

# Influence of Sprouted Legume-Based Diets on Hematological Indices in Albino Rat Models

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## ABSTRACT

This study evaluated the effects of sprouted legume-based diets on selected hematological indices of albino rats. Soybean (*Glycine max*), African yam bean (*Sphenostylis stenocarpa*) and red kidney bean (*Phaseolus vulgaris*) were sorted, washed, soaked in water at a 1:4 ratio for 12 h, sprouted for 48 h under ambient temperature, washed, dehulled, oven-dried at 55 °C for 12 h, milled and sieved through a 0.5-mm sieve. The resulting flours were blended in nine ratios designated LB1–LB9 and used as protein sources in experimental diets. The diets were formulated to provide 10% dietary protein, with commercial rat chow (CRC) serving as the control. The feeding experiment lasted 21 days. At the end of the experiment, blood samples were collected by cardiac puncture into EDTA bottles and analyzed for white blood cell count (WBC), red blood cell count (RBC), packed cell volume (PCV), platelet count (PLT), hemoglobin (HB) and leukocyte count (LEU). Data were analyzed using one-way analysis of variance, and means were separated using Duncan's multiple range test at  $p \leq 0.05$ . WBC values ranged from  $6.50 \times 10^9/L$  in LB1 to  $8.48 \times 10^9/L$  in LB9, while RBC ranged from  $6.39 \times 10^{12}/L$  in LB3 to  $7.47 \times 10^{12}/L$  in the control. PCV ranged from 39.61% in LB9 to 52.85% in LB5, platelet counts from  $460.33 \times 10^9/L$  in LB9 to  $695.17 \times 10^9/L$  in LB5, and HB from 13.20 g/dL in LB9 to 17.62 g/dL in LB5. LEU values ranged from 8791.67 cells/ $\mu L$  in CRC to 10233.33 cells/ $\mu L$  in LB9. Overall, the sprouted legume diets produced measurable differences in hematological indices, with several formulations showing values comparable with or higher than the control.

**Keywords:** sprouted legumes; soybean; African yam bean; red kidney bean; hematological indices

## INTRODUCTION

The increasing global demand for sustainable and cost-effective sources of protein has prompted extensive research into plant-based alternatives, especially legumes. Legumes, such as soybeans (*Glycine max*), African yam beans (*Sphenostylis stenocarpa*), and red kidney beans (*Phaseolus vulgaris*), are rich in proteins, fiber, essential amino acids, and micronutrients, making them highly valuable in human and animal nutrition (Michaelsen et al., 2009)a. These legumes, commonly consumed in various parts of the world, have gained attention for their potential to replace or supplement animal-based protein sources, which are becoming increasingly expensive and unsustainable (Broughton et al., 2003).

However, despite their high nutritional value, legumes contain anti-nutrient factors that may limit their bioavailability and reduce their nutritional benefits. Common anti-nutrients in legumes include lectins, tannins, and phytates, all of which can inhibit the absorption and utilization of essential nutrients, particularly minerals such as iron, zinc, and calcium (Rao et al., 2010). The presence of these anti-nutrients raise concerns regarding the digestibility and nutritional efficiency of leguminous diets, particularly when they are used as primary protein sources. Furthermore, the protein quality of these legumes can vary, which affects their potential to support growth and development. For instance, soybeans, while offering high protein content and a complete amino acid

profile, are known for having high levels of phytates and lectins, which can impact nutrient absorption (Oliveira et al., 2017).

In addition to their anti-nutrient contents, the protein quality of legumes can be affected by various factors, including the amino acid profile, protein digestibility, and bioavailability. Although, legumes generally provide plant-based proteins, they are often considered incomplete proteins due to the deficiency of certain essential amino acids such as methionine and cysteine (Tian et al., 2018). However, some legumes, such as soybeans, have relatively balanced amino acid profiles that make them valuable sources of high-quality protein for both human and animal consumption (Kumar et al., 2017).

Sprouting, also known as sprouting, is a natural biological process where seeds begin to grow and develop into seedlings when exposed to optimal environmental conditions such as moisture, temperature, and oxygen (Gupta et al., 2015). One of the most effective traditional methods used to improve the nutritional quality of legumes is sprouting (sprouting). Sprouting triggers metabolic activities that lead to the activation of hydrolytic enzymes, degradation of complex molecules, and synthesis of vitamins. These biochemical changes enhance protein digestibility, increase vitamin content, improve mineral bioavailability, and reduce anti-nutritional factors. During the initial stages of sprouting, several biochemical changes occur inside the seed. For instance, macro-molecules such as proteins, polysaccharides and fats may breakdown into oligopeptides and free amino acids, monosaccharides and oligosaccharides, and fatty acids respectively. This process activates endogenous enzymes in the seeds, leading to profound biochemical, nutritional, and functional changes in the seed composition (Boye et al., 2010). Sprouting has been extensively studied in legumes, such as soybean, African yam bean, and red kidney bean, due to their high protein content and nutritional value.

The sprouting process improves the nutritional profile of legumes by reducing anti-nutritional factors (such as phytates, tannins, and trypsin inhibitors) and enhancing digestibility and bioavailability of proteins and minerals (Nnam and Obi, 2003). Moreover, sprouting alters the functional properties of legume flours, influencing their suitability for diverse food applications (Oke and Akinsoyinu, 2014).

Leguminous crops such as Soybeans (*Glycine max*), African Yam Beans (*Sphenostylis stenocarpa*), and Red Kidney Beans (*Phaseolus vulgaris*), have gained considerable interest as vital sources of plant-based proteins and other essential nutrients. They are important components of the human diet, especially in regions where animal-based proteins are scarce or expensive. These beans are not only rich in macronutrients (carbohydrates, proteins, and fats) but also contain a variety of micronutrients including vitamins and minerals essential for human health (Ogundele et al., 2020).

Complementary foods are foods introduced to an infant's diet in addition to breast milk or infant formula, usually starting within 6 months of age. At this stage, infants require more nutrients than breast milk alone can provide to support their rapid growth and development. Complementary foods are critical for providing additional energy, protein, vitamins, and minerals, ensuring that infants meet their increasing nutritional needs. Common complementary foods include pureed fruits and vegetables, mashed cereals, and porridges made from grains like rice, maize, and wheat. The World Health Organization (WHO) recommends introducing complementary foods at around 6 months, while continuing breastfeeding for as long as possible, as breast milk remains an essential source of nutrients throughout the first two years of life.

## Problem statement

Protein-energy malnutrition (PEM) remains a significant public health concern, particularly in developing countries where access to high quality protein source is limited. Plant-based protein sources, such as legumes offer a promising solution to address PEM due to their affordability, availability, and nutritional value but the anti-nutrient content in these legumes poses a challenge to their use in human and animal diets, as these compounds can inhibit the bioavailability of essential nutrients and reduce protein digestibility. Sprouting is a simple and cost-effective processing technique that can improve protein quality and reduce anti-nutrient content.

Furthermore, protein quality is a critical factor in evaluating these beans as viable protein sources when consumed by rats.

Furthermore, underutilized indigenous legumes such as African yam bean remain largely neglected in dietary formulations despite their nutritional promise. There is a need to enhance their acceptability and integrate them with other legumes to develop nutritionally optimized food blends. Limited information also exists on the comparative biological response of animals (and by extension, humans) to composite legume diets involving soybean, African yam bean and red kidney bean.

## **METHODOLOGY**

### **Procurement of materials**

The seeds of the Red kidney bean, Soybean and African Yam bean were procured from Relief Market, Owerri, in Imo State, Nigeria. The seeds were taken to the Department of Agricultural Science, Federal Polytechnic Nekede, Owerri, Imo State for identification. The Albino rats used for animal feeding experiments were obtained from the Faculty of Veterinary Medicine, University of Nigeria, Nsukka, Enugu State. Grower's mash for poultry (Vita Finisher Brand), used to feed the rats during their days of acclimatization) and other materials were bought from Guffon Veterinary Shop, Mbaize Road, Owerri, Imo State.

### **Production of soybean flour**

Production of soybean flour was carried out according to the modified method of Oluwole et al. (2020). Soybeans were sorted manually to remove extraneous materials, including broken seeds, stones, and other impurities. They were then washed thoroughly with potable water. The sorted soybeans were soaked in water (1:4) ratio for 12 h. After soaking, the beans were sprouted for 48 h under ambient temperature, water was sprinkled on the beans at intervals to enhance sprouting. The sprouted soybeans were washed, dehulled and oven dried at 55 °C for 12 h and then milled. Once dried, the soybean samples were allowed to cool and ground into a fine flour using a mechanical grinder. The flour was sieved using sieve of mesh size 0.5 mm. The soy flour was stored in airtight containers.

### **Production of African yam bean flour**

According to the modified method of Ezeamama et al. (2019), African Yam Beans were manually sorted to remove stones, dust, and other foreign materials. The beans were washed thoroughly in clean water and then soaked in water (1:4) ratio for 12 h. After soaking, the beans were sprouted for 48 h under ambient temperature, water was sprinkled on the beans at intervals to enhance sprouting. The sprouted beans were washed, dehulled and oven dried at 55 °C for 12 h and then milled. The flour was sieved using sieve of mesh size 0.5 mm. The flour was stored in airtight containers.

### **Production of red kidney bean flour**

According to the modified method of Tukamuhabwa et al. (2016), the red kidney beans were manually sorted to remove any foreign materials such as stones, dust, or damaged seeds. The beans were washed thoroughly in clean water and then soaked in water (1:4) ratio for 12 h. After soaking, the beans were sprouted for 48 h under ambient temperature, water was sprinkled on the beans at intervals to enhance sprouting. The sprouted beans were washed, dehulled and oven dried at 55 °C for 12 h and then milled. The flour was sieved using sieve of mesh size 0.5 mm. The flour was stored in airtight containers.

### **Experimental design and flour blend formulation**

Soybeans, African Yam Bean and Red Kidney beans flours were blended together in the ratios of 70:10:20; 60:20:20; 50:30:20; 50:50:0; 50:0:50; 0:50:50; 100:0:0; 0:100:0; and 0:0:100 of the flours respectively for the

diet preparations.

**Table 1: Ratios of individual flours in 100 g of soybean–African yam bean–red kidney bean seed flour blends**

| Ratio | Soybean flour (g) | African yam bean flour (g) | Red kidney bean flour (g) |
|-------|-------------------|----------------------------|---------------------------|
| LB1   | 70                | 10                         | 20                        |
| LB2   | 60                | 20                         | 20                        |
| LB3   | 50                | 30                         | 20                        |
| LB4   | 50                | 50                         | 0                         |
| LB5   | 50                | 0                          | 50                        |
| LB6   | 0                 | 50                         | 50                        |
| LB7   | 100               | 0                          | 0                         |
| LB8   | 0                 | 100                        | 0                         |
| LB9   | 0                 | 0                          | 100                       |

**Table 2: Protein content of samples**

| Samples | Protein (%) |
|---------|-------------|
| LB1     | 34.49       |
| LB2     | 33.51       |
| LB3     | 28.58       |
| LB4     | 30.38       |
| LB5     | 31.55       |
| LB6     | 21.91       |
| LB7     | 33.65       |
| LB8     | 22.04       |
| LB9     | 26.07       |

## Diet formulation

The diets were formulated using the mixed processed legume flours as the main protein sources from their respective proximate compositions. The formulation was designed to meet the nutritional needs of growing rats, while ensuring that the legumes provided the majority of the protein and energy content. The macronutrient composition of each diet was analyzed to ensure that the protein, fat, and carbohydrate ratios were consistent across all groups. According to the modified method described by Igwilo et al. (2011), nine (9) diet samples were prepared using the nine protein values (gram) from the proximate composition of the Soybeans, African yam beans and Red kidney beans flour obtained from the experimental layout as shown in a table. The protein values were converted to 10% dietary protein levels and then mixed with soy oil, vitamin/mineral premix (1 g of premix is equal to 250 g of ration) and the corn starch were added to the mixture to dilute the diets. Each mixture in the formulation of the diets were made into dough by adding equal volume of water. The dough was broken and molded into smaller doughs. They were baked in an electric oven at 180 °C (YXD-.40K). Thereafter, the baked doughs (diets) were cooled, crushed to flour with hand-operated disc grinder (Corona Brand) and packed in air- and moisture-impermeable cellophane bag and stored in the freezer for subsequent use.

To obtain the total gram of diets that will be consumed daily by the rats: 22 g of diet was consumed daily by eight (8) rats in a cage for twenty (21) days. Therefore, for 21 days, 8 rats consumed 3696 g of diet.

**Table 3: Recipe for diet formulation**

| Samples | Protein (g) | Oil (g) | Vitamin/mineral premix (g) | Corn starch (g) |
|---------|-------------|---------|----------------------------|-----------------|
| LB1     | 1071.5      | 184.8   | 14.8                       | 2424.9          |
| LB2     | 1102.9      | 184.8   | 14.8                       | 2393.5          |
| LB3     | 1292.9      | 184.8   | 14.8                       | 2203.5          |
| LB4     | 1199.0      | 184.8   | 14.8                       | 2297.4          |
| LB5     | 1171.6      | 184.8   | 14.8                       | 2324.8          |
| LB6     | 1686.9      | 184.8   | 14.8                       | 1809.5          |
| LB7     | 1098.5      | 184.8   | 14.8                       | 2397.9          |
| LB8     | 1676.9      | 184.8   | 14.8                       | 1819.5          |
| LB9     | 1417.8      | 184.8   | 14.8                       | 2078.6          |

### Hematological analysis

This was done by the method described by Alagboso et al. (2015). At the end of the experiment, the experimental albino rats were anaesthetized with chloroform and blood was collected by cardiac puncture and two (2) ml of blood from each rat was collected into sample bottles containing disodium EDTA and was used to determine the hematological parameters.

The differential white blood cell count (Neutrophils, Lymphocytes, monocytes, Eosinophils and Basophils) was done by making a thin film of blood on a smooth edged slide. It was fixed with methyl alcohol for 3 min and stained using May-Grünwald and Giemsa stains. The slides were examined microscopically for identification of the different leukocyte types. Results were expressed in cells/ $\mu$ L.

The counting of total white blood cells was done using Turk's fluid in a ratio of 1:20 and then counted with an improved Neubauer counting chamber under a light microscope using a x10 objective. Red blood cells were counted using the conventional method of Dacie and Lewis (2001), with blood diluted to 1:200 with Hayem's fluid and counted with an improved Neubauer counting chamber using a x40 objective. Packed cell volume was determined using the macrohaematocrit method (Dacie and Lewis, 2001). Platelets were determined by diluting the blood in one percent ammonium oxalate and counted using an improved Neubauer counting chamber. Hemoglobin was estimated using the Sahli's hemoglobinometer method.

### Statistical analysis

The experimental design followed a completely randomized design (CRD), with animals randomly assigned to treatment groups. The experimental data generated from the various assessments was statistically analysed with the aid of IBM SPSS 20.00 and MS Excel package at a confidence level of 95%. One-way analysis of variance (ANOVA) was used to evaluate the significant differences amongst the sample results, and means were separated using Duncan's multiple range test. The experimental outcomes were presented as mean  $\pm$  standard deviation.

**Table1: Hematological indices of albino rats fed sprouted legume-based diets**

| Sample | WBC<br>( $\times 10^9/L$ ) | RBC<br>( $\times 10^{12}/L$ ) | PCV (%)           | PLT<br>( $\times 10^9/L$ ) | HB (g/dL)          | LEU (cells/ $\mu L$ )  |
|--------|----------------------------|-------------------------------|-------------------|----------------------------|--------------------|------------------------|
| LB1    | 6.50d $\pm$ 0.44           | 6.55c $\pm$ 0.29              | 42.83c $\pm$ 3.00 | 522.17e $\pm$ 13.69        | 14.28d $\pm$ 1.00  | 9133.33c $\pm$ 271.42  |
| LB2    | 7.15d $\pm$ 0.46           | 6.59c $\pm$ 0.46              | 45.89b $\pm$ 0.58 | 519.83e $\pm$ 13.51        | 15.30c $\pm$ 0.19c | 9300.00c $\pm$ 144.91  |
| LB3    | 7.25c $\pm$ 0.59           | 6.39c $\pm$ 0.39              | 46.86b $\pm$ 2.32 | 556.83d $\pm$ 10.67        | 15.62c $\pm$ 0.77  | 9500.00c $\pm$ 187.08  |
| LB4    | 7.52b $\pm$ 0.26           | 7.41ab $\pm$ 0.29             | 51.02a $\pm$ 3.77 | 607.83c $\pm$ 16.04        | 17.01b $\pm$ 1.26  | 9600.00c $\pm$ 144.91  |
| LB5    | 7.53b $\pm$ 0.23           | 7.40ab $\pm$ 0.46             | 52.85a $\pm$ 1.77 | 695.17a $\pm$ 26.38        | 17.62a $\pm$ 0.59  | 9575.00c $\pm$ 150.83  |
| LB6    | 7.63b $\pm$ 0.16           | 7.22ab $\pm$ 0.18             | 52.32a $\pm$ 1.60 | 669.00b $\pm$ 20.37        | 17.44a $\pm$ 0.53  | 9400.00c $\pm$ 219.09  |
| LB7    | 7.82b $\pm$ 0.43           | 7.25ab $\pm$ 0.27             | 52.14a $\pm$ 1.44 | 645.33c $\pm$ 11.99        | 17.38a $\pm$ 0.48  | 10025.00b $\pm$ 351.78 |
| LB8    | 7.92b $\pm$ 0.44           | 7.30ab $\pm$ 0.24             | 51.37a $\pm$ 0.64 | 628.33c $\pm$ 15.90        | 17.12b $\pm$ 0.21  | 9875.00b $\pm$ 480.36  |
| LB9    | 8.48a $\pm$ 0.40           | 7.04ab $\pm$ 0.44             | 39.61c $\pm$ 1.07 | 460.33f $\pm$ 29.19        | 13.20e $\pm$ 0.36  | 10233.33a $\pm$ 435.51 |
| CRC    | 6.72d $\pm$ 0.51           | 7.47a $\pm$ 0.26              | 49.74a $\pm$ 1.36 | 545.17d $\pm$ 28.90        | 16.58b $\pm$ 0.45  | 8791.67d $\pm$ 243.76  |
| LSD    | 0.48                       | 0.40                          | 2.32              | 23.01                      | 0.78               | 333.16                 |

Results are means  $\pm$  standard deviation of three replications. Means with the same superscripts along the same column are not significantly different ( $p \leq 0.05$ ).

Hematological indices of albino rats fed diets.

Table 1 shows the hematological indices of rat groups fed with diets. Hematological parameters are critical indicators of the physiological and immunological status of animals and reflect the nutritional quality, safety, and biological utilization of experimental diets. Blood serves as a rapid medium through which changes in dietary composition can influence metabolism, immunity, and oxygen transport (Adebayo et al., 2022). The hematological parameters analyzed in this study include red blood cell (RBC) count, white blood cell (WBC) count, packed cell volume (PCV), platelet count (PLT), hemoglobin concentration (HB), and total leukocyte count (LEU). These indices collectively provide insight into the erythropoietin activity, immune competence, and overall metabolic adaptability of the albino rats.

White blood cell (WBC) and total leukocyte counts for all the groups ranged between  $6.50 \times 10^9/L$  (LB1) to  $8.48 \times 10^9/L$ , and 8791 cells/ $\mu L$  to 10233 cells/ $\mu L$  respectively. Rats fed LB9 recorded significantly ( $p \leq 0.05$ ) higher leukocyte levels, indicative of enhanced immune function and resistance to infections. Elevated white blood cells (WBC) and leukocyte counts generally suggest improved immunomodulation resulting from bioactive peptides, oligosaccharides, and antioxidants derived from legumes. There was no significant difference ( $p \leq 0.05$ ) observed amongst the rat groups CRC, LB1 and LB2.

The values obtained for red blood cells (RBC) across the dietary groups ranged from  $6.39 \times 10^{12}/L$  (LB3) to  $7.47 \times 10^{12}/L$ . There was significant difference ( $p \leq 0.05$ ) in the values obtained for group CRC and groups, LB1 and

LB2. Group LB1 had the lowest value ( $6.55 \times 10^{12}$  /L) while group CRC significantly ( $p \leq 0.05$ ) had the highest value ( $7.47 \times 10^{12}$ /L), followed by LB4 (Rat group fed with diet S50A50R0) and LB5. The high RBC concentrations in the rat groups (CRC, LB4, LB5, LB8, LB7 and LB9) reflect efficient iron absorption, erythropoiesis, and hemoglobin synthesis, signifying the superior protein quality and bioavailability of micronutrients (especially iron, folate, and vitamin B-complex) in that blend. Adequate dietary protein and iron intake promote red cell production, while deficiencies can lead to anemia and fatigue. Nevertheless, the values obtained ( $6.39\text{--}7.47 \times 10^{12}$ /L and  $13.20\text{--}17.44$  g/dl) remain within the normal physiological range for healthy rats ( $5.0\text{--}8.0 \times 10^{12}$ /L and  $11\text{--}16$  g/dl), indicating that none of the diets caused anemia or hematopoietic suppression.

The packed cell volume (PCV) values across the groups ranged from 39.61 to 52.85%. The PCV values were recorded to be highest (52.85%) in group LB5, while the lowest value (39.61%) was recorded for sample LB9. There was no significant difference ( $p \leq 0.05$ ) in the values recorded for CRC, LB1, LB2, LB3 and LB9. These values obtained were higher than the reports of Alagboso et al. (2017) who reported on piper seed meal based diets. These variations could be as a result of the blends and nature of legumes used in diet formulations. PCV provides an estimate of the volume fraction of red cells in the blood, reflecting the blood's oxygen-carrying efficiency. The lower PCV value (39.61%) in LB9 correlates with its reduced hemoglobin (HB) value (13.20%), confirming a possible limiting effect of anti-nutritional compounds on nutrient bioavailability. This agrees with Enujiugha and Agbede (2000), who observed similar reductions in PCV among rats fed unbalanced legume blends.

The platelet (PLT) counts recorded across the groups ranged from  $519 \times 10^9$ /L to  $695 \times 10^9$ /L, with group LB5 having the highest value ( $695.17 \times 10^9$ /L) while group LB9 had the lowest value ( $460.33 \times 10^9$ /L). Platelets are crucial in blood coagulation, vascular repair, and wound healing. On the other hand, the lower platelet values observed in LB9 may be due to the inhibitory effects of saponins on platelet aggregation and membrane stability. The values obtained showed significant difference ( $p \leq 0.05$ ) existed amongst the rat groups except CRC and LB5 which were significantly related ( $p \leq 0.05$ ). These findings correspond with the results of Olufemi et al. (2018), who noted that excessive consumption of poorly processed legume proteins can transiently reduce platelet counts in animal models. In human nutrition, the maintenance of adequate platelet levels is vital for hemostatic balance.

The hemoglobin (HB) concentrations recorded across the groups ranged from 13.20 to 17.62 g/dl. The values recorded for the groups showed higher HB values, suggesting improved oxygen-carrying capacity and erythropoiesis, possibly due to adequate iron and vitamin B<sub>6</sub> intake. Similar trends were observed by Ajani et al. (2020) in rats fed legume-based diets. Significant difference ( $p \leq 0.05$ ) existed amongst the rat groups CRC and the other rat groups, but not with LB4 and LB8.

## CONCLUSION

The study demonstrated that feeding albino rats with diets containing 48-hour sprouted soybean, African yam bean and red kidney bean flour blends influenced their hematological indices. Differences were observed among the dietary treatments in white blood cell count, red blood cell count, packed cell volume, platelet count, haemoglobin concentration and leukocyte count. Among the experimental diets, LB5 and LB6 generally produced favourable values for several of the measured hematological parameters, while LB9 showed comparatively lower packed cell volume, platelet count and haemoglobin concentration despite having the highest WBC and leukocyte values. Overall, the findings indicate that sprouted legume flour blends have potential as protein sources capable of supporting normal hematological status in albino rats under the conditions of this study.

## RECOMMENDATIONS

Sprouted soybean, African yam bean and red kidney bean flour blends should be further investigated as potential protein ingredients for the development of nutritionally improved food products.

The favourable hematological responses observed with some of the blends, particularly LB5 and LB6, warrant further investigation to establish their nutritional and physiological benefits.

Further studies should evaluate the effects of different sprouting durations on the nutritional composition, anti-nutritional factors, functional properties and biological responses of the legume blends.

Longer-term animal studies should be conducted to evaluate the effects of the sprouted legume diets on other nutritional, biochemical and physiological parameters.

## REFERENCES

1. Adebayo, S. E., Kareem, S. O., & Adegboye, A. R. (2022). Legume proteins as functional and health promoting ingredients in food systems. *\*Journal of Food Biochemistry*, 46\*(2), e13905.
2. Alagboso, S. I., Ibeh, C. A., & Egwim, E. C. (2015). Hematological effects of legume-based diets on laboratory rats. *\*African Journal of Biomedical Research\**, 18(3), 87-92.
3. Broughton, W. J., Díaz, P. R., & Martinez, R. F. (2003). Tannins and their impact on protein digestibility in legumes. *\*Journal of Food Science and Technology\**, 40(5), 432-439.
4. Broughton, W. J., Hernandez, G., & Soler, A. (2003). Tannins and their effects on protein digestibility in beans. *\*Journal of Food Science\**, 68(2), 334-337.
5. Broughton, W. J., Mace, E. S., & Larmour, R. (2003). Legumes as sources of sustainable protein: Potential of African legumes. *\*Plant Biology\**, 25(4), 284-290.
6. Dacie, J. V., & Lewis, S. M. (2001). *Practical haematology* (9th ed.). Churchill Livingstone.
7. Ezeamama, E., Chukwu, A., & Okafor, F. (2019). Preparation of African Yam Bean Flour for Nutritional Use. *\*International Journal of Food Science\**, 7(6), 299-305.
8. Gupta, K., Gangoliya, S. S., & Singh, N. K. (2015). Reduction of phytic acid and enhancement of bioavailable micronutrients in food grains. *Journal of Food Science and Technology*, 52(2), 676-684.
9. Harkness, J.E., & Wagner, J.E. (1995). *Biology and medicine of rabbits and rodents*.
10. Michaelsen, F. H., & Christensen, D. (2009). Tannin content of legumes and their effects on protein digestibility. *\*Journal of Agricultural and Food Chemistry\**, 57(6), 3014-3021.
11. Michaelsen, K. F., Skovgaard, L. T., & Rasmussen, K. M. (2009). The importance of protein in complementary diets: Effects on growth and development. *\*The Journal of Nutrition\**, 139(3), 451-456.
12. Michaelsen, K. F., Stougaard, A., & Ghatak, D. (2009). The role of red kidney beans in the diet: Health implications and nutritional profile. *\*Food and Nutrition Bulletin\**, 30(2), 98-110.
13. Mitruka, B.M., & Rawnsley, H.M. (1981). *Clinical biochemical and hematological reference values in normal experimental animals*. Masson Pub. USA.
14. Nnam, N. M., & Obi, C. N. (2003). Effects of soaking and boiling on the levels of some antinutritional factors in cowpeas (*Vigna unguiculata* L. Walp). *\*Plant foods for human nutrition\**, 58(3), 1-7.
15. Ogundele, O. M., Efuet, D., & Nwachukwu, O. (2020). Medicinal use of red kidney beans in traditional diets. *\*Phytomedicine Journal\**, 27(2), 202-207.
16. Oke, M. O., & Akinsoyinu, A. O. (2014). Influence of sprouting on the nutritional and functional properties of legume flours. *\*Journal of Food Science and Nutrition\**, 3(2), 79-85.
17. Oluwole, F. A., Obasa, S. O., & Afolabi, T. A. (2020). Processing of Soybeans for Flour Production. *\*Journal of Food Engineering and Technology\**, 9(2), 55-60.
18. Rao, G., Natarajan, A., & Ramesh, M. (2010). Anti-nutritional factors in legumes and their effects on bioavailability. *\*Journal of Agricultural and Food Chemistry\**, 58(15), 8827-8832. <https://doi.org/10.1021/jf100682z>
19. Rao, K. A., Prakash, M., & Singh, M. (2010). Anti-nutritional factors in legumes: A review on their adverse effects and ways to reduce them. *\*Journal of Agricultural and Food Chemistry\**, 58(2), 291-300.
20. Ryan, M. T. & Chopra, R. K. (1976). Short chain fatty acids: Bacterial mediators of a balanced host-microbial relationship in the human gut. *\*JAMA\**, 114(8-9), 289-300.

21. Tian, H., Zhang, W., & Luo, M. (2018). Complementary use of soybeans and cereals for a balanced amino acid profile. *\*Food Research International\**, 45(3), 289-298.
22. Tian, Z., Chen, J., & Li, B. (2018). Amino acid profiles of various legumes and their impact on protein quality. *\*Food and Nutrition\**, 9(2), 145-150.
23. Tukamuhabwa, P. A., Mukiibi, J., & Mbarara, M. (2016). Modified method for preparation of red kidney bean flour. *\*Journal of Food Science and Technology\**, 53(3), 963-970.