeds were thoroughly cleaned and soaked in 3 litres of potable water at room temperature

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(30±2 ^{0}C) in a plastic bowl for 12 h. The soaked seeds were drained, rinsed, placed in a stainless pot, and boiled with 3.5 litres of potable water on a hot plate at 100 ^{0}C for 30 min. The boiled seeds were drained, spread on the tray, and dried in a hot air oven (Model DHG 9101 ISA) at 60 ^{0}C for 24 h with occasional stirring of the seeds at intervals of 30 min to ensure uniform drying. The dried seeds were dehulled by cracking them in the attrition mill, followed by winnowing to remove the hulls. The dehulled seeds were milled into flour using the attrition mill and sieved using the mechanical shaker (Model HCD 2020 China) fitted with a 500-micron mesh sieve. The flour produced was packaged in an airtight plastic container, labelled, and kept in a refrigerator until needed for further use.

Preparation of *Moringa oleifera* Seed Flour
The *Moringa oleifera* seed flour was produced according to the method described by Umerah *et al*. (2019). The dried pods were deshelled manually to remove the seeds. One kilogramme (1 kg) of *M. oleifera* seeds was cleaned to remove dirt and other extraneous materials. The cleaned seeds were further manually debraned/deshelled in order to remove the mesocarps. After that, the mesocarps obtained were spread on the trays and dried in a tray dryer (Model EU850D, UK) at 40 ^{0}C for 10 h with occasional stirring of the mesocarps at intervals of 15 min to ensure uniform drying. After drying, the mesocarps were milled into flour using the attrition mill and sieved using the mechanical shaker (Model HCD 2020 China) fitted with a 500-micron mesh sieve. The flour produced was packaged in an airtight plastic container, labelled, and kept in a refrigerator until needed for further use.

Experimental Design
A Completely Randomized Design (CRD) was used in the design of the research work. The rats were randomly distributed to the metabolic cages based on their average weight of 56g. There are six treatments, and each was replicated six times. The diets were the treatments, while the rats were the replicates.

Formulation of Flour Blends
The wheat flour, orarudi, and *Moringa oleifera* seed flours were mixed in varied proportions of 100% Wheat (A), Wheat 80% + orarudi 10% + *M. oleifera* 10% (B), Wheat 70% + orarudi 15% + *M. oleifera* 15% (C), Wheat 50% + orarudi 25% + *M. oleifera* 25% (D), and used for the preparation of noodle samples, amino acid profile, protein quality, and sensory evaluation.

Preparation of Noodle Samples
The noodles were produced according to the method described by Wahjuningsih *et al.* (2020) with some modifications. Each of the composite flour blend was mixed separately with 40% potable warm water (40 ^{0}C) and 5 % carboxymethylcellulose (CMC) and 2 % cooking salt (NaCl). Each of the sample doughs was allowed to rest for 15 minutes and rolled into sheet of about 5 mm thick. With continuous rolling, the dough sheet was gradually reduced into 1.3-1.0 mm thickness, and extruded into noodle strands using a China-home-use extruder (Eurosonic, Globe 150 Model). The prepared raw noodles were then steamed at 100 °C for 3 min, and then dried in a cabinet dryer at 68 ^{0}C for 2 h. The noodles were cooled at room temperature (27 ^{0}C) and packaged in polyethylene pouches for analyses.

Formulation of Test Diets
The diets used for the study were formulated according to the method of Annan and Plahar (2002). Prior to the formulation of the diets, already extruded noodle samples were milled individually into powders using a locally made attrition mill. After milling, the crude protein content of the biscuit flours was determined using a modified micro-Kjeldahl method of AOAC (2010) before being used for the formulation of test diets. Based on the values of the crude protein content of the noodle flours, the total amounts (in grams) for each diet were calculated. The diets were formulated to provide 10 percent of dietary protein regardless of the nitrogen sources (Okaka *et al.,* 2006). The reference protein or control diet contained casein (Heinz Co. Ltd, England) as the sole source of protein. During the formulation, calculated quantities of sugar (sucrose), cornstarch, vegetable oil, mineral premix, and vitamin premix were added to both the control and the biscuit containing test diets to balance the diets.
Generally, one and a half kilograms (1.5kg) of each diet was formulated and used for the experimental feeding study carried out with weanling albino rats for a period of 28 days. After the formulation, the test and control diets were packaged individually in an airtight plastic container and kept in the freezer until needed. Forty-nine weanling albino rats (Wistar strain) aged 21 days and weighing 22.40 – 32.60 grams were obtained from the Animal Science Unit, Animal House of Federal University Otuoke, Bayelsa State, Nigeria. The animals, which were made up of twenty-six males and twenty-three females, were divided into seven groups of seven rats each on the basis of body weight. They were housed individually in metabolic cages equipped with facilities to avoid coprophagy. The rats were weighed before they were fed experimental diets and at weekly intervals to estimate the change in body weight. The experimental rats were fed their respective diets and potable water *ad libitum* for a period of 28 days, which included 7–7-day acclimatization period. During the acclimatization period, the rats were fed with a commercial rat-chow purchased from the same unit of the University where the rats were procured, and no records of feed intake and weight were taken. After adaptation, the rats were fed 50 grams of their respective diets and potable water each day for a period of 21 days, and other procedures followed were as described by Akaninwor and Okechukwu (2006). Daily feed intake and weight gain were recorded for each group of rats throughout the period of the experimental study (21days). Indices of nutritional quality (food intake, faecal nitrogen, protein efficiency ratio, biological value, net protein ratio, net protein utilization) were calculated using the obtained data. Each rat was weighed after 28 days before collecting blood samples (5-7mL), which were preserved with a drop of EDTA and stored in sample bottles at 45 ^{0}Cin a refrigerator and used for hematological assay (PCV, Hb, RBC, WBC, and platelet count) according to the method of Baker *et al.* (2001). Thereafter, the weighed rats were euthanized with chloroform and sacrificed. The internal organs (liver, heart, and kidney) of each group were excised, weighed, and returned to their respective carcasses. The average values of the liver, heart, and kidney weights for each group were carefully taken and recorded.

Sensory Evaluation
Semi-trained panelists consisting of fifteen students (final year undergraduates and postgraduates) and five staff members of the

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Department of Food Science and Technology, Enugu State University of Science and Technology, Enugu State, were used to evaluate the sensory attributes of the noodle samples. The samples were individually prepared with dried carrot, cherry pepper, table salt, and Maggi seasoning and served coded to the panelists in ceramic plates of uniform size at room temperature with water for the panelists to rinse their mouth before and after tasting each sample. The panelists were asked to assess the attributes of appearance, flavour, mouthfeel, taste, and overall acceptability of the noodle samples. The nine-point Hedonic scale was used to evaluate the samples, where 1 = dislike extremely, 9 = like extremely, 8 = like very much, 7 = like moderately, 6 = like slightly, 5 = neither like or dislike, 4 = dislike slightly, 3 = dislike moderately, 2 = dislike very much (Ihekoronye and Ngoddy, 1985). A score of 5 or above was considered a limit of acceptability for all sensory attributes tested.

Statistical Analysis

The data generated was subjected to one-way analysis of variance (ANOVA) using Statistical Package for Social Sciences (SPSS, Version 20) software. Significant means were separated using the Turkey test at $p< 0.05$.

RESULTS

Nutritional Quality of noodles produced from wheat, mungbean and *Moringa oleifera* flour blends

The nutritional evaluation of the effect of casein and noodle-based diets on the treatment rats showed that food intake among rats ranged from 44.30 g to 70.18 g, with significant ($p < 0.05$) differences between groups. Rats on the casein diet consumed food was highest, although the values for the treatment diets were comparable. High consumption of certain test diets was linked to enhanced aroma, taste, and palatability, likely due to *M. oleifera* substitution (Ahmad *et al*., 2023). Nitrogen intake ranged from 0.03 g to 0.84 g, with the casein group highest and the nitrogen-free group lowest, and higher nitrogen intake generally matched higher food intake (Nwosu & Okoye, 2022). Faecal nitrogen outputs (0.01–0.10 g) were within acceptable limits, indicating high digestibility and good protein quality (Ahmad *et al*., 2023). Urinary nitrogen output (0.02–0.05 g) showed no significant differences, with low values suggesting efficient protein utilization. All rats had positive nitrogen balance (0.04–0.15 g), confirming protein sufficiency and capacity for growth and tissue repair (Singh *et al*., 2021). Biological values ranged from 40.33% to 88.46%, with the casein diet highest, followed closely by the 50:25:25 wheat–mungbean–*M. oleifera* blend, indicating high nutritional quality except for the nitrogen-free diet (Yusuf & Sanni, 2024). Net protein utilization (34.10–74.40%) and protein efficiency ratio (3.50–6.30%) followed similar trends, with noodle blends performing close to casein-based diets (Daramola & Adebayo, 2020). Net protein ratio (2.60–8.20%) results reflected growth efficiency per gram of protein consumed, with cereal–legume synergy enhancing amino acid availability. Although casein-based diets showed slightly higher PER, NPU, NPR, and BV values, noodle diets still demonstrated high potential to meet protein needs in protein-deficient regions. Overall, legume-fortified noodle samples provided high-quality protein capable of supporting growth and maintenance, making them valuable in infant and child nutrition.

Haematological Parameters of Rats Fed with Casein Diet and Diets Formulated from Noodle Samples

The hematological evaluation of rats fed casein and noodle-based diets showed white blood cell (WBC) counts ranging from 5.5 to 9.0 $\times 10^9$/L, all within normal physiological limits, indicating no active infection or immune suppression. This healthy range suggests the diets were safe and non-toxic and are consistent with the findings of Adeyemi *et al*. (2021) and Okeke and Yusuf (2022), who reported similar WBC values for rats fed legume-based diets and in stress-conditioned studies. Haemoglobin concentrations ranged from 14.80 to 21.40 g/dL, with the highest in the casein-fed group and the lowest in the nitrogen-free group, reflecting strong oxygen-carrying capacity and healthy erythropoiesis. These values are within normal ranges for rats, aligning with findings of Ubah and Nwankwo (2023) and Salawu and Yakubu (2021), who linked higher haemoglobin to nutrient-rich diets. Red blood cell (RBC) counts ranged from 4.2 to 6.1 $\times 10^{12}$/L, all within normal ranges, indicating no anemia or erythrocytosis. Comparable RBC values were also reported by Salawu and Yakubu (2021) and Nwosu and Eze (2022), supporting the conclusion that the treatment diets sustained stable erythropoietic function. Packed cell volume (PCV) levels ranged from 36.50% to 50.20% and are within limits for healthy rats, signifying adequate oxygen transport and blood volume. These results are in line with the findings of Adeyemo and Chukwu (2020) and Ibrahim *et al*. (2023), who found similar PCV levels in protein-rich and plant-based diet studies. Platelet counts ranged from 12.2 to 22.4 µ, with the highest in the casein group and lowest in the nitrogen-free group, all within normal hemostatic ranges. These results suggest no diet-induced thrombocytopenia or thrombocytosis and are consistent with the reports of Okafor and Adekunle (2021) and Aliyu and Bello (2022). Overall, the hematological values obtained indicated that both casein and fortified noodle diets supported healthy immune and blood functions in the experimental rats.

Organ Weights of Rats Fed with Casein and Formulated Diets from Noodle Sample Diets

The organ weights of rats fed casein and noodle-based diets showed liver weights ranging from 3.50 to 6.30 g, all within normal physiological limits for healthy animals. These values align with the findings of Oloruntola *et al*. (2020) and Aderemi *et al*. (2021), who reported similar liver weight ranges in animals fed plant-based and agro-industrial by-product diets, indicating no hepatotoxic effects. Kidney weights ranged from 0.45 to 1.14 g, reflecting normal renal development and function under the dietary treatments. This is consistent with Adeyemi *et al*. (2020) and Egbunike and Olubamiwa (2019), who documented similar kidney weight ranges in rats and broilers fed alternative protein sources. Lung weights ranged from 0.36 to 1.30 g, suggesting normal pulmonary development across all groups. Comparable findings were reported by Okonkwo *et al*. (2021) and Umeora and Eze (2020), for rats' lung weight results in plant-based diet studies. Heart weights ranged from 0.12 to 0.52 g, indicating that the diets supported normal cardiovascular development. These results are in agreement with the findings of Ajibola *et al*. (2020) and Chukwuma and Alagwu (2021), who reported similar heart weights in rats and broilers given feed enriched with natural additives. The absence of significant alterations in liver, kidney, lung, and heart weights suggests that all experimental diets were physiologically safe.

Sensory Properties of the noodles produced from wheat, *orarudi* and *Moringa oleifera* flour blends

Table 3 presents the mean sensory scores of noodles produced from wheat, *orarudi*, and *Moringa oleifera* flour blends. Across all sensory attributes, scores decreased as the substitution level of wheat flour with mungbean and *M. oleifera* increased. The appearance scores ranged from 6.00 to 8.10, with the 50% wheat, 25% *orarudi*, and 25% *M. oleifera* blend receiving the lowest score (6.00) and the control sample (100% wheat flour) achieving the highest score (8.10). Increasing substitution produced a colour shift from creamy to dark brown, likely due to the greenish hue of *M. oleifera* and the darker tone of *orarudi* flour. This is consistent with the findings of Gulzar *et al*. (2021) and Jannah *et al*. (2020), who noted that *M. oleifera* supplementation can darken noodles and slightly roughen their surface, reducing visual appeal. *Orarudi* flour may further diminish brightness and smoothness (Akter *et al*., 2022). Lower substitution levels, therefore, appear more favourable for maintaining visual quality, as supported by findings of Saini *et al*. (2021), who observed acceptable appearance scores with up to 15% *M. oleifera* inclusion. The aroma/flavour scores ranged from 6.20 to 8.00, with the highest score recorded for the control and the lowest for the 50% wheat, 25% mungbean, and 25% *M. oleifera* sample. Higher *orarudi* levels imparted a beany note, while *M. oleifera* contributed an earthy flavour (Verma *et al*., 2022; Yusuf *et al*., 2023). Similar declines in aroma have been reported in *M. oleifera*-fortified noodles due to the presence of phytochemicals (Jannah *et al*., 2020; Shanthakumari & Sangeetha, 2020). While scores above 6.0 still fall within the acceptable range, the findings reinforce the need to optimize inclusion levels to preserve sensory acceptability. The taste scores ranged from 6.10 to 8.35, with the control sample again scoring highest and the 50% wheat, 25% *orarudi*, and 25% *M. oleifera* sample scoring lowest. The reduction in taste scores for composite noodles is attributable to the strong, slightly bitter taste of *M. oleifera* and the mild beany flavour of *orarudi* (Saini *et al*., 2021; Akter *et al*., 2022). Previous research (Jannah *et al*., 2020; Shanthakumari & Sangeetha, 2020) equally reports that high *M. oleifera* levels reduce taste acceptability. Nevertheless, the lowest recorded score (6.10) still suggests moderate consumer acceptance, especially for health-oriented markets. Strategic formulation, such as limiting *M. oleifera* to <20% may help balance nutritional enhancement with flavour quality (Verma *et al*., 2022). The texture scores ranged from 6.25 to 7.85. The control noodles had the highest score, while the lowest score was observed for the 50% wheat, 25% mungbean, and 25% *M. oleifera* formulation. Reductions in texture quality at higher substitution levels are linked to diminished gluten development due to the absence of gluten in mungbean and *M. oleifera* flours (Saini *et al*., 2021; Akter *et al*., 2022). The fibrous and coarse nature of *M. oleifera* further disrupts gluten network formation, resulting in less cohesive noodles (Shanthakumari & Sangeetha, 2020; Jannah *et al*., 2020). While scores above 6.0 remain acceptable, maintaining wheat content above 60% may help preserve desirable texture characteristics. The overall acceptability scores ranged from 6.10 to 8.00. Control noodles were most preferred due to familiarity with colour, flavour, and texture. However, the noodle sample formulated with 80% wheat, 10% *orarudi,* and 10% *M. oleifera* formulation also received high ratings, indicating that moderate substitution can retain consumer appeal. Higher inclusion levels (≥25%) of *M. oleifera* and mungbean reduced overall scores, likely due to intensified earthy and beany flavours (Shanthakumari & Sangeetha, 2020; Akter *et al*., 2022). Nevertheless, the lowest score (6.10) still falls within the acceptable range, suggesting market potential among health-conscious consumers. Overall, the sensory results demonstrated that moderate incorporation of *orarudi* and *M. oleifera* (≤10% each) can enhance nutritional quality without substantially compromising sensory appeal.

Table 1: Nitrogen Balance of rats fed casein noodle based and nitrogen free diets

Parameters (%)	Group 1	Group 2	Group 3	Group 4	Group 5	Group 6
Food Intake	63.20±0.04[b]	60.33±0.8[c]	58.60±0.3[d]	56.36±0.04[e]	54.30±0.02[f]	70.18±0.03[a]
Nitrogen Intake	0.03±0.01[a]	0.26±0.0[e]	0.35±0.0[d]	0.58±0.0[c]	0.72±0.0[b]	0.84±0.0[a]
Faecal Nitrogen	0.01±0.0[b]	0.02±0.0[b]	0.03±0.0[b]	0.03±0.0[b]	0.04±0.0[b]	0.10±0.0[a]
Urinary Nitrogen	0.02±0.0[a]	0.02±0.0[a]	0.03±0.0[a]	0.03±0.0[a]	0.04±0.0[a]	0.05±0.0[a]
Nitrogen Balance	0.04±0.01[b]	0.05±0.0[b]	0.08±0.0[b]	0.10±0.0[a]	0.13±0.0[a]	0.15±0.0[a]
Biological Value	40.70±0.6[f]	51.10±0.04[e]	64.22±0.03[d]	72.34±0.02[c]	84.60±0.06[b]	88.46±0.03[a]
Net Protein Utilization	34.10±1.01[f]	45.08±0.06[e]	60.05±0.03[d]	66.10±0.06[c]	70.45±0.04[b]	80.35±0.03[a]
Protein Efficiency Ratio	3.50±0.05[f]	4.20±0.01[e]	4.06±0.03[d]	5.02±0.02[c]	6.05±0.0[b]	6.30±0.03[a]
Net Protein Ratio	2.60±0.05[f]	3.30±0.02[e]	5.12±0.01[d]	6.20±0.03[c]	7.80±0.02[b]	8.20±0.01[a]

Values are mean± standard deviation of fifteen panelists' determinations. Means within the same column with different letters are significantly different at p<0.05. Sample WMM_0 = 100% Wheat; Sample WMM_1 = Wheat 80% + Orarudi 10% + M. oleifera 10%; Sample WMM_2 = Wheat 70% + Orarudi 15% + M. oleifera 15%; Sample WMM_3 = Wheat 50% + Orarudi 25% + M. oleifera 25%.

Table 2: Effects of the diets formulated from casein and Composite-Noodles (Wheat, Mungbean and *Moringa oleifera* Flour Blends) on Haematological Parameters of Wistar rats

Groups/ Parameters	White Blood Cell ($x10^8$/l)	Haemoglobin (g/dl)	Red Blood Cell ($x10^{12}$/l)	Packet Cell Volume (%)	Platelets count (µ)
1	5.01^f±0.01	14.54^f±0.0	4.20^f±0.0	36.20^f±0.01	12.40^f±0.0
2	6.72^e±0.04	15.32^e±0.01	4.77^e±0.01	44.60^e±0.04	15.27^e±0.01
3	6.96^d±0.01	16.14^d±0.02	5.34^d±0.02	46.20^d±0.01	16.44^d±0.02
4	7.84^c±0.00	16.84^c±0.01	5.51^c±0.01	46.60^c±0.00	16.71^c±0.01
5	8.20^b±0.01	19.96^b±0.03	5.80^b±0.03	47.00^b±0.01	18.88^b±0.03
6	9.60^a±0.02	21.04^a±0.05	6.10^a±0.05	50.40^a±0.02	22.01^a±0.05

Values are mean± standard deviation of fifteen panelists' determinations. Means within the same column with different letters are significantly different at p<0.05. Sample WMM_0 = 100% Wheat; Sample WMM_1 = Wheat 80% + Orarudi 10% + M. oleifera 10%; Sample WMM_2 = Wheat 70% + Orarudi 15% + M. oleifera 15%; Sample WMM_3 = Wheat 50% + Orarudi 25% + M. oleifera 25%.

Table 3: Effects of the diets formulated from casein and Composite-Noodles (Wheat, Mungbean and *Moringa oleifera* Flour Blends) on Organ Weights (g) of Wistar rats

Groups/ Parameters (g)	Liver	Kidney	Lungs	Heart
1	3.50^f±0.01	0.45^e±0.0	0.36^f±0.01	0.12^e±0.0
2	4.72^e±0.04	0.53^d±0.01	0.68^e±0.04	0.17^e±0.01
3	5.46^d±0.01	0.81^c±0.02	0.80^c±0.01	0.24^d±0.02
4	5.84^c±0.00	1.04^{ab}±0.01	1.03^b±0.00	0.37^c±0.01
5	6.20^b±0.01	1.09^a±0.03	1.17^a±0.01	0.48^b±0.03
6	6.50^a±0.02	1.14^a±0.05	1.30^a±0.02	0.52^a±0.05

Values are mean± standard deviation of fifteen panelists' determinations. Means within the same column with different letters are significantly different at p<0.05. Sample WMM_0 = 100% Wheat; Sample WMM_1 = Wheat 80% + Orarudi 10% + M. oleifera 10%; Sample WMM_2 = Wheat 70% + Orarudi 15% + M. oleifera 15%; Sample WMM_3 = Wheat 50% + Orarudi 25% + M. oleifera 25%.

Table 4: Mean sensory scores of noodles produced from wheat, mungbean, and *Moringa oleifera* flour blends

Noodles	Appearance	Flavour	Taste	Mouthfeel	Overall acceptability
WMM_0	8.10^a±0.04	8.00^a±0.01	8.35^a±0.05	7.85^a±.0.02	8.00^a±0.00
WMM_1	7.80^b±0.05	7.65^b±0.05	7.90^b±0.02	7.55^b±0.02	7.75^b±0.04
WMM_2	7.55^c±0.04	7.60^b±0.03	7.75^c±0.01	7.20^c±0.00	7.55^c±0.04
WMM_3	6.00^e±0.01	6.20^c±0.00	6.10^e±0.01	6.25^e±0.02	6.10^e±0.01

Values are mean± standard deviation of fifteen panelists' determinations. Means within the same column with different letters are significantly different at p<0.05. Sample WMM_0 = 100% Wheat; Sample WMM_1 = Wheat 80% + Orarudi 10% + M. oleifera 10%; Sample WMM_2 = Wheat 70% + Orarudi 15% + M. oleifera 15%; Sample WMM_3 = Wheat 50% + Orarudi 25% + M. oleifera 25%.

Conclusion

This study evaluated the nutrient quality, haematological, and sensory properties of noodles developed from blends of wheat, mung bean, and *Moringa oleifera* seed composite flour blends. The nutritional quality of the formulated diets carried out with weaning albino rats showed that the indices for the rats fed on formulated blend made from *orarudi* and *Moringa oleifera* flours compared favourably with the casein-based diet used as control, than those fed on the nitrogen-free diet, so also were the organ weights (liver, kidney, heart, and lungs) of the rats. The organ weight study equally revealed that the dietary treatments used in this study did not impose cardiac stress or hypertrophy in the test subjects. The scores of hematological parameters of the rats showed that the casein and noodle-based diets used for the experimental feeding study were generally adequate for the maintenance of healthy nutritional status in weaning rats. The sensory properties of the samples revealed that acceptable and highly nutritious noodles could be produced from blends of wheat flour, *orarudi,* and *Moringa oleifera* seed flours. Based on the findings obtained in this present study, there is a need to take prototypes of these noodle samples for commercial production for the noodle-producing industries in developing countries like Nigeria. There is a need to educate the public on the nutrient benefits of incorporating composite flours from *orarudi* and *Moringa oleifera* seeds in food preparations at home.

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Plate 1: Image of Noodle Sample (100% wheat noodle)

Plate 2: Image of the Composite Noodle (80% Wheat: 10% Orarudi :10% *Moringa* oleifera)

Plate 3: Image of the Composite Noodle (70% Wheat : 15% Orarudi :15% *Moringa* oleifera)

Plate 4: Image of the Composite Noodle 50% Wheat:25% Mungbean:25% *Moringa* oleifera).